North Atlantic
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ENCLOSURE 1 TO NYN-93083

REVISION 4 TO THE SEABROOK STATION EVACUATION TIME ESTIMATE STUDY

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EVACUATION TIME ESTIMATE

STUDY

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LIST OF EXHIBITS

1. INTRODUCTION

This report describes the analyses undertaken, and the results obtained, in a study to update the existing Evacuation Plan for Seabrook Station, located in Seabrook, New Hampshire. This plan is designed to protect the health and safety of the public in the event that an emergency evacuation is ordered as a protective action in response to an accident at Seabrook Station.

This effort was performed over the period extending from mid-August 1985 to the date of this publication. During the initial development phase, seven Progress Reports were prepared. The first of these was published on November 11, 1985 and the final one on April 7, 1986. These Progress Reports were combined and edited to form an initial Draft Report dated May 1, 1986, subsequently revised on June 2, 1986.

The Progress Reports were reviewed and commented upon by the Federal Emergency Management Agency (FEMA). Other reviews were undertaken by the Civil Defense Agencies of Massachusetts and New Hampshire. This document includes responses to these reviews as well as editorial changes designed to enhance the report. In addition, work products developed by other consultants to the State Civil Defense Agencies were incorporated, where appropriate. Finally, local and State public officials, as well as private citizens, were interviewed. In particular, we wish to express our appreciation to all the Police Chiefs of the communities within the Seabrook Station Emergency Planning Zone (EPZ) who provided valued guidance in the development of this plan.

Other guidance is provided by documents published by federal government agencies. Most important of these are:

Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants, NUREG 0654/FEMA-REP-1, Rev. 1, November 1980.

Analysis of Techniques for Estimating Evacuation Times for Emergency Planning Zones, NUREG/CR-1745, November 1980.

State of the Art in Evacuation Time Estimate Studies for Nuclear Power Stations, NUREG/CR-4831, March, 1992

1.1 Overview of the Plan Update Process

The following outline presents a brief description of the work effort in chronological sequence:

1. The initial effort consisted of gathering information:

   o Initial meeting with the Massachusetts Civil Defense Agency (MCDA) to define the scope of work.

   o Review of existing reports describing past evacuation studies.

   o Conducted a field survey of the EPZ highway system in 1992 and of beach-area traffic conditions during the last two weeks in August 1985 and over the Labor Day Weekend. Beach area parking and vehicle occupancy studies were conducted during the July 4, 1992 holiday weekend.

   o Retained a subcontractor to acquire data describing beach traffic in the Salisbury-Seabrook-Hampton area on the weekends of August 24th and 31st (Labor Day weekend) 1985 and the mid-week period between these weekends.

   o Developed a survey instrument to solicit data describing the travel patterns, car ownership and household size of the population within the Seabrook EPZ. This survey also obtained data on the public's projected responses to an emergency at Seabrook Station.

   o Retained a subcontractor to conduct a stratified random-sample telephone survey of the populace within the Seabrook EPZ in the summer of 1992.

   o Conducted onsite interviews with emergency planning personnel (fire departments, police departments, State Troopers, planning personnel, public works departments, town managers); town elected officials; regional planning

agencies; Chambers of Commerce; State Park Departments, highway and planning officials; and citizen emergency planning committees.

- Obtained 1990 U.S. Census Data.

- Obtained demographic data from state planning offices.

- Received, and analyzed, aerial photographs of the coastal areas within the Seabrook EPZ. These photographs were taken on weekends during August 1985 and July 1987. During July, 1992, additional aerial photography was undertaken. Results of the analysis of the 1992 photographs indicated lower beach population than was previously noted. Due to better weather conditions present on the earlier photographs, we retained the population observed on them.

2. After reviewing and analyzing this information, it was decided to proceed with the task of preparing the preliminary input stream for the IDYNEV model.

   - Estimated the traffic demand based on the available information derived from census data, from prior studies undertaken by the NRC, data provided by local and state agencies and from the telephone survey.

   - Employed the procedures specified in the 1985 Highway Capacity Manual (HCM) and the data acquired during the field survey, to estimate the capacity of all highway segments comprising the evacuation routes.

   - Developed the link-node representation of the evacuation network, which is used as the basis for computer analysis, which calculates the Evacuation Time Estimates (ETE). The IDYNEV System, developed by KLD for FEMA, was used to perform these calculations.

   - Prepared the input streams for the IDYNEV System.

- o Executed IDYNEV to provide the initial estimates of evacuation routing and Evacuation Time Estimates (ETE) for a single scenario.

3. Based primarily on the survey results, the distributions of Trip Generation times were estimated for the various population segments: permanent residents and transients (i.e., tourists and employees).

4. Evacuation scenarios were defined. These scenarios reflect the variation in demand, trip generation distribution and in highway capacity, associated with different seasons, day of week, time of day and weather conditions.

5. Updated the demand estimation of employees who work within the EPZ, based on more recent information obtained from State Labor agencies.

6. Defined a preliminary set of traffic management tactics to be applied at specified Traffic Control Posts (TCP), for subsequent review by local and State Police personnel.

7. Updated and expanded the preliminary ETE results to reflect the recent information quantifying the current employment estimates.

8. Partitioned the EPZ into Emergency Response Planning Areas (ERPA), then defined "Regions", where each region consists of a grouping of contiguous ERPA. Each region either approximates a circular area or a quadrant within the EPZ, as required by NUREG 0654. Each ERPA is an aggregation of two or more adjoining communities.

9. Conducted sensitivity tests with the IDYNEV model to quantify the change in ETE associated with different beach-area populations.

10. Assigned Host Communities to each community within the EPZ and developed traffic routing patterns for evacuating vehicles.

11. Conducted an initial survey of police chiefs within the EPZ to solicit their opinions and recommendations on traffic routing, control and management. The preliminary design (items 6 and 10, above) was used as the basis for discussion. The traffic management plan was subsequently reviewed with state and local law enforcement officials in 1991 and 1992 to obtain changes and updates.

12. Using the traffic management policies derived in step 11, a complete set of ETE was computed. This set consists of over 134 distinct cases; eac[illegible]ase corresponds to the evacuation of a specified <u>region</u> for a specified evacuation <u>scenario</u>. A total of 13 regions and 10 scenarios were considered plus four scenarios for the beach region.

13. Documented the results of these studies in formats responsive to NUREG 0654.

14. Identified Access Control Posts (ACP) at locations along the periphery of the EPZ and developed traffic management control to be applied there.

15. Identified a diversion route circumventing the EPZ.

16. Estimated demand for transit services for persons at home. Determined the number of bus tr[illegible] buses required for each route within each communit[illegible] Th[illegible]e estimates were based on the survey data base and [illegible]lysis of route travel times.

17. Determined the ETE for all transit activities.

18. Designed a procedure to confirm the evacuation process and estimated person resources for its implementation.

19. Discussed the advisability of aerial, patrol, and fixed point surveillance and the stationing of tow trucks at strategic locations inside the EPZ and along its periphery.

1.2 Description of the Emergency Planning Zone (EPZ)

The Seabrook Station site is located near the northern boundary of the town of Seabrook in Rockingham County, New Hampshire, approximately 2 miles west of the Hampton Harbor Inlet.

The Emergency Planning Zone (EPZ) for the plume exposure pathway includes 6 communities in Essex County, Massachusetts and 17 communities in Rockingham County, New Hampshire:

Massachusetts	New Hampshire	
Amesbury	Brentwood	Newfields
Merrimac	East Kingston	Newton
Newbury	Exeter	North Hampton
Newburyport	Greenland	Portsmouth
Salisbury	Hampton	Rye
West Newbury	Hampton Falls	Seabrook
	Kensington	South Hampton
	Kingston	Stratham
	New Castle	

Portsmouth and Newburyport are cities. The other communities are towns.

Figure 1-1 displays the general site area including the location of Seabrook Station (Δ), the EPZ boundary, all communities within the EPZ, the major highways in the area and the Host Communities (*) where the reception centers are located. Figure 1-2 indicates the geographical area around Seabrook Station.

The coastal area extending from Plum Island, Massachusetts, in the town of Newbury, northward to Portsmouth, New Hampshire is a popular summer tourist attraction. To a large extent, the most popular beach areas are separated from the mainland by marshlands. The topography east of Interstate Route 95 is mostly flat. To the west of I-95, the country side is rolling with some hills exceeding 300 feet in elevation.

There are many lakes, rivers and streams within the EPZ. The most prominent of these are the Merrimack River which is about 5 miles south of Seabrook Station, the Squamscott River about 8 miles to the northwest, Lake Attitash about 7 miles to the southwest and several large ponds in Kingston about 10 miles to the west.

The highway system is comprised primarily of two-lane two-way highways. The major routes include the Interstate Routes 95 and 495. The former is four lanes wide in each direction throughout most of its length within the EPZ although it narrows to three lanes where it crosses the Piscataqua River into Maine, on the north, and the Merrimack River toward the south. Interstate 495 is two lanes in width in each direction where it joins I-95 but widens to three lanes about two miles south of that point.

Other limited access highways include the Spaulding Turnpike, two lanes in each direction, at the northern extremity of the EPZ and Route 51/101, which is the major east-west route in the area, and offers one lane in each direction within the EPZ.

Major routes which are not limited access include the north-south U.S. Routes 1 and 1A. Route 1 is parallel to the coast and about 3-4 miles inland. Access to Route 1 is limited in the Newburyport area but is at grade elsewhere; Route 1 is three lanes wide throughout most of its length in New Hampshire, four lanes wide in Newburyport, and mostly two lanes (one in each direction) elsewhere. Route 1A is the coastal route and provides two lanes in each direction for a portion of its length and one lane elsewhere. Other important routes, with one lane in each direction, are State Routes 84, 85, 87, 88, 101, 107, 107A, 108, 110, 111, 113, 125, 151 and 286. See Figure 1-1 for locations.

This area enjoys a variable climate with temperature ranging from well below zero (F) in the winter to as high as 100 degrees (F) in the summer. Average annual rainfall is about 43 inches while snowfall averages about 63 inches. The monthly variations in temperature and precipitation in Durham, New Hampshire over 3 decades is given in Table 1-1.

1.3 Preliminary Activities

Since this plan constitutes an update of prior work, it was necessary to familiarize ourselves with the existing plan. These activities are described below.

Initial Meeting: Defining the Scope of Work

The initial activity was a meeting in 1985 with staff of the Massachusetts Civil Defense Agency (MCDA). At that meeting, MCDA staff outlined the scope of our activities:

- To update the current evacuation plan and to compute revised Evacuation Time Estimates (ETE).
- To acquire whatever current information is needed for this activity.
- To meet with the six EPZ Planning Committees in Massachusetts to solicit information, to describe the activities which are being undertaken and to address any concerns which are expressed.
- To cooperate with all other emergency planning groups and public officials and emergency personnel, both in Massachusetts and New Hampshire.
- To report all progress to, and accept direction from, MCDA staff.

A subsequent meeting was held in Concord, New Hampshire at the office of the New Hampshire Office of Emergency Management (NHOEM). That meeting served to extend the scope of the effort to include that portion of the EPZ which is in New Hampshire.

The 1992 ETE update work effort was based upon discussions with the emergency planning staff of Seabrook Station. Out of these discussions was developed a scope of services which is reflected in the Revision 4 text and figures contained within this report.

Literature Review

KLD Associates was provided with copies of documents describing past studies and analyses leading to the development of evacuation plans and of ETE. We also obtained supporting documents from a variety of sources, which contained information needed to form the data base used for conducting evacuation analyses.

Appendix E is a listing of the major sources of information and includes brief descriptions and summaries of the data contained therein.

Field Surveys

KLD professional personnel drove the entire highway system within the EPZ and for some distance outside. Each driver recorded the characteristics of each section of highway on audio tape. These characteristics include:

- Number of lanes
- Pavement width
- Shoulder type & width
- Intersection configuration
- Lane channelization
- Unusual characteristics: Narrow bridges, sharp curves, poor pavement, flood warning signs, inadequate delineations, etc.
- Posted speed
- Actual free speed
- Abutting land use
- Control devices
- Interchange geometries
- Geometries: curves, grades

The audio cassettes were then transcribed. This information was referenced while preparing the input stream for the IDYNEV model.

Field surveys were performed both during weekdays and on weekends. Much of the time on the August 1985 weekends was spent at the beach areas. Unfortunately, congested conditions were limited along the beach access roads for these weekends due to mild -- but not hot -- weather, plus occasional rain. One Saturday night, however, the weather was pleasant and the beach areas were crowded.

Additional field surveys were performed, primarily on the beach areas, over the July 4th weekend, 1986. The weather was good on Friday, July 4th with crowded beaches; pleasant on Saturday morning, July 5th, becoming cloudy with some rain in the afternoon; cloudy with rain on Sunday, July 6th. This survey gathered data on vehicle occupancy. Additional vehicle ground count surveys and vehicle occupancy counts were conducted over the July 4, 1992 weekend. Data from the 1992 surveys indicated lower beach occupancy, but earlier data were used due to the better weather conditions present during the earlier surveys.

Aerial photographs at the beach areas were taken on July 18, 1987 together with supporting ground surveys of traffic movement. Additional aerial photography of beach areas were performed during July, 1992. However, due to better weather conditions present during earlier photography, the earlier data were used.

<u>Telephone Survey</u>

A telephone survey was undertaken in order to gather information needed for the evacuation study. Appendix F exhibits the survey instrument. Appendix G contains tabulations of some of the data compiled from the survey returns.

This data was utilized to develop estimates of vehicle occupancy during an evacuation and to estimate elapsed times between notification of an emergency and the start of evacuation trips. This data base was also referenced to estimate the number of transit-dependent residents and commuter traffic patterns.

<u>Onsite Interviews</u>

KLD personnel visited the EPZ area on a bi-weekly basis during the first 2 1/2 months of the original work effort. Each visit consisted of from 2 to 4 days; each day included several interviews with different groups of people.

These interviews consisted primarily of KLD personnel acquiring information which could prove useful for developing an evacuation plan. Participants in these interviews included town police and fire chiefs, emergency planners, public work supervisors, town managers, elected officials, chamber of commerce personnel, state planning and

elected officials, chamber of commerce personnel, state planning and highway personnel, regional planning commission personnel, state parks personnel, and state emergency planning personnel. KLD was invited to address two citizen emergency planning committees in Massachusetts. At these meetings, the work effort was described and questions answered. Visits were also made to the Seabrook Station to gather information.

ASLB Litigation

This Evacuation Time Estimate Study was extensively litigated as part of the Atomic Safety and Licensing Board (ASLB) hearings on the New Hampshire Radiological Emergency Response Plan (NHRERP) and Seabrook Plan for Massachusetts Communities (SPMC). These hearings were held periodically from 1987 through 1989. The hearings resulted in two decisions, December 1988 and November 1989, both of which discussed aspects of this study. All important information and studies that were developed to support these hearings and any subsequent ASLB recommendations for changes and or improvements have been incorporated into this study.

Developing the Evacuation Plan

The overall study procedure to develop Evacuation Time Estimates (ETE) is outlined in Appendix D. Particular attention was focused on estimating tourist traffic, especially that which is concentrated in the beach areas. Aerial photographs were obtained which were used to estimate parking capacity at the beach areas and to obtain counts of vehicles parked at the beach areas. Other photographs enabled us to estimate maximum people density on the beach itself.

Demographic data was obtained from several sources, as detailed later in this report. This data was analyzed and converted into vehicle demand data.

Highway capacity was estimated for each highway segment based on the field surveys and on the principles specified in the 1985 Highway Capacity Manual. The link-node representation of the physical highway network was developed using large-scale maps and the observations obtained from the field survey. This network is shown

in Figure 1-3, with the general directions of evacuating traffic indicated thereon.

The input stream for the IDYNEV system was then created, checked, and debugged.

Analytical Tools

A variety of analytical tools was employed for this study. The most prominent of these is the IDYNEV (Interactive DYnamic Network EVacuation) computer system which was developed by KLD under contract with the Federal Emergency Management Agency (FEMA).

IDYNEV consists of three submodels:

- o An equilibrium traffic distribution and assignment model (for details, see Appendix B)

- o A macroscopic traffic simulation model (for details, see Appendix C)

- o An intersection capacity model (for details, see Highway Research Record No. 772, Transportation Research Board, 1980, papers by Lieberman and by McShane and Lieberman).

The procedure for applying IDYNEV within the framework of developing an update to the Seabrook Evacuation Plan is outlined in Appendix D. Appendix A is a glossary of terms used in Traffic Engineering.

The evacuation analysis procedures are based upon the need to:

- o Route traffic along paths of travel that will

  - expedite their travel from their respective points of origin to points outside the EPZ

  - restrict movement toward Seabrook Station to the extent practicable

- disperse traffic demand so as to avoid focusing demand on a limited number of highways

o Satisfy, to the extent possible under emergency conditions, perceived "best" paths out of the EPZ

o Move traffic in directions which are generally radial, relative to the location of Seabrook Station.

A Trip Table, which is a matrix of origin-destination demand volumes, was developed which satisfied the specified linkage between communities within the EPZ and host communities outside the EPZ. The IDYNEV Traffic Assignment model is executed to produce output which identifies the "best" traffic routing, subject to the design conditions outlined above. In addition to this information, [very] rough estimates of travel time are provided, together with turn-movement data required by the IDYNEV simulation model.

The simulation model is then executed to provide a detailed description of traffic operations on the evacuation network. This description enables the analyst to identify bottlenecks and to develop countermeasures which are designed to expedite the movement of vehicles.

As outlined in Appendix D, this procedure consists of an iterative design-analysis-redesign sequence of activities. If properly done, this procedure converges to yield an Evacuation Plan which best services the evacuating public.

TABLE 1-1

CLIMATIC CONDITIONS IN DURHAM, NH: 1951-1980

	Temperature (deg.F)		Rainfall (inches)		Snow (inches)	
Month	Low	High	Mean	Max.	Mean	Max.
Jan.	-30	61	3.51	9.68	16.5	38.5
Feb.	-22	69	3.12	5.88	14.3	48.5
March	-18	82	3.66	10.82	12.0	43.6
April	9	90	3.80	13.35	2.1	9.3
May	22	94	3.57	12.00	0	0.2
June	30	98	3.00	6.88	0	0
July	35	99	3.00	6.69	0	0
Aug.	28	102	3.31	6.97	0	0
Sept.	24	99	3.37	8.40	0	0
Oct.	14	87	3.91	10.50	0.3	3.0
Nov.	3	76	4.70	10.31	3.0	14.5
Dec.	-22	68	4.28	9.72	15.2	36.5

FIGURE 1-1
GENERAL HIGHWAY MAP

2. DEMAND ESTIMATION

The estimates of demand constitute a critical element in developing an evacuation plan. This estimate consists of three components:

1. An estimate of population, stratified into groups, in communities within the EPZ.

2. An estimate, for each population grouping, of mean occupancy per evacuating vehicle. This estimate is used to determine the number of evacuating vehicles.

3. An estimate of potential double-counting of vehicles.

A variation of this approach was applied in order to estimate beach area traffic. This was necessary since the majority of beach traffic consists of transients, most of whom enter the EPZ from locations outside.

As a result, we relied on empirical observation of the number of vehicles to determine the reasonably expected peak population within the beach area. This is a valid approach since discussions with public officials confirmed that, with few exceptions, people at the beach have access to a vehicle. Thus, the evacuation of people from the beach area will be primarily reflected in the number of evacuating private vehicles.

By accurately estimating the number of vehicles within the beach area, we have satisfied the input requirements for an evacuation plan. Estimates of population can be based on accurate estimates of per-vehicle person occupancy. Thus, for the beach area, more reliable estimates are forthcoming if we reverse the sequence of steps 1 and 2, above, by first estimating the number of evacuating vehicles, then using the vehicle-occupancy figure to estimate population.

During the summer season, vacationers and tourists enter the EPZ in large numbers. These non-residents may dwell within the EPZ for the entire season, for a short period (e.g., one or two weeks), for a weekend, overnight, or may enter and leave within one day. Estimates of the size of these population components must be obtained, so that the associated number of vehicles can be ascertained.

The specter of double-counting of people and vehicles must be addressed: a vehicle and its occupants cannot occupy two disparate locations at the same time. Consider a vacationing family that registers at a motel, travels to the beach in the morning, then does some shopping, away from the beach, in the evening before returning to the motel. If we consider a scenario where the accident occurs at about 2:00 PM when the beaches are most crowded, then this family, and its vehicle, would most likely be at the beach. If an evening scenario is being studied, then the vehicle would be at a retail parking lot, or perhaps, back at the motel.

Clearly, since this vehicle cannot be at all 3 locations simultaneously, its location at the instant an order to evacuate is announced, depends on the scenario being studied.

It is seen that the number of vehicles at each location depends on time of day. It is clearly wrong to estimate counts of vehicles by simply adding up the capacities of different types of parking facilities, without considering the whereabouts of the vehicles. For example, motel parking lots which are full at dawn, may be almost empty at noon. Similarly, beach parking lots which are full at noon, may be almost empty at dawn.

Another element that must be considered in an evacuation plan is the need to provide for transit-dependent people. These people may be youngsters in school, persons in institutions without access to private vehicles or who cannot provide for themselves, as well as residents and tourists who do not have access to a private vehicle.

Trip Generation

Evacuation trips do not "just happen". These trips are "generated" at the time the vehicle leaves its "origin" (i.e., driveway of a residence, motel lot, public parking lot, etc.) to begin the evacuation trip.

Between the time notification of a accident is given b activation of sirens to the time that the evacuation trip begin , the evacuees may be performing a sequence of preliminary activities, depending on time-of-day and other scenario considerations:

- o Commuters will prepare to leave work and secure their places of business, if necessary.
- o Commuters will travel home from work.
- o Families will pack clothes and other provisions, and secure their homes (or farms).

Another time lag is notification time -- the elapsed time between the issuance of the order to evacuate, and the receipt of this notice by members of the public.

These elapsed times will vary from one population group to the next, from one scenario to the next and, of course, from one household to the next. Thus, the trip generation time (i.e., the elapsed time between the issuance of the order to evacuate and the beginning of the evacuation trip) will vary from one group of people in a vehicle to another.

We can state that the time lag associated with each preliminary activity can be represented by a statistical distribution which describes the range of elapsed times for the evacuating public. The survey (see Appendix F) obtained information which quantified 3 of these distributions, Figure 2-1 displays these distributions. Both the prior survey results and the 1992 survey results ar presented in the figure. The close match between the two sets of results confirms the validity of the prior survey.

For each scenario, we must perform a series of calculations, using the distributions of Figure 2-1, plus a reasonable estimate of the distribution of notification time, to obtain the distribution of Trip Generation time.

Experience -- and theory -- indicate that ETE is generally insensitive to this distribution of Trip Generation time, whenever the temporal extent of the trip generation process is significantly less than the evacuation time (ETE). This is generally the case when evacuating traffic experiences extensive congestion. On the other hand, when congestion is absent, or limited in spatial and/or temporal extent, then travel time can be small relative to trip generation time. In these cases, the ETE will directly reflect the trip generation time (i.e., ETE = Trip Generation time + [small] travel time).
(See Section 10.)

Permanent Residents

The estimates of permanent population within the EPZ are given in Appendix E, Item 15. The two major sources of these data -- State projections and Town Clerk estimates -- are in general overall agreement, but with some incomplete data at the town level. Therefore, for the 1992 update, we have decided to accept the State estimates since they represent data acquired in early 1991 and may therefore be more accurate.

The second step of the estimation process is presented in Exhibit 2-1. As detailed there, we employ data obtained from the telephone survey to estimate the average person occupancy of vehicles evacuating from the EPZ. Supporting data are presented in Figures 2-2 and 2-3 and in Appendix G. Figures 2-2 and 2-3 also include comparisons between the prior survey and the 1992 results. The comparisons indicate that there is a slightly smaller household size (2.67 vs. 2.87 persons) that arises from analysis of the 1992 survey results. Further, the 1992 survey indicates that slightly more vehicles are available for households with more than three persons than was noted previously. The effects of these changes on the computations presented in Exhibit 2-1 would be to increase [fractionally] the evacuating persons per vehicle estimates. Because of the small increase noted using the 1992 survey data and the fact

that the sample size of the 1992 survey was about 1/2 of the prior survey, we will continue to use a vehicle occupancy value of 2.6 persons.

Using an average vehicle occupancy of 2.6, the number of evacuating vehicles servicing the permanent residents may be calculated. Table 2-1 presents these results.

Table 2-2 presents a comparison of the resident population estimates obtained for the 1990 update and the current effort. The table indicates that the rate of growth of the resident population in the area has slowed, leading to a lower future population estimate.

Beach Population

During the 1992 July 4th holiday, KLD personnel collected data on beach parking demand and vehicle occupancy. The results showed a lower demand than that used for the previous studies. This demand reduction can be attributed to such factors as weather conditions and local and regional economic conditions. We will therefore use the previous beach and transient population estimates so that the resultant ETE has a degree of conservatism associated with it.

An estimate of the beach population was obtained by counting vehicles within the beach area from aerial films. The number of persons was determined by counting the number of people in cars traveling to the beach areas to estimate the average person occupancy.

Our studies indicate that beach population can vary widely, from day to day, depending most strongly on weather conditions. Beach population also varies with time of day. On a sunny day it generally peaks at about 2:00 PM; another, lower, peak occurs at night.

Appendix E, Item 20, presents the beach area vehicle counts based upon an aerial survey done on July 18, 1987. The results of this survey, which was done shortly after noon, were projected to the 2:00 PM peak population period. The peak number of vehicles projected to be present includes vehicles in transit. This total of 30,733 vehicles plus an estimated 2,085 vehicles in beach area parking spaces hidden from aerial observation, provides a reasonable

periods of time. This is based on the use of approximately 90% of the maximum parking capacity which can be estimated at 39,000 spaces. However, this peak-of-peaks is too limited temporally to be of value to the protective action decisionmaker.

It is instructive to compare the estimates of beach area vehicle population presented by other investigators, with those obtained using the earlier aerial photographs taken in 1985. Table 2-3 lists these comparisons. Of course, the data obtained from the 1987 aerial photographs supercedes the earlier data. Aerial photographs obtained in 1992 revealed lower beach area vehicle population than earlier efforts.

It must be emphasized that parking capacities limit the number of people who occupy the beach areas <u>at any point in time</u>. This statistic is quite different from the statistic which quantifies the number of people who visit the beach areas <u>over a 24-hour period</u>. The evacuation plan must consider the reasonably expectable peak traffic which could occupy the beach areas.

According to data collected by HMM Associates in 1983 (see item 9, Appendix E), the peak traffic volume occurred on Saturday, July 16th. Table 2-4 roads: summarizes the traffic counts entering Hampton and Seabrook Beaches over a 24-hour period along all access roads.

Access Road	Direction	Total Entering Traffic (veh.)
Route 51	Eastbound	12,604
Route 1A, north of Route 51	Southbound	11,634
Route 1A, north of Route 286	Northbound	14,659
	Total	38,897

At a mean occupancy of 2.4 persons per vehicle, approximately 93,350 people entered Hampton and Seabrook Beaches over 24 hours. (Of course, some portion of these trips were multiple trips made by the same persons in the same vehicle). Of particular relevance, is the rate of accumulation of vehicles within this beach area as well as the maximum net influx of vehicles on this peak summer weekend day. Table 2-4 presents this data.

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As is indicated in Table 2-4, the maximum net influx occurred in early afternoon at about 2:00 PM and amounted to 5,674 vehicles. This figure compares with a total parking capacity for Hampton and Seabrook Beaches of 10,420 vehicles. Thus, this maximum influx of vehicles, on the most crowded day of 1983 (which was a banner year), consumed about 55 percent of the estimated available parking capacity. This figure confirms other studies (item 6, App. E) which show that about half of all tourists are day-trippers. The maximum net increase in population, at 2.4 persons per vehicle, was about 13,600.

Still another approach that may be used in estimating demand is to compute the maximum person capacity of the (sandy) beach. This approach is valid since peak beach capacity takes place at about 2:00 PM when the net influx approaches zero (note change in sign for the net influx, Table 2-4).

As noted in the Dufresne-Henry report (item 3, App. E), the Hampton Beach sandy area, north to Route 101E, has a capacity which can accommodate 19,000 persons at high tide (the sand is wet below the mean high tide mark and is not used for spreading blankets). Thus, with 2.4 persons per vehicle, on average, a total of 7,917 "car-loads" would fill the beach to capacity. This compares with a parking capacity in that area of about 8,300 cars (7,770 + 500). In addition, a significant number of people park north of Route 101E and in Seabrook Beach, then walk to Hampton Beach or take the shuttle bus. Of course, not all the people in the beach area are on the beach.

In summary, estimates based on differing perspectives of the empirical data base, tend to confirm one-another. Specifically, direct observations of parking capacity <u>and</u> of traffic volumes entering and leaving the area <u>and</u> of the sandy beach person capacity, all provide consistent estimates of vehicle and person population.

Seasonal Housing Residents

The vehicle population on the beach areas, which represents weekend occupancy of seasonal housing there, has already been included in our count of beach parking. However, we must consider the vehicle population which is off the beach areas and which services seasonal residents.

A primary source of double-counting must be considered. If the beaches are packed to capacity, it follows that at least a portion of the vehicles servicing seasonal vacationers located off the beach, will have been driven to the beach and parked there. Of course, some of the seasonal dwellings are close enough to the beach for people to leave their cars and walk to the beach. To the extent that vehicles are driven to the beach, it would be improper to count these vehicles at the seasonal dwelling and at the beach.

In order to estimate tourist population, not included in the beach area vehicle count, we seek an estimate of the number of those vehicles which remain in the EPZ at the time the beach is most crowded, but are not at the beach.

We will, therefore, accept the figures provided by the NRC[1], as shown in Figure 2-4, with the following exceptions:

1. We will exclude from consideration those vehicles at seasonal housing which are located on the beaches, since these vehicles have already been counted. Excluding the vehicles in the seaward sectors of Figure 2-4 from 2 miles, outward, will avoid double-counting of the beach vehicles.

2. Based on discussions with managers of tourist facilities, they estimate that 74 percent of visitors at off-beach facilities will travel to the beach and park their vehicles there, during mid-day peak weekend conditions. We will adopt a conservative factor of 50 percent (i.e., one-half of tourists lodging at inland facilities will drive to the beach on a sunny day).

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[1] See the NRC report prepared by M. Kaltman and referenced in Item 14, Appendix E; also see related text of Item 14.

Note that the NRC estimates assume 2.5 vehicles per dwelling, a figure which we confirmed with an onsite survey. The results are shown in Figure 2-5.

Overnight Accommodations

Again, the vehicles associated with those hotels, motels and guest houses located on the beach area have already been counted. We must also consider vehicles associated with such accommodations which are located off the beach.

The need to avoid double-counting for these vehicles leads to consideration of the following:

- Many patrons of overnight accommodations do not arrive at the facility until late afternoon or early evening, after the beach population has dropped from its peak content.

- Many patrons also leave the area in the early morning before peak conditions occur on the beaches.

- Other patrons stay for several days. Of these:

  - Some depart the facility to go to the beach or some other attraction.

  - The remainder stay at the facility to swim in the pool or walk in the area.

- The number of cars per unit for off-beach motel/hotel accommodations may be less than one because:

  - A family, or friends, travelling in one car may occupy two units.

  - Travelers on one charter bus will occupy many units.

In any event, we seek an estimate of the number of these vehicles which are within the EPZ at the time the beach is most crowded, but not at the beach.

We will accept, as a basis, the NRC count of overnight accommodation units, as shown in Figure 2-6. Based on discussions with managers of tourist facilities, we estimate that about 50 percent of the vehicles servicing these units remain within the EPZ, but not at the beach when peak conditions prevail there. These discussions also revealed that several of the largest hotels set aside blocks of rooms on the weekend for guests who arrive by tour bus, at the rate of about 20 units for one tour bus.

Estimates of guests who utilize more than one unit per car, range from 5 percent to 40 percent. On the basis of this information, we estimate that approximately 0.85 vehicle per unit, is a reasonable expectation.

The results of an analysis to estimate off-beach vehicles at mid-day who remain within the EPZ are shown in Figure 2-7.

Campgrounds

The estimate of the number of vehicles at campgrounds within the EPZ is developed in a manner which is similar to that for seasonal residents. The primary difference is that 2.5 vehicles are assumed for each seasonal dwelling while campground capacity is expressed in terms of sites, where one vehicle per site is standard.

We again accept the NRC data, as shown in Figure 2-8, excluding, as before, the vehicle spaces which were already included in our beach area count. In addressing the issue of double-counting, the considerations are essentially the same as noted earlier for the overnight accommodations.

Based on discussions, campground operators estimate that approximately 75 percent of campground sites are unoccupied by a vehicle during the day when the beach exhibits peak occupancy. Most of these vehicles are driven to the beach areas, with the remainder leaving the area. As a result, the number of additional vehicles, not at the beach, but remaining in the area and must be considered, is shown in Figure 2-9.

Seabrook Greyhound Park

This park, which is located a little over 2 miles west of the Station, has a parking lot with capacity for about 3,100 vehicles, according to the NRC report. We seek an estimate of the maximum number of parked vehicles during the weekend mid-day, when the beach is experiencing peak attendance. Those vehicles belonging to permanent residents must be excluded since they are counted elsewhere. Based on the information available and direct observation, we have estimated a figure of 1,500 vehicles at mid-day. Note that this estimate of 1,500 vehicles excludes those that have already been counted. That is, we assume that these visitors are all day-trippers. Night-time attendance can be double this figure, but would include many tourists and residents who have already been counted.

Parking at Retail Establishments

The NRC report presents an estimate of vehicles parked in lots servicing retail establishments, e.g., shopping centers, restaurants, large stores, municipal lots, etc. This estimate, shown in Figure 2-10, is premised on the assumption of 100 percent occupancy. The applicant indicated that some 40 percent of the spaces are filled at maximum periods during the summer.

Several factors should be considered:

- Do the "maximum periods" occur concurrently with the peak periods of beach attendance?
- What percentage of parked vehicles belong to permanent residents?

We have not been able to acquire data to respond to these questions; therefore, we will make no deductions to account for the possibility that there are different peak periods for shopping and for beach traffic. On the other hand, it is not reasonable to assume that all lots servicing retail establishments are filled to capacity on a day when the weather attracts people to the beach area. Adoption of the estimate of 40 percent occupancy appears to be prudent, in the absence of other empirical evidence. This estimate is shown in Figure 2-11.

Employment

This subject is treated in greater detail in Section 5.

Seabrook Station

Employment at Seabrook Station will probably stabilize in the area of 300-400 after construction is completed. On this basis, we estimate 500 vehicles there, to account for any contractor and visitor vehicles, in addition to commuter vehicles.

Medical-Related Facilities

The NRC report presents estimates of the population of facilities such as hospitals, nursing and retirement homes and other health-related facilities. See Figure 2-12. The number of vehicles associated with this estimate depends on the patients' state of health. Buses can transport up to 40 people; vans, up to 12 people; ambulances, up to 2 people (patients).

Once again, the prospect of double-counting is present. The population of nursing and retirement homes is included in the resident population. Thus, the vehicle estimates for this group have already been determined on the basis of 2.6 persons per vehicle. Since many residents can be transported in buses (up to 40 persons) while others in ambulances (1 or 2 persons), it is reasonable to state that these people are already accounted for, in terms of the resident vehicle count.

Total Demand in Addition to Permanent Population

The total number of vehicles servicing tourists, which are off the beach and are in addition to those servicing permanent residents, is obtained by summing the entries in Figures 2-5, 2-7, 2-9, and 2-11, then adding those at Seabrook Park. These totals are shown in Appendix M.

Uncertainties

Every plan which *forecasts* events which can take place, definitionally involves some uncertainties. Such uncertainties, do not compromise the effectiveness of a plan if they are accounted for in a reasonable manner.

The statistics derived by the NRC and cited in the prior subsections are the outcome of a painstaking effort by HMM Associates. These results were then reviewed and refined by the NRC. Finally, additional data obtained by KLD addressed the issue of double-counting which did not receive attention previously.

The NRC data did not extend beyond the 10-mile radius to the EPZ boundary. We have called the larger facilities and estimate 1,000 additional tourist vehicles may be stored there outside the 10-mile boundary, but within the EPZ.

The towns of Brentwood, Greenland, Kingston and Newfields also have large areas within the EPZ but outside the 10-mile boundary. The first 3 have campgrounds but no hotels; we obtained the necessary information from the respective town governments.

There will be vehicles travelling through the EPZ (external-external trips) at the time of the accident. It is reasonable to expect that, at the time evacuation gets under way, these through travellers will also be evacuating since they are already in their cars. These through vehicles are assumed to travel on interstate routes I-95 and I-495 which are the primary routes through the EPZ. Observation of these highways showed that the level of service (LOS) did not exceed LOS B or C. These levels of service correspond to a range of 2,990 to 6,900 vehicles based on the total lane miles within the EPZ.

For calculation of the ETEs approximately 3,000 vehicles were initially placed upon the highway links. Then for midweek/midday scenarios the origin nodes were programmed to generate 4,400 additional through vehicles during the first hour and 2,200 vehicles during the second hour after the order to evacuate. For weekend and evening scenarios 2,200 and 1,100 vehicles were used for the first and second hour respectively.

Table 2-1. Estimated Vehicle Population - Permanent Residents

Massachusetts	Population Census(1)	Population Estimated(2)	Proj. Pop. (1993)(3,4)	Est. Vehicles (1993)
Amesbury	14,997	15,588	15,349	5,903
Merrimac	5,166	5,502	5,365	2,063
Newbury	5,623	6,244	5,988	2,303
Newburyport	16,317	17,185	16,832	6,474
Salisbury	6,882	8,606	7,870	3,027
West Newbury	3,421	3,774	3,629	1,396
New Hampshire				
Brentwood	2,590	2,586	2,721	1,047
E. Kingston	1,352	1,382	1,438	553
Exeter	12,481	12,294	12,565	4,833
Greenland	2,768	2,781	2,934	1,128
Hampton	12,278	12,172	12,539	4,823
Hampton Falls	1,503	1,528	1,562	601
Kensington	1,631	1,628	1,697	653
Kingston	5,591	5,591	5,946	2,287
New Castle	840	839	821	316
Newfields	888	898	915	352
Newton	3,473	3,495	3,587	1,380
North Hampton	3,637	3,638	3,682	1,416
Portsmouth	25,925	22,260	22,260	8,562
Rye	4,612	4,581	4,596	1,768
Seabrook	6,503	6,454	6,567	2,526
South Hampton	740	755	776	298
Stratham	4,955	5,035	5,788	2,226
Totals:	144,173	144,816	145,427	55,935

(1) For Massachusetts, the Census data is for the year 1990; for New Hampshire, the year 1990.

(2) For Massachusetts, the estimated population are 1995 MISER projections. For New Hampshire, the estimates are for 1991 (provided by the New Hampshire State Planning Office).

(3) For Massachusetts, the projected 1993 population is calculated by interpolation between the 1990 census figure and the 1995 MISER estimate.

(4) For New Hampshire, the projected 1993 population is calculated by: $(1991\ population\ /\ 1980\ population)^{.2} \times 1991\ population$.

Table 2-2

Comparison of 1990 and 1993 Resident Population Estimates

Community	1990 Population Estimate	1993 Population Estimate	Percent Difference
Amesbury	14717	15349	4.29%
Merrimac	4971	5365	7.93%
Newbury	5706	5988	4.94%
Newburyport	16816	16832	0.10%
Salisbury	7960	7870	-1.13%
West Newbury	3413	3629	6.33%
Brentwood	2163	2721	25.80%
East Kingston	1432	1438	0.42%
Exeter	13133	12565	-4.32%
Greenland	2420	2934	21.24%
Hampton	12511	12539	0.22%
Hampton Falls	1550	1562	0.77%
Kensington	1678	1697	1.13%
Kingston	5071	5946	17.25%
New Castle	740	821	10.95%
Newfields	850	915	7.65%
Newton	3411	3587	5.16%
North Hampton	3952	3682	-6.83%
Portsmouth	26485	22260	-15.95%
Rye	5373	4596	-14.46%
Seabrook	7294	6567	-9.97%
South Hampton	761	776	1.97%
Stratham	5633	5788	2.75%
	148040	145427	-1.77%

TABLE 2-3

COMPARISONS OF BEACH AREA VEHICLE CAPACITIES AND COUNTS

(Refer to Appendix E for details)

1. Dufresne-Henry Report (Item 3, App. E):	
o Capacity of all parking areas in Hampton Beach, including on-street:	4,034 cars
compared with	
o KLD estimate of parking capacity, including driveways, backyards, etc.:	7,770 cars
2. The SNHRPC Report (Item 6, App. E):	
o Count of parked cars on a crowded weekend, on NH beaches:	12,650 cars
o KLD estimate of parking capacity in NH:	14,580 cars
3. The HMM Report (Item 13, App. E):	
o Daily transient (i.e., seasonal, overnight, daily) vehicles on weekend:	17,147 cars
o KLD estimated capacity:	25,470 cars
4. The NRC Reports (Item 14, App. E):	
o Estimates of beach area parking during peak conditions, within the EPZ:	19,700 cars
o KLD estimated capacity:	25,470 cars

TABLE 2-3

COMPARISONS OF BEACH AREA VEHICLES

CAPACITIES AND COUNTS (cont.)

5. The Costello, et al., Report (Item 16, App. E):

This report does not break out the estimate of beach area traffic, explicitly, so no comparison is possible.

6. The HMM "Beach" Report (Item 10, App. E):

Location	Parking Capacity Estimates HMM	KLD
Salisbury Beach	6367	8060
Seabrook Beach	1530	2650
Hampton Beach	7426	7770
North Beach	1420	1300
Plaice Cove, etc.	539	600
Rye, Bass, Jenness	656	1440

7. Aerial Beach Survey on July 18, 1987 (Item 20, Appendix E)

	Location	Parked Vehicles	Vehicles in Transit
a.	Plum Island (Ipswich, Rowley, Newbury, Newburyport)	3,095	103
b.	Salisbury	6,119	153
c.	Seabrook	3,040	123
d.	Hampton	13,257	750
e.	North Hampton	308	109
f.	Rye	3,474	202
	TOTAL	29,293	+ 1,440 = 30,733

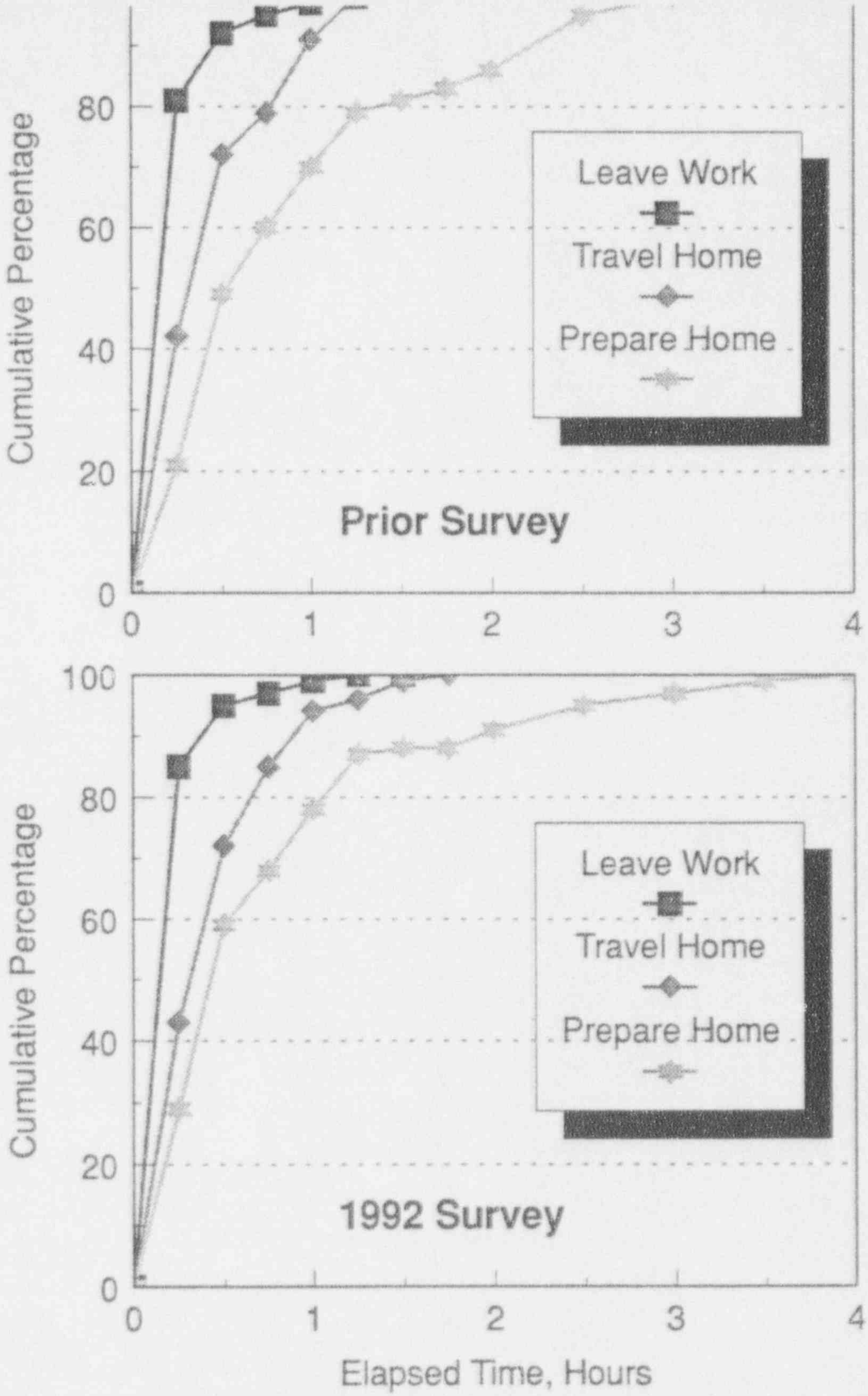
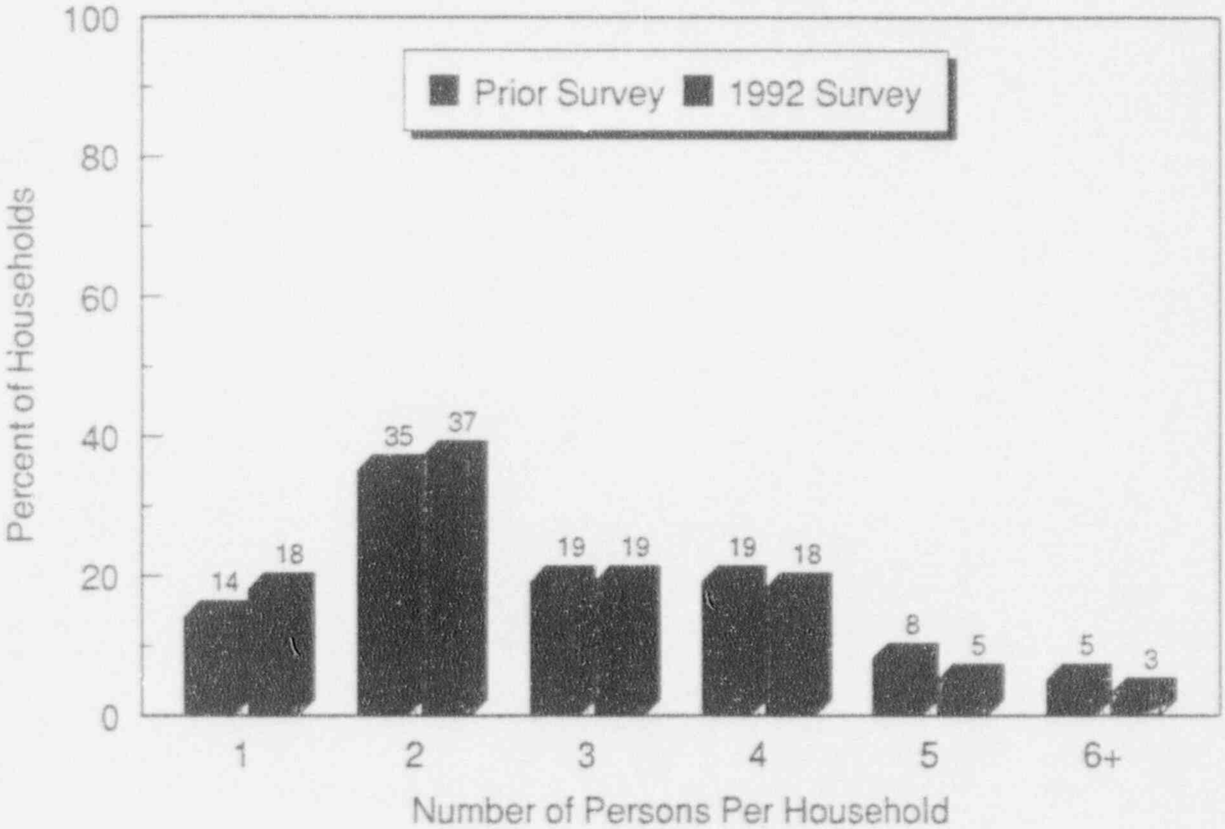


Figure 2-1. Comparison of Elapsed Times For Various Pre-Evacuation Activities

Figure 2-2. Comparison of Telephone Survey Results Household Size Within Seabrook Station EPZ



Average Household Size:
Prior Survey - 2.87
1992 Survey - 2.64
1990 Census - 2.72

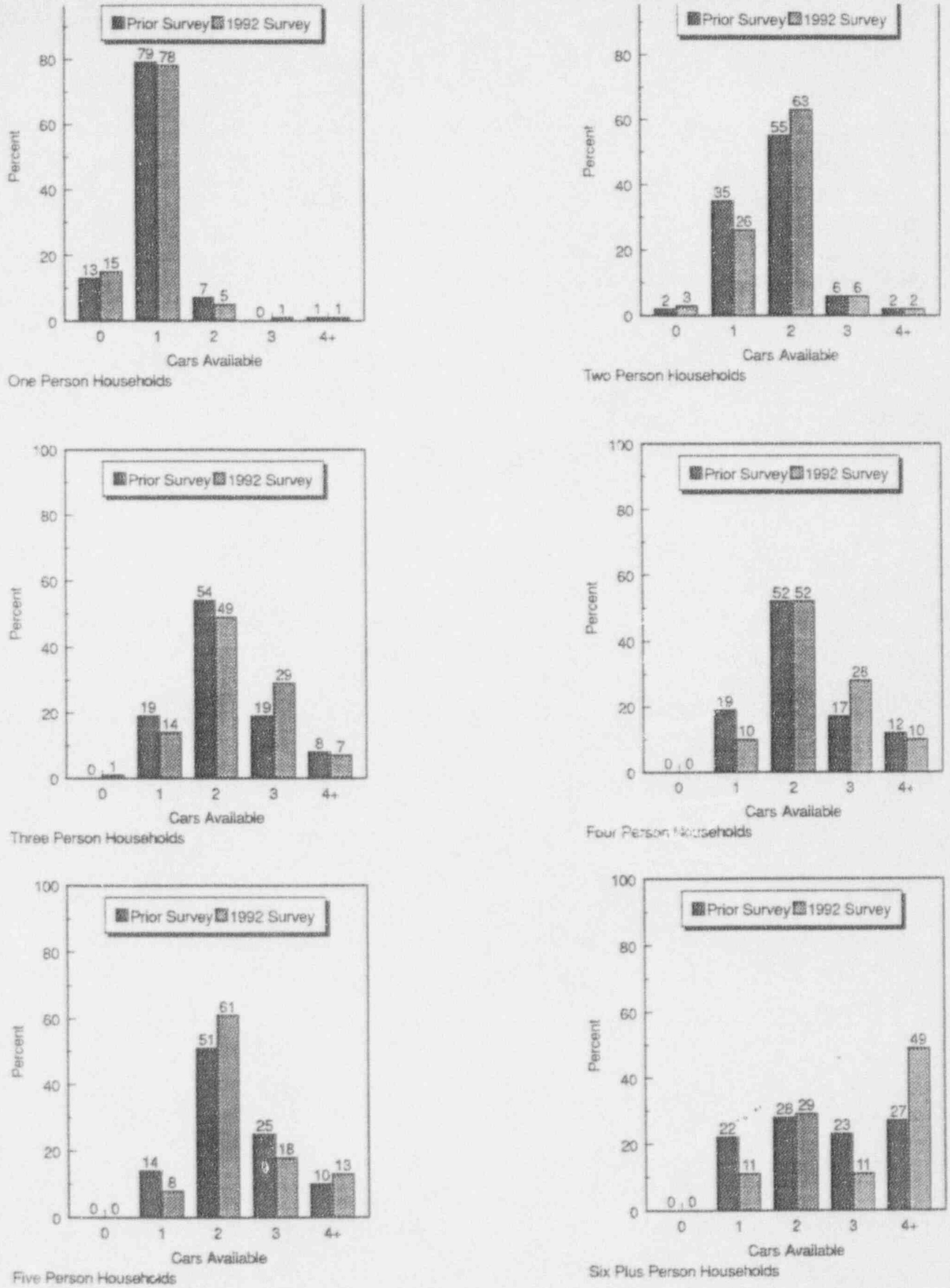


Figure 2-3. Comparison of Auto Ownership of Households Within Seabrook Station EPZ

3. ESTIMATION OF HIGHWAY CAPACITY

The ability of the road network to accommodate demand is a major factor in determining how rapidly an evacuation can be completed. It is, therefore, necessary to know the capacity of the available roadways.

In general, the capacity of a facility is defined as the maximum hourly rate at which persons or vehicles can reasonably be expected to traverse a point or uniform section of a lane of roadway during a given time period under prevailing roadway, traffic and control conditions. (From the 1985 Highway Capacity Manual.)

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

Because of the effect of weather on the capacity of a roadway, it is necessary to adjust capacity figures to represent estimated road conditions during inclement weather. Based on limited empirical data, weather conditions such as heavy rain reduce the values of capacity for highways by approximately 20 percent. For inclement weather conditions during the winter months, we have estimated capacity reductions of approximately 25 percent relative to normal weather conditions. We also reduce free flow speeds for inclement weather conditions: 20 percent for rain, 25 percent for snow.

In the congested traffic environment which is often characteristic of an evacuation scenario, travel time on a roadway section is, to a large extent, determined by the capacity of that section. For that reason, estimates of roadway capacity must be determined with great care. Because of its importance, a brief discussion of the major factors which influence capacity, is presented in this section.

The major factors which control capacity include:

o On the approach to intersections

  - Saturation queue discharge headways
  - Turning movements
  - Competing traffic streams
  - Control policy

o Along sections of roadway

  - Roadway geometrics
  - Traffic composition

o General considerations

  - Weather conditions
  - Pavement conditions
  - Lighting

Capacity Estimations on Approaches to Intersections

At-grade intersections are apt to become the first bottleneck locations under heavy traffic volume conditions. This characteristic reflects the need to allocate access time to the respective competing traffic streams by exerting some form of control. During evacuation, however, control at critical intersections, will often be provided by traffic control personnel assigned for that purpose, whose directions may supercede traffic control devices.

The per-lane capacity of an approach to an intersection can be expressed in the following form:

$$Q_{cap,m} = \frac{3600}{h_m} * [\frac{(G-L)}{C}]_m = \frac{3600*P_m}{h_m} \quad (1)$$

where:

$Q_{cap,m}$ = Capacity of traffic on an approach, which execute movement, m, upon entering the intersection; vehicles per hour (vph)

h_m = Mean queue discharge headway of vehicles on an approach, which are executing movement, m; seconds per vehicle

G_m = The mean duration of GREEN time servicing vehicles on an approach, which are executing movement, m, for each control cycle; seconds

L = The mean "lost time" for each control cycle; seconds

C = The mean duration of each control cycle; seconds

P_m = The proportion of time allocated for vehicles executing movement, m, from an approach. This value is specified as part of the control treatment.

m = The movement executed by vehicles after they enter the intersection: through, left-turn, right-turn, diagonal.

The turn-movement-specific mean discharge headway h_m, depends in a complex way upon many factors: roadway geometrics, turn percentages, the extent of conflicting traffic streams, the control treatment, and others. A primary factor is the value of "saturation queue discharge headway", h_{sat}, which applies to through vehicles that are not impeded by other conflicting traffic streams. This value, itself, depends upon many factors including motorist behavior, but is relatively straightforward to determine empirically in the field. Formally, we can write,

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

| where:

h_{sat} = Saturation discharge headway for through vehicles; seconds per vehicle

F_1, F_2 = The various known factors influencing h_n

f_n (.) = Complex function relating h_n to the known (or estimated) values of h_{sat}, F_1, F_2

The estimation of h_n for specified values of h_{sat}, F_1, F_2, ... is undertaken by a mathematical model* which has been programmed into the Traffic Assignment and Traffic Simulation software of the IDYNEV System. The resulting values for h_n always satisfy the condition:

$$h_n \geq h_{sat}$$

That is, the turn-movement-specific discharge headways are always more than, or equal to, the saturation discharge headway for through vehicles.

It is seen that, given the ability to determine h_n from h_{sat}, the determination of capacity of the approaches to intersections depends upon obtaining estimates of h_{sat}. Such estimates were obtained empirically at representative intersections throughout the EPZ. In all cases, the values of h_{sat} used in developing the evacuation plan represent conservative estimates** based on this empirical data. Specifically, observed values for h_{sat} ranged from 2.1 to 2.4 sec/veh; the higher (more conservative) figure was adopted to account for any uncertainty in driver-responses at intersections.

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* Lieberman, E., "Determining Lateral Deployment of Traffic on an Approach to an Intersection", McShane, W. & Lieberman, E., "Service Rates of Mixed Traffic on the far Left Lane of an Approach." Both papers appear in Transportation Research Record 772, 1980.

** Interestingly, studies have shown that h_{sat} decreases (i.e., capacity increases) during periods of congestion, relative to that during off-peak traffic conditions. This behavior reflects the fact that motorists are more attentive and are highly motivated to reduce their travel time, during congested conditions. Our estimates do not include this beneficial effect.

To summarize the foregoing discussion:

- o The saturation queue discharge headways, h_{sat}, for through vehicles can be quantified by empirical observation

- o The turn-movement-specific headways, h_m, are then calculated, taking into account the effects of turn movement percentages, link geometry and other factors

- o With the control treatment prescribed as part of the evacuation plan, the value of P_m may be defined

- o The per-lane capacity for each turn movement is then formed from equation (1).

Capacity Estimation Along Sections of Highway

The capacity of highway sections -- as distinct from approaches to intersections -- is a function of roadway geometrics, traffic composition (e.g., percent heavy trucks and buses in the traffic stream) and, of course, motorist behavior. There is a fundamental relationship which relates service volume (i.e., the number of vehicles which can pass a point in a given time period) to traffic density. Figure 3-1 describes this relationship.

As indicated there, the service volume increases as density increases, until the service volume attains its maximum value, V_E, which is the capacity of the highway section. Note that as density increases beyond this "critical" value, the rate at which traffic can be serviced (i.e., the service volume) declines below capacity. Therefore, in order to realistically represent traffic performance during congested conditions (i.e., when density exceeds the "critical" value), it is necessary to estimate the service volume, V_F, under congested conditions. This value, V_F, which is less than capacity, V_E, should be used for developing the evacuation plan and for estimating evacuation times, whenever congested conditions prevail.

The value of V_F can be expressed as:

$$V_F = R \cdot V_E$$

where:

R = Reduction factor which is less than unity.

The 1985 Highway Capacity Manual (HCM) discusses the reduction in capacity that can be experienced on freeways under Level Of Service (LOS) F conditions. Observed capacity ranged from 75% to 100% of "normal" capacity. We therefore apply a mean value of R = 0.85, approximately the average of the 0.75 to 1.00 range. It is important to mention that some investigators, on analyzing data collected on freeways, conclude that little or no reduction in capacity occurs even at Level of Service, F. While there is conflicting evidence on this subject, we will again adopt the conservative approach and use a lower value of capacity, as discussed above.

For calculation of the ETEs, the R = 0.85 capacity reduction factor was also applied to the estimates of nominal capacity of all at-grade roadway sections or links, whenever congested conditions prevail. For at-grade roadways, this capacity reduction represents the potential for inefficient traffic operations due to a variety of factors which may prevail under emergency evacuation conditions, including driver uncertainty and short term disruptions in a congested traffic environment.

The estimated value of capacity, V_E, is based primarily upon the type of facility (e.g., controlled access such as I-95, uncontrolled access such as Route 111 and on roadway geometrics. Clearly, a winding narrow road has significantly lower service volume than does the Exeter-Hampton Expressway. Sections of roadway with poor geometrics are characterized by:

o Lower free-flow speeds than on highways with good geometrics.

o Longer headways separating moving vehicles.

The (v/c) ratio at capacity flow is 1.0 from Table 3-1 of the HCM. The lane width factor, f_w, taken from HCM Table 3-12 = 1, for a facility with 12 ft. lanes, 6 ft. shoulder, and a 6 or 8 lane facility.

The vehicle mix factor, f_{HV}, is computed in a manner similar to that for the rural road segments. The value obtained is $f_{HV} = 0.96$.

The final factor, f_p, is designed to adjust the service flow to account for differing driver characteristics. The suggested values [HCM, Table 3-10] range from 0.75 to 1.0 for weekday or commuter traffic. It is expected that during an evacuation, the most experienced person in the group will drive. Further, it is assumed that virtually all drivers are familiar with the major roads in the Seabrook EPZ. Therefore, a factor $f_p = 0.90$ was selected.

On the basis of these factors, a freeway capacity V_E = 1728 vphl was selected.* Some indication of this value may be obtained from an analysis of Sunday traffic data on I-95, provided by NH DOT.

The highest one-way daily volume in 1985 was recorded on Sunday, July 7th: 79,119 vehicles. Unfortunately, we do not have hourly volumes. We can, however, compute the peak hourly flow based on the value of V_E:

Peak Hour Volume = 1,728 vph x 4 lanes = 6,912 vph

This value is only 8.74 percent of the recorded ADT. (Usually, peak hour volumes exceed 10 percent of the ADT.) Thus, even in the absence of hourly data, the estimate of V_E appears to be realistic.

Freeway Ramps

The nominal capacities for ramps during undersaturated flow conditions is estimated to be 1330 vphl. During congested conditions, the estimated capacity of freeway ramps is estimated to be 1130 vphl. This is consistent with the HCM, Table 5-5.

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*V_E is synonymous with SF, as used in the HCM.

Note that the actual capacity for a portion of the traffic stream on link, i, could be less if its movement-specific headway, $h_m \geq h_{sat}$ as discussed earlier.

Fog

The issue of ground fog must be addressed. Discussions with public officials in communities along the coast indicate that ocean fog is an unusual occurrence during the summer months. All agree that such fog, when it does appear, occurs primarily in the early morning and generally dissipates by 9 A.M., and no later than 10 A.M., in any event. Fog can also occur in the evening after the sun has set.

It is generally acknowledged that beach area population is significantly below capacity in early morning and late evening. Thus, Scenarios 1 and 2 are certainly more severe than an early morning scenario which includes the presence of fog.

Fog also occurs inland and qualifies as inclement weather, regardless of its location. The 1985 Highway Capacity Manual indicates "that 10 to 20 percent reductions [in capacity] are typical and higher percentages are quite possible". Our capacity reductions of 20 percent for rain and 25 percent for snow are responsive to these guidelines.

Ice

An exhaustive literature search has revealed no estimate of the effect of ice on highway capacity. In the absence of such data, application of the ETE for snow conditions (which includes a 25 percent reduction in capacity) appears acceptable for the following reasons:

- Highway capacity during an ice storm may be less than that during a snowfall, thus tending to increase travel time relative to snow. Note, however, that sanding operations would restore capacity of icy pavement to a significant extent.

- In general, there is no need to shovel a driveway in an ice storm as is assumed within the ETE to be required for a snowstorm, thus tending to reduce trip generation time, relative to snow. A reduction in trip generation time tends to reduce ETE.

Note, however, that under severe ice conditions, in the absence of sanding, some highway sections with extended upgrades may become virtually impassable. Thus, sanding may be necessary to assure adequate traction on such highway sections.

Link Capacities

Appendix N presents the link capacities, V_E, for the evacuation network shown in Figure 1-3. All links are identified by name and location (community).

Recommended Highway System Improvements

These recommendations address those highway improvements which increase capacity in a manner which would be most beneficial in expediting the movement of evacuating vehicles, thus reducing the ETE. Such recommendations are required by NUREG 0654 guidelines.

Analysis of the ETE results has identified five candidate system improvements which have potential for significantly reducing evacuation travel time. Since many of these improvements are associated with beach area traffic, they would also greatly benefit travelers under normal circumstances, particularly during the tourist season. Discussions were held with NH DOT personnel to review the practicality of these improvements and to estimate costs.

Subsequent to these discussions, a series of sensitivity tests were undertaken to study the potential for reducing ETE by implementing the candidate highway improvements. The results of this study are given in Section 10. The discussion below describes these improvements and summarizes the conclusions emerging from the sensitivity tests.

1. Route 286 in Seabrook, NH and Salisbury, MA and its interchange with I-95

This route, extending between I-95 in Salisbury and Route 1A in Seabrook Beach, would be widened to at least three lanes or to a four-lane undivided highway. Such widening, however, would not be fully utilized unless additional access can be provided to and from I-95. Therefore, any widening of Route 286 should be extended by widening existing ramp servicing traffic entering southbound I-95 from Route 286, so as to accommodate two lanes of traffic.

These changes, if implemented, would provide two-lane service from Seabrook Beach to I-95 for trips originating in Seabrook town (including the beach) south of Seabrook Station. The sensitivity tests reveal that significant reduction in ETE for the summer scenarios would accrue from this improvement.

2. Route 51/101 in Hampton, NH and to the west

This route would be widened to a four-lane divided highway from Hampton Beach to the present four-lane section of Route 101. The State is currently widening Route 51/101 extending from I-95, westward. The third westbound lane is needed to service the weaving traffic movement on this overpass associated with westbound traffic from Route 27 (101C) merging with Route 51 traffic at the eastern end of the bridge and the subsequent diverging of traffic either entering I-95 from Route 51 or continuing west on Route 51, at the western end of the bridge.

To exploit the full capacity of this widening, the interface between Route 51 and the local street system in Hampton Beach would have to be redesigned. Specifically, there is either a need for a direct connection between Ashworth Avenue and Route 51 or some other configuration which will permit traffic to exploit the full capacity of Route 51 in both directions.

The sensitivity tests reveal that significant reductions in ETE for the summer scenarios would accrue from this improvement.

3. Beach Road (Route 1A) and Route 110 in Salisbury, MA

Beach Road (Route 1A) would either be channelized for three lanes and widened if necessary, or be widened to four lanes. The current plan calls for traffic to form two-lanes outbound (i.e., westbound) from Salisbury Beach to the interchange of Route 110 with I-95. Implementing this recommendation will ease that process somewhat by virtue of the road being permanently delineated (i.e., striped) to guide two outbound lanes of traffic.

As discussed earlier, the intersection of Routes 1A and 110 with U.S. Route 1 must be upgraded to provide safe access for two lanes of westbound traffic.

If Beach Road is widened to four lanes, then the opportunity exists for establishing an additional left-turn bay on the westbound approach to Route 1. This turn bay can service a third lane of traffic which will move south on Route 1. Traffic moving south on Route 1, however, could exacerbate congested conditions in Newburyport and in Newbury unless other adjustments are implemented there (see below).

Consistent with the above improvement, the present railroad overpass on Route 110 should be replaced with a modern structure which will service four lanes of traffic. Also, Route 110 should be channelized for three lanes for the entire distance between Route 1 and the interchange with I-95, and widened, as necessary. Most of this section of Route 110 is already channelized for three lanes.

4. Access to Scotland Road from Newburyport, MA

Presently, there is no direct access to Scotland Road from the built-up central area of Newburyport City. Access is now possible from Low Street via Graf Road. Low Street is not easily accessible from the downtown area. Access to Scotland Road is also possible from Parker Street (in fact, Parker Street is renamed Scotland Road at the Newbury-Newburyport town boundary), but the Parker Street approach is from the east across Route 1, which would limit its utility during an evacuation.

We recommend that consideration be given by the City of Newburyport to extending Graf Road north and into the downtown area. Of course, any such decision should be consistent with the city's long-term plan and land-use zoning. Given that such a connector is feasible and attractive, it would provide another direct evacuation route from downtown Newburyport.

This additional route would lessen the demand for service on Route 1 and on Route 113 (toward I-95) and would expedite the evacuation of the city.

5. We recommend that consideration be given to constructing a ramp at the junction of Route 151 and I-95 in North Hampton, to permit access from northbound Route 151 onto I-95, northbound. This could expedite the movement of evacuating vehicles from within the towns of Hampton and North Hampton and relieve the demand on U.S. Route 1 northbound, thereby expediting the traffic movement from the coastal areas and the towns of Rye, North Hampton and Portsmouth.

As a result of these analyses, we limit our recommendations to candidates 1 and 2:

- o The cost of widening Route 286 to 4 lanes was estimated at $12.5 million. Reconstruction of the entry ramp from westbound Route 286 to southbound I-95 would cost an additional $5 million. Widening Route 286 to 3 lanes instead of 4 lanes would greatly reduce the estimate of $12.5 million.

4. ESTIMATION OF TRIP GENERATION TIME

Federal Government Guidelines (see NUREG 0654, Appendix 4) specify that the planner estimate the distributions of elapsed times associated with activities undertaken by the public in preparation for evacuation. We define the sum of these distributions of elapsed times, to be defined later, as the Trip Generation Time Distribution.

Background

In general, an accident at a nuclear power station attains one or more "classes" of Emergency Action Levels (see Appendix 1 of NUREG 0654 for details):

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

At each level, the Federal Guidelines specify a set of Actions to be undertaken by the Licensee, and by state and local offsite authorities. Evacuation of the general public within a two-mile radius and five miles downwind will be the protective action recommended when the plant status is classified as a General Emergency. Beach areas may be closed, at lower emergency classifications, during the summer season (May 15 to September 15) as a precautionary action. Because of the proximity of some of the beaches to Seabrook Station, beach closure would be considered by New Hampshire and Massachusetts at the Alert classification.

As a Planning Basis, we will adopt a conservative posture, in accord with Federal Regulations, that a rapidly escalating accident will be considered in calculating the Trip Generation Time. We will assume:

- The initial emergency classification is a Site Area Emergency.
- That further escalation to a General Emergency occurs 15 minutes later.

- That the Order to Evacuate is transmitted to the public 10 minutes after the General Emergency is declared.

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

- Establish a temporal framework for estimating the Trip Generation distribution in the format recommended in Appendix 4 of NUREG 0654.

- Identify temporal points of reference for the purpose of uniquely defining "Clear Time" and Evacuation Time Estimates (ETE).

It is more likely that a longer time will elapse between the various classes of an emergency at Seabrook. For example, suppose two hours elapse from the declaration of a General Emergency to the Order to Evacuate. In this case, it is reasonable to expect some degree of spontaneous evacuation during this two-hour period. As a result, the population within the EPZ will be lower when the Order to Evacuate is announced, than at the time of the General Emergency. Thus, the time needed to evacuate the EPZ, after the Order to Evacuate will be significantly less than the estimates presented in this report.

On the other hand, there is a low probability that an "immediate" General Emergency can arise, with the Order to Evacuate given almost simultaneously. In this case, the evacuation time estimates (ETE) will be somewhat longer than the figures presented herein.

The planning basis adopted here approximates the "worst case" conditions, and is within 25 minutes of the most extreme condition. Sensitivity tests provide quantitative indications of the effects of accident scenarios which depart from this planning basis. The results of these tests are presented in Section 10.

The notification process consists of two events:

- o Transmitting information (e.g., using sirens, tone alerts, EBS broadcasts, loudspeakers).

- o Receiving and correctly interpreting the information that is transmitted.

The resident population within the EPZ exceeds 140,000 persons who are deployed over an area of approximately 200 square miles, and engaged in a wide variety of activities. During the summer, an additional 100,000 persons would be within the EPZ. It must be anticipated that some time will elapse between the transmission and receipt of the information.

The amount of elapsed time will vary from one individual to the next depending where that person is, what that person is doing, and related factors. Furthermore, persons who will be directly involved with the evacuation process may be outside the EPZ at the time that the emergency is declared. These people may be commuters, shoppers and other travelers who reside within the EPZ and who will return to join the other members in the household upon receiving notification of an emergency.

As indicated in NUREG 0654, the estimated elapsed times for the receipt of notification can be expressed as a distribution reflecting the different notification times for people within, and outside, the EPZ. By using time distributions, it is also possible to distinguish between different population groups and different day-of-week and time-of-day scenarios, so that more accurate assessments may be obtained.

Furthermore, the spatial distribution of the EPZ population will differ with time of day -- families will be united in the evenings and at night, but dispersed during the day. In this respect, weekends will differ from weekdays.

Fundamental Considerations

The environment leading up to the time that people begin their evacuation trips, consists of a sequence of events and activities. Each event occurs at an instant in time and (other than the first) is the outcome of an activity.

Activities are undertaken over a period of time. Activities may be in "series" (i.e., to undertake an activity implies the completion of all preceding events) or may be in parallel (two or more activities may take place over the same period of time).

Activities conducted in series are functionally dependent on the completion of prior activities; activities conducted in parallel are functionally independent of one-another. The relevant events associated with the public's preparation for evacuation are:

Event Number	Event Description
1	Transmission of emergency notification
2	Awareness of accident situation
3	Depart pla~e of work
4	Arrive hom.
5	Leave home to evacuate the area

Associated with each sequence of events are one or more activities, as outlined below:

Event Sequence	Activity
1 --> 2	Public receives notification information
2 --> 3	Prepare to leave work
2,3 --> 4	Travel home
2,4 --> 5	Prepare to leave for evacuation trip

These relationships may be depicted graphically as shown in Figure 4-1.

Note that event 5, "Leave to evacuate the area" is conditional either on event 2 or event 4. That is, depending on the circumstances, activities 2 --> 5 can be undertaken by some evacuees in parallel with activities 2 --> 3, 3 --> 4 and 4 --> 5, undertaken by other evacuees, as shown in Figure 4-1 (a) and (c). Specifically, it is possible that one adult member of a household can prepare to leave home (i.e., secure the home, pack clothing, etc.), while others are travelling home from work. In this instance, the household members would be able to evacuate sooner than if such preparation had to be deferred until all household members had returned home. However, we will adopt the conservative posture that all activities will occur in sequence.

It is seen from Figure 4-1, that the Trip Generation time (i.e., the total elapsed time from Event 1 to Event 5) depends on the scenario and will vary from one household to the next and from one category of evacuees to another. Furthermore, Event 5 depends, in a complicated way, on the time distributions of all activities leading to that event. Specifically, in order to estimate the time distribution of Event 5, we must somehow obtain estimates of the time distributions of all preceding events.

Estimated Time Distributions of Activities Preceding Event 5

The time distribution of an event is obtained by "summing" the time distributions of all prior, contributing activities. (This "summing" process is quite different than an algebraic sum since we are operating on distributions -- not numbers.)

Time distribution of the Notification Process:
Activity 1 --> 2

We know of no survey which has accumulated empirical information describing the rate at which notification information is received. Nevertheless, there is sufficient data to obtain a reasonable estimate of a notification time frame, based largely on

the information obtained from the telephone survey[1]. (See Appendices F and G.)

The following information is relevant:

Estimated Population: 145,427
Average Household (HH) Size: 2.87
Estimate Number of HH: 145,427/2.87 = 50,671

Avg. Number of Commuters per HH: 1661/1300 = 1.28
Percentage of Residents who will be within the EPZ if accident occurs at mid-week, mid-day:

$$\frac{0.582\ (1.28) + (2.87-1.28)}{2.87} \times 100 = 81.4$$

since 58.2 percent of all commuters work within the EPZ, according to the survey results.

The population within the EPZ includes 81.4 percent of all residents, as computed above, and 100 percent of all tourists and employees, by definition.

The tourist population may be estimated by estimating the average value of persons per vehicle. The subject of vehicle occupancy has received much attention in past studies (see Appendix E, items 6, 10, 13; also the Costello Report referenced in item 16).

For this purpose, we reason that during the summer, the vehicles on the access roads to the beach areas, at points close to the beaches, are predominately tourists. In August 1985, a count of vehicle occupancy was conducted for KLD, as reported in item 18 of Appendix E. The results of this field count are presented in Table 4-1. These results for the major beach access roads may be summarized as follows:

---

1 The survey results presented in Appendices F and G were obtained from responses to a telephone survey conducted in 1992. Comparison of the resultant time distributions indicated that no significant differences existed between the 1992 results and the 1985 results. Consequently, due to the fact that the earlier survey had a larger sample size, we will continue to use the results of that survey.

Elapsed Time (min)	Cum. Pct. Ready to Evacuate
95	97
100	98
105	98
110	99
115	99
120	100

Calculation of Trip Generation Time Distribution

Associated with each event is a time distribution reflecting the range of time for the population to complete the preceding activity, and the time distribution of the preceding event.

When an event, k+1, depends upon a prior event, k, then the time distribution of this event, k+1, can be calculated if:

- o The time distribution of event, k, is known, and
- o The time distribution of the activity k->k+1, is known or can be estimated.

We now present the analytical treatment to compute the distribution of event, k+1, given the distribution of the prior event and of the connecting activity.

Algorithm No. 1 (Dependent Events)

Computationally, all distributions are represented as histograms composed of elements (i.e., each element represents a percentage of the population). The following definitions apply:

Let $T_i(k)$ = Time at which the ith element of the histogram has completed event, k; i=1,2...,I

t_j = Time required for jth element of the histogram to perform the activity, k->k+1; j=1,2,...,J

$P_i(k)$ = Percent of population represented by the ith element of the histogram for event, k. That is, $P_i(k)$ percent of the population has completed the event, k, at time, $T_i(k)$, over the interval, $\Delta T = T_i(k) - T_{i-1}(k)$.

P_j = Percent of population which requires t_j minutes to complete activity, k ->k+1.

$T_m(k+1)$ = Time at which mth element of the histogram has completed event, k+1; m=1,2,...,i+j-1,...I+J-1

$P_m(k+1)$ = Percent of population represented by the mth element of the histogram for event, k+1. That is, $P_m(k+1)$ percent of the population has completed the event, k+1, at time, $T_m(k+1)$, over the time interval, $\Delta T = T_m(k+1) - T_{m-1}(k+1)$

Then,

$$P_m(k+1) = \sum_{\substack{i,j \rightarrow \\ i+j-1=m}} P_i(k) p_j / 100$$

$T_m(k+1) = T_i(k) + t_j$ where i+j-1=m

NOTE

$$\sum_{m=1}^{I+J-1} P_m(k+1) = 100$$

Distribution	Explanation
A	Time distribution of commuters leaving work. Also applies to employees who work within the EPZ and who live outside the EPZ.
B	Time distribution of commuters arriving home.
C	Time distribution of residents with commuters leaving home to begin the evacuation trip.
D	Time distribution of residents with no commuters in the household and tourists leaving home to begin the evacuation trip.
E	Time distribution of beach area tourists leaving the area to begin the evacuation trip.

Trip Generation Distributions for Week-end Scenarios

For these scenarios it is assumed that the initial emergency classification is a Site Area Emergency (SAE). Upon declaration of the SAE, the entire EPZ population is notified of the emergency event and the beaches are closed during the summer season. It is expected that the evacuation process will begin within the beach areas immediately following notification that the beach areas are closed.

It is postulated that the Order to Evacuate (OTE) is given 25 minutes after the SAE is declared. Thus, for the "planning-basis" accident scenario, we postulate two evacuation stages (beach area and inland) which are displaced in time with respect to one-another:

1. The Trip Generation time distribution for the beach areas has its origin point (i.e., time, zero) at the time of the announcement of the Site Area Emergency.

2. The Trip Generation time distributions for the remainder of the EPZ have their origin point (i.e., time zero) at the time the General Emergency is declared or 15 minutes after the Site Area Emergency.

On this basis, reference to Dist. E of Table 4-2 indicates that an estimated 9 percent of the population in the beach area has been mobilized at the time the General Emergency is announced. Also, about 32 percent of the beach area population is ready to evacuate -- and has started to evacuate -- at the time the Order to Evacuate is given. On the other hand, only one percent of the inland resident and tourist population (Distribution D), and 10 percent of the employee population (Distribution A) will be prepared to evacuate when the order to evacuate is issued.

The IDYNEV model is designed to accept varying rates of trip generation for each origin centroid, expressed in the form of histograms. We partition these centroids into three sets -- those for beach area traffic, for inland residents and tourists and inland employees. These histograms, which represent Distributions A, D and E, properly displaced with respect to one another, are tabulated in Table 4-3.

These tabulations present the trips generated <u>and</u> the rates of trip-making within each indicated time period, both expressed as a percentage of the total number of trips to be generated at each centroid. The rate of trip making is found by:

$$\text{Rate} = \frac{\text{Trips Generated in Time Period (percent)}}{\text{Duration of Time Period (hours)}}$$

<u>Trip Generation Distribution for Week-day Scenarios</u>

The mid-day scenario produces a Trip Generation distribution which is a linear combination of Distributions C and D. Distribution C applies to those households with at least one commuter, while Distribution D applies to those households with no commuters. This linear combination results in Distribution F, reflecting the fact that about 25 percent of the households within the EPZ has no commuters, according to the telephone survey (see Appendix G). Distribution F is listed in Table 4-4 and is also presented in Table 4-5 in a format suitable for input to the IDYNEV system.

Snow Clearance Time Distribution

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

Consequently, it is reasonable to assume that the highway system will remain passable -- albeit at a lower capacity -- under the vast majority of snow conditions. Nevertheless, for the vehicles to gain access to the highway system, it is necessary for driveways and employee parking lots to be cleared to the extent needed to make them passable. These clearance activities take time, and this time lag must be incorporated into the trip generation time distributions. Thus, we must postulate a separate distribution for the driveway snow clearance activity and then introduce this distribution into the procedure used to calculate the trip generation time distribution.

The time needed to clear a driveway depends on the depth of snow, the available equipment and the number of able-bodied personnel to perform the task. Since this area is accustomed to heavy recurring snowfalls (see Table 1-1), it is reasonable to expect that virtually all households have made provision for snow clearance by either owning some form of equipment or by contracting for such service to be performed by others. The following distribution is postulated based on direct observation and on discussions with people in the area, for a heavy snowfall.

Elapsed Time (min.)	Cum. Percent of Cleared Driveways
15	5
30	10
45	25
60	40
90	70
120	90
150	100

It is recognized that the snow clearing activity can take place in parallel with other activities, e.g. preparing for evacuation. Nevertheless, we will adopt the conservative point of view that this activity _follows_ the preparation activity, rather than proceeding in parallel with it. This posture will lengthen the temporal extent of the trip generation process.

The above distribution will be identified as Distribution 5. The event "Driveways cleared of snow" will be identified as Event No. 5 and the event "Leave to Evacuate" is Event No. 6 for both scenarios involving snow conditions.

We must then perform the following additional operations to compute the trip generation distributions for the inclement weather, _snow_ scenarios:

Apply Algorithm No. 1 to	in order to Obtain Dist. for	which is named Distribution
Distributions A and 5	Event No. 6	G
Distributions F and 5	Event No. 6	H
Distributions D and 5	Event No. 6	I

The results of these calculations are shown in Table 4-6 in a format consistent with the others. Note:

- o Distribution G applies to employees
- o Distribution H applies to residents and transients during mid-day

5. ESTIMATION OF EMPLOYEE POPULATION

Table 5-1 lists the annual average employment figures for the years of 1986 and 1992, in the towns located within the Seabrook Station EPZ. The employment figures for the months of July (in-season) and October (off-season) shown in Table 5-2, indicate that summer employment is significant in the Towns of Hampton and Rye, but not elsewhere.

As indicated in Table 5-1, the growth of employment within the area has moderated from the growth rates seen in the earlier ETE studies. Previously, we saw a significant growth in employment over a period of four years: about 20 percent increase in New Hampshire and more than doubling in Massachusetts. These estimates yielded a higher 1986 estimate than we see for the 1992 period. Employment is sensitive to the general health of the nation's economy and, of course, the regional economy.

A careful analysis of the results of the 1992 survey taken of the population within the EPZ (see item 17, Appendix E and Appendix G) indicates that about 59.0 percent of commuters who live within the EPZ, also work within the EPZ. Specifically, the survey also revealed that:

827 Households were interviewed, representing
2374 persons (at 2.87 persons per household) and
1030 commuters (i.e., 0.433 commuters per resident) of whom
607 worked within the EPZ.

On this basis, the projected population (see Table 2-1) of 145,427 residents within the EPZ corresponds to 62,927 commuters. Of these, 36,786 (58.2 percent) work within the EPZ. The remainder (62,927 - 37,152 = 25,775) who work within the EPZ, reside outside the EPZ. Thus, during a mid-week, mid-day scenario, these employees will be evacuating along with the other people within the EPZ.

For purposes of estimating evacuation traffic demand, we focus on those employees who work within the EPZ and who live outside the EPZ. The effect on the ETE of returning commuters who live and work in the EPZ is discussed later in this section.

We wish to compute estimates of the number of employees -- and vehicles -- who commute to each town ...

- From within the town
- From other towns within the EPZ
- From outside the EPZ.

We proceed as follows:

Let:

E_i = Total number of employees within Town, i

C_i = Total number of residents within Town, i, who commute to work

N_i = Total number of residents within Town, i, who commute to work in Town, i

N_{Ii} = Total number of employees in Town i who commute there from another town Inside the EPZ

N_{Ei} = Total number of employees in Town, i, who commute there from outside the EPZ.

R_i = Population of Town, i (i.e., residents)

P_c = Percentage of residents in EPZ who commute = 44.5

P_{ii} = Percent of commuters in Town, i, who work in Town, i

P_{ei} = Percentage of commuters who originate their trips within the EPZ and also work within the EPZ = 58.2

Y_i = Survey expansion factor for Town, i.

The telephone survey results, when combined with the census data provides the following information for each town, i:

1. Estimates of P_c and R_i
2. Estimate of $C_i = P_c R_i$

3. The survey expansion factors, Y_i, for each town: C_i No. of commuters surveyed in town, i
4. The total number of employees, E_i
5. The estimates of P_{ii}

The analysis proceeds as follows:

1. Create an origin-destination (OD) matrix using the survey results for all gowns within the EPZ. The rows of this matrix contain data elements which are the number of commuters surveyed who travel <u>from</u> town, i. The columns contain the number of commuters surveyed who travel <u>to</u> town, j. The data cell, (i,j), contains the number of commuters who travel from town, i, to town, j, based on the survey results. This size of this matrix is N = 23, the total number of towns within the EPZ.

2. Expand this OD matrix to represent the entire commuter population by multiplying the entries in row, i, by the expansion factor, Y_i.

3. Compute $N_{Ji} = \sum_{j \neq i}^{N} N_{ji}$, where N_{ji} is the estimated number of commuters travelling from <u>another</u> town, j, to town, i. That is, we sum all the entries in the data cells in column, j, of the matrix in step 2, excluding that in data cell, N_{ii}.

4. Estimate the number of employees who work in town, i, and who travel from outside the EPZ:

   $N_{Ei} = (1-P_{ii})E_i - N_{Ji}$

Table 5-3 presents the results.

First, we must guard against double-counting those employees who work at the beach since their vehicles have already been accounted for. Conservatively, it is reasonable to estimate that 25 percent of the employees in the Towns of Hampton and Rye work at the beach areas and that 10 percent of employees in the Towns of Seabrook, Salisbury and Newbury work at the beach areas.

This percentage is based on the seasonal employment picture shown in Table 5-[illegible]n, there are some 2,000 more employees in Hampton in the summer than in the off-season. If all these summer employees worked at the beach then about 38% of the total employee population in Hampton would work at the beach. This estimate represents an upper bound since there are numerous inland establishments servicing the seasonal trade that either close or reduce employment in the off season. The estimate of 25% for beach employment is equivalent to the assumption that one of three summer employees works away from the beach. Since Rye also has a significant increase in summer employment the 25% factor is also applied. The other towns with beach areas do not show any significant increase in summer employment so it assumed that only 10% of their employee population works at the beach.

Second, employment over the week-end is some fraction of employment during mid-week. This fraction will vary depending on the season and by location within the EPZ. Since we do not have data for this fraction, we will make some reasonable assumptions:

- For the tourist-oriented Towns of Hampton, Hampton Falls, New Castle, North Hampton, Rye, Seabrook, Salisbury and Newbury, we estimate that 70 percent of all employees work on the weekend, during the summer season.

- For the remaining towns, we will estimate that 40 percent of all employees work on the weekend, during the summer.

- Off-season, we will estimate this fraction of weekend employment at 25 percent for all towns.

- During mid-week, all employees will be considered to be at work.

Third, it is necessary to recognize that the Trip Generation time distribution for employees differs markedly from that which is applicable for residents. The sequence of activities for employees is shown in Figure 4-1(e). We must therefore apply Distribution A (see Table 4-2) to the employee trips.

Table 5-4 presents the estimates of evacuating vehicles containing employees, for various scenarios, taking into account the

comments made above. Table 4-3 presents the Trip Generation distribution for these employees.

Internal Returning Commuters

Upon notification of the public to evacuate, people who live and work within the EPZ will be travelling home on roads within the EPZ. Consistent with current practice, these trips from work to home were not explicitly modelled with the IDYNEV model. The effect of work to home trips has been accounted for explicitly in the estimation of capacity by considering their presence as inbound vehicles in estimating the directional split of traffic (Section 3). In addition, their effect on capacity is represented as contributing to the 15% reduction in road capacity whenever the road link experiences congestion.

A study has been done to quantify the effect of these returning commuters and to determine if the 15% capacity reduction is appropriate. To accomplish this study, the number of work-home trips for EPZ inter-town and intra-town commuters was determined based upon employment data (Table 5-3) and telephone surveys (Appendices E, F, G). These trips were then assigned appropriately to various EPZ intersections and links along critical evacuation routes during the time frame when these commuters would be travelling home. This additional traffic volume was then evaluated to determine its impact on capacity expressed as a percentage. The following table presents the result of this analysis:

Congested Location	Number of Commuter Trips	Impact of Commuter Traffic in Percent of Capacity	
		Over 2 Hours	Over 7 Hours
Salisbury Square	631	15.1	3.9
Route 110	294	9.2	1.8
Route 1 at Route 286	430	12.4	3.5
Route 51	79	2.7	[illegible].8
Route 101 at Route 1	1,134	21.9	6.3

These results show, that over the 7 hours required to evacuate the EPZ, the reduction in capacity caused by internal commuter travel is well within the 15% capacity reduction incorporated into the IDYNEV model. Therefore, there is no reason to explicitly model these trips in the ETE calculation.

Additionally, two ETE sensitivity studies were undertaken to explicitly represent commuter traffic travelling from work to home along critical evacuation paths during the early stages of the evacuation. These studies considered internal, and in some select locations, external commuters. The results of these sensitivity runs indicate that there is no material difference in the ETE between the original treatment, where the effects of commuter traffic were represented as part of the 85% capacity reduction factor, and those sensitivity runs which explicitly modelled commuter traffic.

TABLE 5-1

YEAR-ROUND EMPLOYMENT POPULATION

ESTIMATES BY COMMUNITY

Community	Total Employment 1986(Proj)	Total Employment 1992 Est.
New Hampshire		
Brentwood	170	305
East Kingston	89	54
Exeter	5,430	5,988
Greenland	718	1,961
Hampton	4,109	4,688
Hampton Falls	387	529
Kensington	103	126
Kingston	885	674
New Castle	43	82
Newfields	908	877
Newton	145	173
North Hampton	1,218	1,255
Portsmouth	16,570	15,963
Rye	728	628
Seabrook	7,579	4,066
South Hampton	377	73
Stratham	1,290	1,348
New Hampshire Subtotals	40,749	38,790

SOURCES:

1986 Projections as reported in Rev. 2 of the ETE report.

Massachusetts State Department , Division of Employment & Training - 1992 estimates

New Hampshire Department of Employment Securities - 1991 Estimates

TABLE 5-1

YEAR-ROUND EMPLOYMENT POPULATION

ESTIMATES BY COMMUNITY (cont.)

Community	Total Employment	
	1986(Proj)	1992 Est.
Massachusetts		
Amesbury	7,880	6,525
Merrimac	2,543	2,286
Newbury	2,580	2,486
Newburyport	9,477	7,843
Salisbury	3,252	3,447
West Newbury	1,603	1,550
Massachusetts Subtotals	27,335	24,137
TOTAL in EPZ	68,084	62,927

SOURCES:

1986 Projections as reported in Rev. 2 of the ETE report.

Massachusetts State Department , Division of Employment & Training - 1992 estimates

New Hampshire Department of Employment Securities - 1991 Estimates

TABLE 5-2

EMPLOYMENT POPULATION ESTIMATES BY COMMUNITY FOR THE MONTHS OF JULY AND OCTOBER

Community	July 1984	October 1984
New Hampshire		
Brentwood	152	127
East Kingston	78	75
Exeter	5,634	5,508
Greenland	544	554
Hampton	5,213	3,232
Hampton Falls	318	371
Kensington	79	70
Kingston	719	707
New Castle	54	55
Newfields	848	878
Newton	133	150
North Hampton	980	1,075
Portsmouth	15,233	15,103
Rye	862	643
Seabrook	5,116	6,005
South Hampton	361	367
Stratham	934	1,015
New Hampshire Subtotals	37,258	35,935
Massachusetts		
Amesbury	7,707	7,715
Merrimac	2,486	2,489
Newbury	2,524	2,526
Newburyport	9,268	9,278
Salisbury	3,181	3,184
West Newbury	1,567	1,569
Massachusetts Subtotals	26,733	26,761
TOTAL in EPZ	63,991	62,696

SOURCE:

New Hampshire and Massachusetts Labor Services and Employment Bureaus

Data for summer, 1992 were not available for this study

TABLE 5-3

ESTIMATES OF EVACUATING EMPLOYEES

Community	1986 Pop. R_i	Pii (pct)	1986 Empl. E_i	Employees from Town N_i	External Empl. N_{Ei}	Evac. Empl. Veh.
New Hampshire						
Brentwood	2,721	11.0	305	34	91	78
East Kingston	1,438	15.0*	54	8	46	40
Exeter	12,565	35.0	5,988	2,096	1,448	1,245
Greenland	2,934	10.0	1,508	196	1,645	1,415
Hampton	12,539	24.0	4,688	1,125	1,704	1,465
Hampton Falls	1,562	10.0	529	53	178	153
Kensington	1,697	11.0	126	14	112	96
Kingston	5,946	10.0	674	67	430	370
New Castle	821	15.0*	82	12	0	0
Newfields	915	15.0*	877	132	346	298
Newton	3,587	15.0*	173	26	80	69
North Hampton	3,682	11.0*	1,255	138	512	440
Portsmouth	26,260	33.0	15,963	5,268	6,674	5,740
Rye	4,596	13.0	628	82	41	35
Seabrook	6,567	23.0	4,066	935	1,307	1,124
South Hampton	776	15.0*	73	11	3	3
Stratham	5,788	10.0	1,348	135	648	557

* Estimated. These estimates are based on the need to obtain a reasonable relationship between the resulting values of N_i and E_i.

TABLE 5-3

ESTIMATES OF EVACUATING EMPLOYEES (cont.)

	1986 Pop. R_i	Pii (pct)	1986 Empl. E_i	Employees from Town N_i	External Empl. N_{Ei}	Evac. Empl. Veh.
Massachusetts						
Amesbury	15,349	26.0	6,525	1,697	3,835	3,298
Merrimac	5,365	15.0	2,286	343	1,857	1,597
Newbury	5,988	15.0	2,486	348	1,717	1,477
Newburyport	16,832	29.0	7,843	2,274	2,282	1,963
Salisbury	7,870	31.0	3,447	1,069	1,437	1,236
West Newbury	3,629	25.0	1,550	388	746	642
TOTAL in EPZ	145,427		62,474	16,451	27,139	23,341

$\sum_i N_{Ii}$ = 0.590 x 62,927 - 16,451 = 20,676

N_E = 68,084 - 0.582 x 63,206 = 31,298

r = 12,858/31,298 = 0.411

Average vehicle occupancy: 1.16 employees

N_E = 62,474 - 16,451 = 27,139

TABLE 5-4

EVACUATING EMPLOYEES FOR VARIOUS SCENARIOS, EXPRESSED IN VEHICLES

Community	Summer Week-end (off-beach)	Off-Season Week-end	Off-Season Midweek (Total)	Season Midweek (off-beach)
New Hampshire				
Brentwood	8	5	20	20
East Kingston	19	12	47	47
Exeter	328	206	822	822
Greenland	575	357	1,435	1,435
Hampton	760	362	1,450	1,087
Hampton Falls	97	35	141	141
Kensington	15	9	38	37
Kingston	94	59	234	234
New Castle	0	0	0	0
Newfields	72	45	181	181
Newton	35	22	88	88
North Hampton	251	89	358	358
Portsmouth	2,664	1,669	6,656	6,656
Rye	0	0	0	0
Seabrook	727	295	1,151	1,038
South Hampton	42	16	63	63
Stratham	209	131	523	523
Massachusetts				
Amesbury	1,110	694	2,775	2,775
Merrimac	762	476	1,904	1,904
Newbury	998	396	1,583	1,424
Newburyport	651	408	1,646	1,646
Salisbury	678	269	1,072	966
West Newbury	279	175	699	699
TOTAL in EPZ	10,376	5,730	22,886	22,144

We will adopt the conservative posture that some households whose size is reduced to 4 or fewer persons when the children are in school, and who have access to more than one vehicle, will take two vehicles in anticipation of the eventual need to accommodate the children. In addition, we anticipate that many parents will pick up their children -- and, perhaps, those of neighbors -- at school, prior to their own evacuation. Thus, we will not apply the indicated 3 percent reduction in vehicle demand, for the purpose of estimating evacuation travel times. Instead, the evacuating vehicle population for residents used for the off-season scenarios will be the same as used for the in-season scenarios.

<u>Evacuating Volumes for the Summer Mid-week, Mid-day Scenario</u>

For this scenario, it is assumed that:

1. Beach area population is 75 percent of peak weekend population.

2. Employment within the EPZ is at usual mid-week levels. That is, no allowance is made for the fact that some workers will be on vacation.

3. Commuters who live within the EPZ will return home, then evacuate with the other members of the household.

4. The Trip Generation distributions are:

   - Distribution E for beach area
   - Distribution A for inland employees
   - Distribution F for inland residents and tourists

The estimate of mid-week beach area population is based on an extensive data base compiled by HMM Associates in a report entitled "Beach Area Traffic Count Program - Seabrook Station EPZ", in 1983.

7. TRAFFIC CONTROL AND MANAGEMENT TACTICS

This section presents the current set of traffic control and management tactics which are designed to expedite the movement of evacuating traffic. The resources required to implement these tactics include:

- o Personnel with the capabilities of successfully performing the planned control functions of traffic guides.

- o Equipment to assist these personnel in the performance of their tasks:

  - Traffic Barriers
  - Traffic Cones

- o A plan which defines all necessary details and is documented in a format which is easy to understand.

The functions to be performed in the field are:

1. Facilitate evacuating traffic movements which expedite travel out of the EPZ along routes which the analysis has found to be most effective. This may entail implementation of capacity enhancement measures to expedite traffic flow through critical areas.

2. Discourage traffic movements which permit evacuating vehicles to travel in a direction which takes them significantly closer to the power station, or which interferes with the productive flow of other evacuees.

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

- o He/she may be traveling home from work or from another location, to join other family members preliminary to evacuating.

- o An evacuating driver may be taking a detour from the evacuation route in order to pick up a relative.

- o The driver may be an emergency worker enroute to perform an important activity.

The implementation of a plan must provide room for the application of sound judgment. The traffic cones and barriers are deployed as indicated in the NHRERP Traffic Management Manual, MARERP Traffic Management Manual, and Maine Traffic Management Manual, so that there remains room for vehicles to maneuver through these guides. That is, cones and barriers will not physically obstruct passage. In addition, priority will be given to transit vehicles (buses, vans, ambulances) and to other emergency vehicles (police, fire, tow trucks).

This set of control tactics is the outcome of the following process:

1. A field survey of these critical locations.

   The sketches of traffic control posts are based on the data collected during field surveys and upon large-scale maps. We have found these maps to be less than accurate in some respects.

2. Consultation with police department personnel of the towns who will be implementing them.

   Clearly, any control tactics should be reviewed by trained personnel who are experienced in controlling traffic and who are familiar with the likely traffic patterns. Also these personnel know which intersections are probable bottlenecks under heavy traffic demand conditions for normal traffic patterns.

TCP Activation Priority

The most important TCPs and ACPs are at those locations where the Traffic Guides' actions can influence the evacuation time. Since the mobilization of Traffic Guides may take place over the same time frame as the evacuation, the manning of the TCPs and ACPs may not be completed at the start of the evacuation. Therefore it is prudent to prioritize the TCPs and ACPs to ensure that those locations that have the greatest effect on the ETE are staffed first. The TCPs and ACPs in the MARERP Traffic Management Manual and the NHRERP Traffic Management Manual are prioritized to ensure the most efficient use of available personnel.

It should be noted however, that even at these important TCPs, the presence of Traffic Guides influences the evacuation time only after these locations experience congestion. Prior to the onset of congested conditions, there is adequate road capacity to service the evacuation flow. Under these circumstances, the Traffic Guides are of value in guiding traffic and in providing surveillance but they don't influence the ETE.

The assignment of TCPs and ACPs by region depend upon the region's geography. Note that some TCPs and ACPs within the EPZ but outside the region to be evacuated should be activated. Selected TCPs and ACPs located outside the evacuated Region will be needed to expedite the movement of evacuees.

Time to Activate TCPs

Traffic control personnel in Massachusetts and New Hampshire are mobilized at the Alert if the beaches are to be closed or, otherwise, at a Site Area Emergency. They are mobilized to the Northern Essex Community College in Haverhill, Massachusetts and to NH State Police Troop A Headquarters in Epping, NH. After receiving their assignments at their respective mobilization points, they proceed directly to their TCPs and implement their traffic control strategies for beaches being closed or for regions evacuated.

The TCPs are manned by local and State Police personnel. It is expected that local police would be available in about 90 minutes. Based upon discussions with New Hampshire State Police personnel, troopers would be available as follows:

4 troopers in 0 - 15 minutes
3 troopers in 15 - 60 minutes
6 troopers in 60 - 120 minutes
100 troopers in 120 - 300 minutes

Incorporation of TCP and ACP Priorities and Activation Times in the ETE

These TCP and ACP activation priorities and estimated manning times have been included in the calculation of the ETEs. This was accomplished by evaluating the road network and determining alternate routes that the evacuees might take in the absence of traffic guides to implement traffic control strategies. For example, evacuees travelling westbound along Beach Road in Salisbury could elect to either proceed through Salisbury Square onto westbound Route 110 or turn onto southbound Route 1. In addition, some road capacities were reduced to account for the absence of capacity enhancing strategies, such as using both lanes through Salisbury Square for outbound service. This modified network was then analyzed by the Traffic Assignment and Distribution (TRAD, see Appendix B) computer model which determined the vehicle routings through the network. The IDYNEV simulation model was then run with the local traffic patterns switching from pre-TCP activation patterns with concomitant changes in capacity to post activation patterns as each of the TCPs is staffed.

8. TRAFFIC ROUTING, CONTROL AND MANAGEMENT PLANS

Evacuation routes are composed of two distinct components:

- o Routing from a community being evacuated to the boundary of the Emergency Planning Zone (EPZ)

- o Routing of evacuees from the EPZ boundary to host communities and reception centers.

Evacuees should be routed within the EPZ in such a way as to minimize their exposure to risk. This requirement is met by routing traffic so as to move away from the location of Seabrook Station to the extent practicable and by delineating evacuation routes which expedite the movement of evacuating vehicles.

The routing of evacuees from the EPZ boundary to the host communities must also be responsive to several considerations:

- o Minimizing the amount of travel outside the EPZ from the points where these routes cross the EPZ boundary to the reception centers.

- o Relating the anticipated volume of traffic destined to each reception center to the capacity of the reception center facilities.

- o Assigning the residents of those towns who are members of a regional educational system, to the same reception center, to the extent possible. This would expedite the reunion of school children with other members of the household, should the evacuation take place during a school day.

Consequently, there is a linkage between the routing plans and the choice of host communities. In light of this linkage, a review of the allocation of host communities to communities within the EPZ was performed. Table 8-1 presents the current assignment of host communities to communities within the EPZ.

A total of seven Emergency Response Planning Areas (ERPA) are defined:

ERPA	Community
A	Hampton Falls, Hampton Beach, Seabrook
B	Amesbury, Salisbury
C	Kensington, South Hampton
D	Hampton, North Hampton
E	Merrimac, Newbury, Newburyport, West Newbury
F	Brentwood, East Kingston, Exeter, Kingston, Newfields, Newton
G	Greenland, New Castle, Portsmouth, Rye, Stratham

These ERPA are delineated in Figure 10-1.

The routing plans for each of these ERPA are presented in Appendix J. Appendix K presents maps -- one for each ERPA -- delineating the evacuation routes from each community within the EPZ.

When the original ETE study was compiled, these evacuation routes were submitted to the police chiefs of all communities within the EPZ for their review. All police chiefs were permitted to review and comment on evacuation routing in 1991-1992. Table 8-2 is a copy of the letters sent to these personnel. Table 8-3 is a listing of all recipients of the routing and traffic management plans for their respective communities when the original study was compiled. In addition, State Police received a copy of these plans.

Subsequent to the initial review of the routing and traffic management plans with police officials, a second mailing was made to all police chiefs who were interviewed. A typical letter is shown as Table 8-4. A form used to indicate the priority of each TCP was also included. This form is shown as Table 8-5. Prior to the completion of the current update, traffic management plans and evacuation routes were again reviewed with state and local police officials in Massachusetts and New Hampshire.

Subsequent to this most recent review, earlier versions of the TCP diagrams were revised and extended. The NHRERP and MARERP Traffic Management Manuals contain a complete set of traffic control posts. Each post is identified by town or city and by ERPA.

Summaries are presented by community which indicate the numbers of traffic guides and traffic equipment required to implement the plan.

Appendix M presents a tabulation of the destinations assigned to each origin node (refer to Figure 1-3). These assignments are consistent with the assignments of host communities shown in Table 8-1.

TABLE 8-1

ASSIGNMENT OF HOST COMMUNITIES TO COMMUNITIES WITHIN THE EPZ

New Hampshire

Dover	Manchester	Rochester
Greenland	Brentwood	Portsmouth
Hampton	East Kingston	
Hampton Falls	Exeter	
New Castle	Hampton Beach Transients	
North Hampton	Kensington	
Rye	Stratham	
	Newfields	

Salem
Kingston
Newton
Seabrook
South Hampton

Massachusetts

Tewksbury	Wellesley
Amesbury	Newbury
Merrimac	Newburyport
West Newbury	
Salisbury	

9. ACCESS CONTROL WITHIN, AND AT THE PERIPHERY OF, THE EMERGENCY PLANNING ZONE (EPZ) AND DIVERSION ROUTES

The purpose of peripheral access control is to restrict entry to the Emergency Planning Zone (EPZ) and to expedite the traffic movement of evacuating vehicles. Entry should be permitted for the following groups:

- Commuters returning to the EPZ, to gather members of their household for the purpose of evacuation.
- Transit vehicles (buses, vans, ambulances) dispatched to the EPZ to participate in any evacuation.
- All vehicles transporting emergency response personnel.

All other travelers seeking to gain entry to the EPZ should be denied access and provided with local diversion routes. These local diversion routes will enable those denied entry to reverse their paths and seek other routes outside the EPZ.

Access Control Posts (ACP) will be activated approximately two hours after the Order to Evacuate (OTE), providing that inbound traffic volume has declined to the extent that the activity of screening motorists will not result in the formation of long queues of inbound vehicles. If traffic volume remains high after the elapsed two hour period following the OTE, such that the screening process creates long queues (approximately 20 or more vehicles), then screening activities will temporarily cease to allow the queue to dissipate.

Figure 9-1 indicates the major diversion route and the cordon line around the EPZ. The intersections of this cordon with highways demark the locations of Access Control Posts. The NHRERP Traffic Management Manual, the MARERP Traffic Management Manual, and Maine Traffic Management Manual detail the location control, tactics and the personnel and equipment needed at each ACP.

The diversion route was developed to satisfy the following objectives:

1. The route should be sufficiently removed from the EPZ so as to minimize the extent that diverted traffic will mingle with, and thereby impede, the evacuating vehicles travelling toward their respective host relocation centers. Any such mingling and consequent impedance should take place well outside the EPZ.

2. To the extent possible, the diversion route should consist of high-capacity highways.

A comparison of the diversion route in Figure 9-1, with the evacuation routes shown in Appendix K and described in Appendix J, will indicate that the first objective is satisfied. Specifically, evacuating traffic from North Exeter, Newfields and Stratham will mingle with diverting traffic on U.S. Route 4 in New Hampshire. The closest point where such merging takes place is the intersection of U.S. 4 and U.S. 202 in Northwood, NH, a distance of over 15 miles from the EPZ boundary. Traffic to Manchester will, to an extent, utilize I-93. The closest point on I-93 to the EPZ boundary is about 10 miles.

To satisfy the second objective, the available Interstate Highways are utilized (I-93, I-293) as well as sections of other access-controlled highways (U.S. 3, Massachusetts 128). We have also specified the best available routes north of the EPZ: U.S. Routes 4 and 202 and Maine 111.

The northern end of the diversion route connects with I-95 at Biddeford, Maine while the southern ends connect with I-495, Massachusetts 128 and the Boston metropolitan area.

The cordon line and the ACP locations were developed to satisfy the following objectives:

1. Control all open roads crossing the EPZ boundary.

2. Select ACP locations.

- as close to the EPZ boundary as possible so as to minimize the number of people who could originate a trip into the EPZ from points between the ACP and the EPZ boundary.

- so as to minimize the number of personnel needed to secure the EPZ boundary.

- which will enable those vehicles denied entry to the EPZ, to safely change direction with a minimum of delay and turbulence.

These ACP are specified at the same level of detail, as are the Traffic Control Posts (TCP) in the NHRERP Traffic Management Manual, MARERP Traffic Management Manual, and the Maine Traffic Management Manual. The procedure employed for developing these specifications are:

- o Perform a field survey
- o Sketch all ACP
- o Distribute to State Police for review

The field survey was completed and the detailed sketches developed. This report has been distributed to Massachusetts and New Hampshire State Police for review.

Some of the existing TCP within the EPZ also serve as "internal" ACP. That is, if a specific region is to be evacuated, then those TCP on the periphery of that region must also serve as ACP restricting entry to the region. Fortunately, since all the TCP controls restrict movements toward the Station, there is no need to alter these controls when they undertake the dual role of ACP.

The NHRERP and MARERP Traffic Management Manuals identify which TCPs also perform an ACP function. At the completion of the evacuation process only the appropriate ACP will continue to be manned.

Identification and Installation of Control Devices

All Access Control Posts are designed not to restrict access into the Emergency Planning Zone (EPZ) or into the Region ordered to evacuate, to those vehicles where occupants will provide some form of emergency-related service. The remaining traffic will be denied entry and will be provided an alternative route which directs them away from the EPZ.

Whenever traffic operations at a location are restricted, it is sound practice to inform drivers in a timely and unambiguous manner, and to assert guidance control. Both needs are fulfilled, in part, by installing suitable traffic control devices as detailed in the NHRERP Traffic Management Manual, the MARERP Traffic Management Manual, and Maine Traffic Management Manual.

The attached exhibits are excerpts from the Manual on Uniform Traffic Control Devices (MUTCD). These excerpts provide general guidance that may be useful in determining the traffic control devices to be used at the TCP and ACP during an emergency evacuation. These excerpts discuss the following topics:

Exhibit 9-1 Purpose and Use of Traffic Control Devices
Exhibit 9-2 Signing for Civil Defense
Exhibit 9-3 Use and Application of Barricades
Exhibit 9-4 Use and Application of Traffic Cones

Control devices for implementing short-term traffic strategies under emergency conditions need not be in strict compliance with the MUTCD recommendations for work zones. For example, traffic cones, suitably reflectorized, provide a highly visible means for alerting and channelizing traffic, and would be an adequate alternative to barricades for short term control of emergency operations. The use of cones is warranted since emergency response personnel normally respond in automobiles with limited storage capacity which can accommodate cones but not barricades.

10. EVACUATION TIME ESTIMATES (ETE) FOR GENERAL POPULATION

This section presents the current results of the computer analyses using the IDYNEV System. These results cover:

- Ten evacuation scenarios as described in Table 10-1.
- Fourteen regions within the Seabrook Station EPZ, as defined in Table 10-2. Each region consists of one or more Emergency Response Planning Areas (ERPA). These ERPA are shown on Figure 10-1. The communities comprising each ERPA are listed in Table 10-3.

These ETE for each Region-Scenario combination, are presented in Tables 10-4 through 10-8. The ETE values in Table 10-8 apply to combinations of ERPAs on which protective action decisions are based; they are, therefore, the ETE values to be used for protective action decisions.

- Table 10-4 presents the ETE for the area within a circle with a radius of two miles centered at Seabrook Station.
- Table 10-5 presents the ETE for the area within a circle with a radius of five miles centered at Seabrook Station.
- Table 10-6 presents the ETE for the area within a circle with a radius of ten miles centered at Seabrook Station.
- Table 10-7 presents the ETE for the entire Emergency Planning Zone (EPZ) of Seabrook Station.
- Table 10-8 presents the ETE for the regions ordered to evacuate. For example, if it is determined that everyone within 5 miles of the Station should evacuate, then all communities within Region 5 (ERPA A, B, C, D) will be ordered to evacuate. The ETE of interest, then, are those which apply to evacuees who begin their trips from within 5 miles of the Station. Additional travel time from the regional boundary to the EPZ boundary is somewhat of academic interest since the evacuees are then outside the specified area of potential risk. Thus Table 10-8 presents the ETE which are of primary importance within the context of emergency planning.

Table 10-9 presents the evacuation time estimates from the beach areas, only, for Scenario 1 conditions.

The values of ETE are obtained by interpolating from IDYNEV output, which are generated at 30-minute intervals, then rounded to the nearest 5 minutes. Thus, the numerical precision of these values is within ±10 minutes. Recently, software was developed to perform this interpolation, providing somewhat more accurate estimates. Again we emphasize that all ETE are referenced to the Order to Evacuate.

Discussion of ETE

A total of 134 cases have been analyzed -- each case represents a possible evacuation protective action.

These ETE data are presented in a concise tabular format in Tables 10-4 through 10-9. Each entry in these tables is the value of ETE for the indicated circumstances (i.e., Scenario as defined in Table 10-1), protective action (i.e., Region ordered to evacuate), and radius of the circular area centered at Seabrook Station.

Sensitivity Tests

The ETEs have been calculated several times to reflect updated information. These calculations included several sensitivity studies to analyze certain variables of interest. The results of these sensitivity studies provide useful insight into the evacuation process and the resulting ETEs. The following selections summarize the results of these studies, some of which do not reflect the most current data. (The Region and Scenario definitions have not changed.) Thus these ETEs are not necessarily comparable to the ETEs shown in Tables 10-4 through 10-9. Nevertheless, these studies are useful because they indicate the sensitivities of the ETEs to variations in the underlying inputs.

Varying Beach Populations

The population of permanent residents and permanent employees within the Seabrook Station Emergency Planning Zone (EPZ) remain reasonably stable over the year. In contrast, the tourist population increases greatly during the summer months of July and August, relative to the level that prevails over the other months of the year.

The beach area population is even more volatile than the seasonal tourist population. Roughly half of the beach traffic on a crowded day is comprised of day-trippers. Thus, the beach area population is "weather-driven" as expressed by a member of a local Chamber of Commerce. If the weather is unappealing, the beach area traffic could be less than half of what it would otherwise be on a hot, sunny day. Day-of-week is another factor which influences beach population.

It is therefore prudent to quantify the "elasticity" of Evacuation Time Estimates (ETE) with respect to beach areas population, particularly in view of the high volatility of this population as noted above.

Sensitivity tests were performed, which reduced the beach population by as much as 60% below the reasonably expected peak as determined by the July 1987 aerial survey (Appendix E item 20). The results for Region 1 (entire EPZ) and Scenario 1 (summer weekend, mid-day, good weather):

Percent Difference In Beach Area Population Relative to the Peak Value	ETE	Percent Difference in ETE Relative to That for the Peak Value of Beach Area Population
0 (peak)	7:40	0.0
-20	7:05	-7.6
-40	6:35	-14.1
-60	6:10	-19.6

This study shows that for evacuation situations where the critical path population (i.e., the last population to leave the EPZ) originate their trips from the beach area, the ETE is reduced in percent by about one third the percent reduction in beach population over the indicated range.

Varying Permanent Population to 1993 Projection

The IDYNEV model was executed for all regions and scenarios using the 1993 population estimates.

- o Permanent resident population reflected 1993 estimates reported in Section 2.

- o It was assumed that transient population levels were unchanged from the peak levels identified in 1986.

- o Employee population estimates reflect 1993 levels.

The results of these computations with IDYNEV using projected residential population estimates for 1993 are presented in Tables 10-4 through 10-8

Immediate General Emergency with an Order to Evacuate (OTE)

We have explored the extreme case of an "immediate" General Emergency (GE) wherein the initial notification of the public contains an OTE. The results of these sensitivity tests are compared with the results obtained using the Planning Basis where there is 25 minutes between initial notification and the OTE:

ETE to Evacuate the EPZ

	Region 1		Region 5		Region 9	
Scenarios:	1	3	1	3	1	3
Planning Basis	6:15	7:10	6:15	6:10	5:15	4:50
Immediate GE	6:40	7:30	6:40	6:40	5:30	5:15

ETE to Evacuate the Two-Mile Area

	Region 1		Region 5		Region 9	
Scenarios:	1	3	1	3	1	3
Planning Basis	5:50	5:40	5:50	5:40	4:50	4:35
Immediate GE	6:20	6:00	6:20	5:50	5:10	4:55

As indicated above, the effect of an Immediate General Emergency is to extend the ETE up to 20-30 minutes, relative to the ETE calculated for the stated Planning Basis.

These results are consistent with our understanding of the traffic environment for Scenarios 1 and 3. Congestion occurs almost immediately in the beach areas after evacuation begins, either due to a beach closure recommendation or the issuance of an Order to Evacuate. Thus, any delay at the outset (i.e., loss of the "head-start" postulated by the Planning Basis) will translate into a commensurate increase in ETE, particularly within the two-mile area.

Slower Rates of Accident Escalation

Any increase in the head-start afforded beach-area evacuees due to a lengthening of the period between the beach closure recommendations and the Order to Evacuate, will decrease the ETE accordingly.

A series of sensitivity tests was performed to quantify these effects. Specifically, the trip generation distributions were modified as follows:

- o The trip generation distributions for all beach area centroids (representing the populace at the beaches) were unchanged. That is, the distributions used for the Planning Basis, which represented the beach areas being closed at the initial emergency classification level (Site Area Emergency) and followed by evacuation, were retained.

- o The remaining trip generation distributions were modified to reflect the following population responses:

  - Twenty-five percent of this population would evacuate prior to the issuance of the Order to Evacuate, in accord with the applicable distribution describing the event, "Ready to Evacuate."

  - The remaining 75 percent will prepare for evacuation, as determined for the Planning Basis, but will await the Order for Evacuate before starting the evacuation trip.

Three rates of accident escalation, in addition to that of the Planning Basis, were studied for the case represented by Scenario 1 (summer weekend) and Region 1 (entire EPZ ordered to evacuate). Associated with these three rates are varying elapsed times between the beach closure recommendation and the Order to Evacuate, as follows:

- o Twenty-five Minutes (used as the Planning Basis)
- o One Hour and Five Minutes
- o Two Hours and Five Minutes
- o Two Hours and Fifty Minutes

The following table presents the results generated by the IDYNEV model.

Elapsed Time from the Beach Closure to the Order to Evacuate	ETE for Evacuation from Within the Indicated Areas around the Seabrook Station, Referenced to the Order to Evacuate			
	2 miles	5 miles	10 miles	EPZ
0:25 (Planning Basis)	6:25	6:45	7:05	7:05
1:05	5:40	6:00	6:20	6:25
2:05	4:10	4:50	4:55	4:55
2:50	3:30	3:50	4:20	4:45

As indicated, the longer the elapsed time is between the beach closure and the Order to Evacuate, the lower the associated ETE. This sensitivity is most pronounced over the first three hours. During this time frame there is roughly one minute of reduction in ETE for every minute of increase in elapsed time from the SAE to the Order to Evacuate.

As this elapsed time increases beyond 2:50, it is likely that the ETE will settle down to approximately 3:25. This estimate is based on the facts that members of most households will be assembled and prepared to evacuate at the Order to Evacuate, that the transients and 25 percent of all others will have left the EPZ, and that the remaining population within the EPZ will be somewhat less than that for Scenario 8.

Evacuee Mobilization

Sensitivity runs were conducted using the IDYNEV model to study the effects of slower evacuee mobilization time following the Order to Evacuate. These runs extended the trip generation process by 40 minutes for Scenario 3 (summer, midweek, mid-day, good weather) and Regions 1, 5 and 9 (evacuation of full 10, 5, and 2 mile areas, respectively). This scenario was chosen because it accounts for beach, transients and employee populations. The results of this study indicate that while there are some differences in the internal distribution of evacuation time, there is no overall impact on the ETE.

This result would be expected because the evacuation network is saturated (i.e., links in the network experience traffic demand that exceed roadway capacity throughout the course of the evacuation). While saturated conditions exist, extending the trip generation time has little or no influence on the total time required to service the demand, as long as the extended trip generation time is materially less than the eventual evacuation time. Since the extended mobilization time in the sensitivity run was under 5 hours, which was well below the ETE for the summer scenarios, the extension of the trip generation process did not effect the ETE.

Time to Activate TCPs

As discussed in Section 7, the ETEs reflect the expected staffing rate of the TCPs. A sensitivity run was done to evaluate the net effects of traffic control for Region 1 (Entire EPZ), Scenario 1 (summer weekend, midday, good weather) and for Scenario 5 (off-season, mid-week, mid-day, good weather). The results for the individual cases are:

CASE DESCRIPTION		ETE Results Scenario 1	Scenario 5
A.	All traffic guides are at the TCPs at the start of beach evacuation	7:35	5:40
B.	Staged arrival of traffic guides at TCPs. (Using mobilization described in Section 7)	7:40	5:35
C.	No TCPs are manned throughout the evacuation	9:00	6:30

External Shadow Evacuation Time Estimates

Additional sensitivity tests were conducted to assess the impact on the ETE of anticipated voluntary evacuation by persons outside the EPZ up to a distance of 20 miles from Seabrook. Estimates of summer population in this area were obtained from State and Federal agencies. Runs were conducted for Region 1, Scenario 1, which assumed a 20% uniform rate of voluntary evacuation. This study showed that voluntary evacuation in this area, up to a 20% level, would not influence the ETE for those evacuating from within the ETE.

Effect of Road Impediments

A sensitivity study was done to evaluate the effect of ten road impediments on a Region 1, Scenario 1 evacuation. The number 10 represents the number of automobile accidents that would be anticipated based on vehicles miles of travel during an evacuation. (See discussion in Section 12.) This study also used the overly conservative assumption that all accidents resulted in road impedances. The results show that impedances of one to two hours in duration resulted in an ETE increase of 0 - 10 minutes. Impedances of two to three hours in duration resulted in an ETE increase of 30 - 60 minutes. Note that the ETE is not extended the same amount as the longest impediment since traffic is free to redistribute on alternative outbound routes, if one route is experiencing some loss of capacity.

Highway Improvements

In Section 3, five candidate highway improvements were described. Of these, it was concluded that two of them would significantly reduce the ETE for summer scenarios.

These conclusions were drawn from the results obtained from a series of sensitivity tests conducted for Scenario 1 (summer weekend) and Region 1 (entire EPZ):

Highway Improvements	ETE for Evacuation from Within the Indicated Areas around the Seabrook Station, Referenced to the Order to Evacuate			
	2 Miles	5 Miles	10 Miles	EPZ
Planning Basis	5:50	6:10	6:15	6:15
Candidates 1 and 2:				
Widen Routes 286 & 51	3:40	5:15	5:40	6:15
All 5 Candidates	3:40	4:15	5:40	5:50

Note that highway improvement Candidates 1 and 2 provide a two-hour (37 percent) reduction in ETE for those evacuating from within two miles of Seabrook Station, including Hampton and Seabrook beaches. These improvements also afford a one-hour (15 percent) reduction in ETE for those evacuating from within a five-mile radius of the Station. A lesser reduction in ETE (35 minutes, 10 percent) is realized by those evacuating from within 10 miles of the Station.

Additional highway improvements provide incremental benefits primarily to those within five miles of the Station; here, the reduction in ETE, relative to the Planning Basis ETE, is almost 2 hours (30 percent), double the reduction provided by Candidates 1 and 2. These additional highway improvements would not substantially benefit people outside the 5-mile area. We have not identified which of candidate improvements 3, 4 and/or 5 provide these incremental reductions in ETE.

Patterns of Traffic Congestion during Evacuation (Region 1, Scenarios 1 and 5)

Figures 10-2a through 10-2d illustrate the patterns of traffic congestion which arise for the case when the entire EPZ is ordered to evacuate (Region 1) on a summer weekend day at the time when the beach area population is at capacity (Scenario 1).

Traffic congestion, as the term is used here, is defined as Level of Service F. This term is defined in the 1985 Highway Capacity Manual, as follows:

- Level-of-Service F is used to define forced or breakdown flow. This condition exists wherever the amount of traffic approaching a point exceeds the amount which can traverse the point. Queues form behind such locations. Operations within the queue are characterized by stop-and-go waves, and they are extremely unstable. Vehicles may progress at reasonable speeds for several hundred feet or more, then be required to stop in a cyclic fashion. Level-of-Service F is used to describe the operating conditions within the queue, as well as the point of the breakdown. It should be noted, however, that in many cases operating conditions of vehicles or pedestrians discharged from the queue may be quite good. Nevertheless, it is the point at which arrival flow exceeds discharge flow which causes the queue to form, and Level-of-Service F is an appropriate designation for such points.

This definition is general and conceptual in nature, and applies primarily to uninterrupted flow. Levels of service for interrupted flow facilities vary widely in terms of both the user's perception of service quality and the operational variables used to describe it.

All highway "links" which experience Level-of-Service F are delineated in the Figures by a thick dark line. All others are lightly indicated.

As expected, for Region 1, Scenario 1, traffic congestion develops rapidly (see Figure 10-2a) within the beach areas and along the major beach egress routes. Congestion spreads shortly afterwards to the major population centers (Amesbury, Exeter, Hampton, Merrimac, Newburyport, Portsmouth and Seabrook) and along the major egress routes (Rts. 51, 110, 107, 108, 1, 151, 101 and 1A). Shortly after 3:30, Amesbury, Exeter and Merrimac have essentially cleared while the beach areas and the other population centers remain congested. Hampton and Newburyport clear by shortly after 5:30.

Gradually, the congestion attenuates. Shortly after 5:30, all of Massachusetts is clear of congestion. The evacuation of Seabrook Beach is delayed by the joining of beach area traffic with inland traffic at points where Route 286 meets Route 1 and Main Street. Hampton Beach traffic moves west (along Route 51) and north (along Route 1A).

The access roads leading to I-95 northbound in Portsmouth remains congested throughout the evacuation process.

Figures 10-3a through 10-3c illustrate the patterns of traffic congestion which arise for the case when the entire EPZ is ordered to evacuate (Region 1) on a midweek day outside the tourist season, at a time when employment is at a peak (Scenario 5).

The pattern for this case differs from the previous one, in that congestion develops rapidly within population (and employment) centers, rather than in the beach areas. With the exception of Exeter (which clears within 3 hours due to the many egress routes available), congestion prevails in these centers for over 3 hours. Amesbury, Exeter, Hampton and Merrimac are clear within 4 hours; Seabrook clears shortly thereafter. Newburyport is almost clear by 5 hours while Portsmouth remains congested until the end of the evacuation process, as before.

Distribution of Population and Vehicles

The NRC/FEMA guidelines in NUREG 0654 recommend that the distribution of population (see Section 2 and 5 for source data) and of vehicles within the Emergency Planning Zone (EPZ) be presented in the format of population roses. Figures 10-4 through 10-9 present this information for the three population groups considered:

- o Permanent Residents
- o Employees who Live Outside the EPZ
- o Transients

These population roses present the peak population identified for each group. Note that the evacuation scenarios are a mix of peak and off-peak values for the transient and employee population groups [permanent resident population is always assumed to be present at peak levels]. Details of the population considiered for each evacuation scenario are presented in Appendix M.

The Figures are identified below:

Description	Population	Vehicles
Permanent Residents	10-4	10-5
Employees	10-6	10-7
Transients	10-8	10-9

It must be emphasized that this format is for presentation purposes, only. To define the spatial distribution of traffic demand at a higher level of resolution a total of 153 Origin Nodes (i.e., centroids) were created. Each represents an area (or "Zone") within a community. The traffic demands at all such centroids are presented in Appendix M. The locations of these centroids are shown in Figure 1-3.

Summary of Evacuation Time Analysis

A summary of evacuation times is presented in Tables 10-10, which are presented in the format recommended in Appendix 4 of NUREG 0654. The analyses of Confirmation Time and of the ETE for Special Population segments are presented in Sections 12 and 11, respectively.

The estimates of 1993 Permanent Resident and Vehicle Population are those of Table 2-1. These town estimates were aggregated to form ERPA estimates and then Region estimates. The transient population includes all transients -- tourists, beach area day-trippers and employees who live outside the EPZ. These estimates were presented in Sections 2 and 5.

The column labeled Evacuation Capacity Per Hour for each region was ascertained by aggregating the highway capacities of all outward-bound roads which pierce the region's outer boundary. Here, we have employed the capacity estimates associated with Level of Service F conditions, which is estimated at 85 percent of the LOS E values obtained from the 1985 Highway Capacity Manual.

The capacities given represent clear weather conditions. These capacities are reduced by 20 percent for rain and 25 percent for snow. It is assumed that all roads are passable and that the recommended traffic control tactics are in effect.

These estimates of available capacity may overstate the actual accessible capacity. Specifically, the high capacities offered by the Interstate Highways (I-95, I-495) cannot be fully utilized due to the limited number of entry ramps within the EPZ and to the limited capacities of these ramps. Reference to Figures 10-2a through 10-3c indicate that these Interstate Highways are never congested, while many entry ramps to these highways are congested over a period of many hours. These entries are not used in the calculation of ETE since they represent only the potential capacity and not the actual capacity utilized during an EPZ evacuation.

The estimated notification, preparation and response (i.e. trip-generation) times which are listed correspond to the 100th percentile of the indicated population. That is, these are the times associated with the completion of the indicated process. The process itself (i.e., notification, preparation to evacuate, and departing on the evacuation trip) is best represented as a continuous distribution (see Table 4-2) which numerically depicts the continuous nature of the process.

TABLE 10-4

ESTIMATED TIMES (HRS.:MIN.) TO EVACUATE FROM WITHIN 2 MILES OF SEABROOK STATION AFTER THE ORDER TO EVACUATE FROM THE INDICATED REGIONS, FOR THE INDIVIDUAL EVACUATION SCENARIOS

	Region													
Scenario	1	5	6	7	8	9	10	11	12	13	14	15	16	17
1	6:30	6:00	6:00	5:45	5:45	5:45	5:40	6:25	6:10	6:00	5:45	5:55	6:00	6:30
2	8:25	7:50	7:50	7:15	7:15	7:00	7:20	7:55	7:45	7:55	7:15	7:50	7:55	8:25
3	4:55	4:30	4:30	4:15	4:15	4:15	4:25	5:00	4:50	4:30	4:15	4:30	4:30	4:55
4	6:25	6:00	5:50	5:35	6:00	5:35	5:35	6:40	6:30	6:10	6:00	5:50	6:10	6:25
5	3:50	3:50	3:55	3:55	3:50	3:55		3:50	3:50	3:50	3:50	3:55	3:50	3:50
6	4:00	4:00	3:55	3:55	4:00	3:55		4:00	4:00	4:00	4:00	3:55	4:00	4:00
7	5:05	5:05	5:05	5:05	5:05	5:05		5:05	5:05	5:05	5:05	5:05	5:05	5:05
8	3:35	3:35	3:35	3:35	3:35	3:35		3:35	3:35	3:35	3:35	3:35	3:35	3:35
9	3:35	3:35	3:35	3:35	3:35	3:35		3:35	3:35	3:35	3:35	3:35	3:35	3:35
10	4:35	4:35	4:35	4:35	4:35	4:35		4:35	4:35	4:35	4:35	4:35	4:35	4:35

TABLE 10-5

ESTIMATED TIMES (HRS.:MIN.) TO EVACUATE FROM WITHIN 5 MILES OF SEABROOK STATION AFTER THE ORDER TO EVACUATE FROM THE INDICATED REGIONS, FOR THE INDIVIDUAL EVACUATION SCENARIOS

	Region													
Scenario	1	5	6	7	8	9	10	11	12	13	14	15	16	17
1	6:40	6:10	6:10	6:00	6:00	6:00	6:00	6:30	6:15	6:30	6:00	6:10	6:15	6:40
2	8:45	8:05	8:05	7:35	7:35	7:30	7:40	8:05	8:00	8:10	7:35	8:05	8:10	8:45
3	6:15	4:40	4:40	4:30	4:30	4:30	5:00	6:05	5:00	5:10	4:55	4:40	5:00	6:15
4	7:55	6:10	6:10	6:00	6:10	6:00	6:15	7:55	6:35	6:30	6:35	6:10	6:40	7:55
5	4:25	4:05	4:05	4:00	4:00	4:00		4:25	4:05	4:05	4:00	4:05	4:05	4:25
6	5:45	5:15	5:15	4:05	4:25	4:05		5:45	5:25	5:20	4:25	5:15	5:25	5:45
7	6:25	5:55	5:55	5:25	5:35	5:25		6:25	5:55	5:55	5:35	5:55	5:55	6:25
8	3:55	3:45	3:45	3:40	3:40	3:40		3:55	3:55	3:55	3:55	3:55	3:55	3:55
9	4:10	3:45	3:45	3:45	3:45	3:40		4:00	3:55	3:55	3:55	3:55	3:55	4:10
10	5:05	5:05	4:55	4:55	5:05	4:55		5:05	4:55	5:05	5:05	4:55	5:05	5:05

TABLE 10-6

ESTIMATED TIMES (HRS.:MIN.) TO EVACUATE FROM WITHIN 10 MILES OF SEABROOK STATION AFTER THE ORDER TO EVACUATE FROM THE INDICATED REGIONS, FOR THE INDIVIDUAL EVACUATION SCENARIOS

	Region													
Scenario	1	5	6	7	8	9	10	11	12	13	14	15	16	17
1	7:00	6:30	6:30	6:10	6:10	6:10	6:05	6:40	6:30	6:30	6:10	6:30	6:30	7:00
2	9:00	8:30	8:30	7:40	7:40	7:35	8:00	8:20	8:00	8:30	7:40	8:30	8:30	9:00
3	7:00	5:10	5:10	4:40	4:35	4:45	5:10	6:55	5:40	6:00	4:40	5:10	5:45	7:00
4	9:00	6:50	6:50	6:15	6:15	6:15	6:30	8:55	7:30	7:30	6:15	6:50	7:35	9:00
5	5:35	4:10	4:10	4:05	4:05	4:05		5:35	4:25	4:30	4:05	4:10	5:05	5:35
6	7:25	5:30	5:30	4:25	4:25	4:25		7:25	5:45	5:45	4:25	5:30	6:40	7:25
7	8:00	6:00	6:00	5:30	5:55	5:30		7:55	6:05	6:20	5:55	6:00	7:15	8:00
8	4.30	3:55	3:55	3:55	3:55	3:55		4:30	3:55	3:55	3:55	3:55	3:55	4:30
9	5:45	4:05	4:00	3:55	4:05	4:05		5:40	4:30	4:55	3:55	4:05	5:05	5:45
10	6:30	5:10	5:10	5:00	5:10	5:00		6:35	5:20	5:10	5:10	5:15	5:30	6:30

TABLE 10-7

ESTIMATED TIMES (HRS.:MIN.) TO EVACUATE FROM WITHIN THE SEABROOK STATION EPZ AFTER THE ORDER TO EVACUATE FROM THE INDICATED REGIONS, FOR THE INDIVIDUAL EVACUATION SCENARIOS

	Region													
Scenario	1	5	6	7	8	9	10	11	12	13	14	15	16	17
1	7:05	6:35	6:35	6:30	6:30	6:30	6:15	6:40	6:30	6:35	6:30	6:35	6:35	7:05
2	9:10	8:35	8:35	8:00	8:05	7:45	8:05	8:30	8:05	8:35	8:00	8:35	8:35	9:10
3	7:05	5:15	5:15	4:45	5:00	4:45	5:15	7:05	5:45	6:05	4:45	5:15	6:00	7:05
4	9:10	7:00	7:00	6:15	6:55	6:15	6:35	9:05	7:40	7:35	6:15	7:00	7:45	9:10
5	5:55	4:25	4:25	4:30	4:30	4:30		5:55	4:25	4:30	4:25	4:25	5:05	5:55
6	7:35	5:30	5:30	4:30	4:30	4:30		7:35	5:45	5:45	4:30	5:30	6:40	7:35
7	8:00	6:00	6:00	5:30	5:55	5:30		8:00	6:25	6:25	5:55	6:00	7:15	8:00
8	4:30	4:00	4:00	4:00	4:00	4:00		4:30	3:55	4:00	4:00	4:00	4:00	4:30
9	6:00	4:00	4:00	4:00	4:00	4:00		6:00	4:30	4:55	4:00	4:00	5:05	6:00
10	6:30	5:25	5:25	5:25	5:10	5:25		6:30	5:30	5:25	5:10	5:25	5:30	6:30

TABLE 10-8

ESTIMATED TIMES (HRS.:MIN.) TO EVACUATE FROM WITHIN THE ASSOCIATED AREA ABOUT THE SEABROOK STATION AFTER THE ORDER TO EVACUATE FROM THE INDICATED REGIONS, FOR THE INDIVIDUAL EVACUATION SCENARIOS

	Region													
Scenario	1	5	6	7	8	9	10	11	12	13	14	15	16	17
1	7:05	6:15	6:15	5:45	5:45	5:45	6:00	6:40	6:15	6:30	5:45	6:15	6:35	7:05
2	9:10	8:10	8:10	7:15	7:15	7:00	7:45	8:30	8:00	8:15	7:15	8:10	8:30	9:10
3	7:05	5:00	5:00	4:15	4:30	4:15	5:00	7:05	5:30	5:35	4:30	5:00	5:35	7:05
4	9:10	6:15	6:15	5:35	6:10	5:35	6:05	9:05	7:05	7:05	6:10	6:15	7:15	9:10
5	5:55	4:05	4:05	4:00	4:00	3:55		5:55	4:25	4:30	4:00	4:05	5:05	5:55
6	7:35	5:20	5:20	4:00	4:25	3:55		7:35	5:45	5:45	4:25	5:20	6:40	7:35
7	8:00	6:00	6:00	5:10	5:55	5:05		8:00	5:55	6:20	5:55	6:00	7:15	8:00
8	4:30	3:55	3:55	3:40	3:40	3:35		4:30	3:55	3:55	3:40	3:55	3:55	4:30
9	6:00	3:55	3:55	3:40	3:40	3:55		6:00	4:35	4:55	3:40	3:55	5:05	6:00
10	6:30	5:05	4:55	4:45	5:05	4:35		6:30	5:00	5:10	5:05	4:55	5:30	6:30

Table 10-10A
Summary of Results of Evacuation Time Analysis: Scenarios 1 & 2

						Relative To Siren Alert						From Recommendation To Evacuate				
								Permanent Response		Transient Response		General Pop. Evacuation			Special Population Evacuation	
	Permanent		Transient		Evacuati	Notify	Prep.	Time	Time	Time	Time	Time	Time	Confirm	Time	Time
Areas	Pop.	Vehs.	Pop.	Vehs.	Capacity	Time	Time	Clear	Adverse	Clear	Adverse	Clear	Adverse	Time	Clear	Adverse
Within Two Miles																
Region 9	9831	3781	36842	15960	11936	00:40	03:30	03:55	03:55	02:10	02:10	05:45	07:00	00:40	05:45	07:00
Within Five Miles																
Region 5	51744	19901	70481	31832	29819	00:40	03:30	03:55	03:55	02:10	02:10	06:15	08:10	01:15	06:15	08:10
Region 6	26052	10020	50759	22334	17959	00:4C	03:30	03:55	03:55	02:10	02:10	06:15	08:10	00:40	06:15	08:10
Region 7	12304	4732	37688	16385	15316	00:40	03:30	03:55	03:55	02:10	02:10	05:45	07:15	00:40	05:45	07:15
Region 8	33050	12711	55718	25033	22785	00:40	03:30	03:55	03:55	02:10	02:10	05:45	07:15	00:40	05:45	07:15
Within EPZ Boundary																
Region 1	145427	55934	98706	47099	36389	00:40	03:30	03:55	03:55	02:10	02:10	07:05	09:10	01:15	07:05	09:10
Region 11	88143	33901	82942	38405	24344	00:40	03:30	03:55	03:55	02:10	02:10	06:40	08:30	01:15	06:40	08:30
Region 12	78916	30352	72822	33306	15466	00:40	03:30	03:55	03:55	02:10	02:10	06:15	08:00	01:15	06:15	08:00
Region 13	83558	32137	83904	39052	23885	00:40	03:30	03:55	03:55	02:10	02:10	06:30	08:15	01:15	06:30	08:15

Table 10-10B
Summary of Results of Evacuation Time Analysis: Scenarios 3 & 4

						Relative To Siren Alert						From Recommendation To Evacuate				
								Permanent Response		Transient Response		General Pop. Evacuation			Special Population Evacuation	
	Permanent		Transient		Evacuati	Notify	Prep.	Time	Time	Time	Time	Time	Time	Confirm	Time	Time
Areas	Pop.	Vehs.	Pop.	Vehs.	Capacity	Time	Time	Clear	Adverse	Clear	Adverse	Clear	Adverse	Time	Clear	Adverse
								Within Two Miles								
Region 9	9831	3781	29465	13147	11936	00:40	03:30	03:55	03:55	02:10	02:10	04:15	05:35	00:40	04:15	05:35
								Within Five Miles								
Region 5	51744	19901	59188	28925	29819	00:40	03:30	03:55	03:55	02:10	02:10	05:00	06:15	01:15	05:00	06:15
Region 6	26052	10020	40779	18683	17959	00:40	03:30	03:55	03:55	02:10	02:10	05:00	06:15	00:40	05:00	06:15
Region 7	12304	4732	30225	13573	15316	00:40	03:30	03:55	03:55	02:10	02:10	04:15	05;35	00:40	04:15	05:35
Region 8	33050	12711	47114	22963	22785	00:40	03:30	03:55	03:55	02:10	02:10	04:30	06:10	00:40	04:30	06:10
								Within EPZ Boundary								
Region 1	145427	55934	92967	51247	36389	00:40	03:30	03:55	03:55	02:10	02:10	07:05	09:10	01:15	07:05	09:10
Region 11	88143	33901	73829	38421	24344	00:40	03:30	03:55	03:55	02:10	02:10	07:05	09:05	01:15	07:05	09:05
Region 12	78916	30352	62909	31722	15466	00:40	03:30	03:55	03:55	02:10	02:10	05:30	07:05	01:15	05:30	07:05
Region 13	83558	32137	74607	38954	23885	00:40	03:30	03:55	03:55	02:10	02:10	05:35	07:05	01:15	05:35	07:05

Table 10-10C
Summary of Results of Evacuation Time Analysis: Scenarios 5 & 6

						Relative To Siren Alert						From Recommendation To Evacuate				
	Permanent		Transient					Permanent Response		Transient Response		General Pop. Evacuation			Special Population Evacuation	
Areas	Pop.	Vehs.	Pop.	Vehs.	Evacuati Capacity	Notify Time	Prep. Time	Time Clear	Time Adverse	Time Clear	Time Adverse	Time Clear	Time Adverse	Confirm Time	Time Clear	Time Adverse
Within Two Miles																
Region 9	9831	3781	6422	3634	11936	00:40	03:30	03:55	03:55	02:10	02:10	03:55	03:55	00:40	03:55	03:55
Within Five Miles																
Region 5	51744	19901	16044	11292	29819	00:40	03:30	03:55	03:55	02:10	02:10	04:05	05:20	01:15	04:05	05:20
Region 6	26052	10020	9558	5934	17959	00:40	03:30	03:55	03:55	02:10	02:10	04:05	05:20	00:40	04:05	05:20
Region 7	12304	4732	6706	3864	15316	00:40	03:30	03:55	03:55	02:10	02:10	04:00	04:00	00:40	04:00	04:00
Region 8	33050	12711	12624	8762	22785	00:40	03:30	03:55	03:55	02:10	02:10	04:00	04:25	00:40	04:00	04:25
Within EPZ Boundary																
Region 1	145427	55934	35837	27879	36389	00:40	03:30	03:55	03:55	02:10	02:10	05:55	07:35	01:15	05:55	07:35
Region 11	88143	33901	24417	18199	24344	00:40	03:30	03:55	03:55	02:10	02:10	05:55	07:35	01:15	05:55	07:35
Region 12	78916	30352	18981	13764	15466	00:40	03:33	03:55	03:55	02:10	02:10	04:25	05:45	01:15	04:25	05:45
Region 13	83558	32137	24525	18497	23885	00:40	03:30	03:55	03:55	02:10	02:10	04:30	05:45	01:15	04:30	05:45

Table 10-10D
Summary of Results of Evacuation Time Analysis: Scenarios 8 & 9

						Relative To Siren Alert						From Recommendation To Evacuate				
								Permanent Response		Transient Response		General Pop. Evacuation			Special Population Evacuation	
	Permanent		Transient		Evacuati	Notify	Prep.	Time	Time	Time	Time	Time	Time	Confirm	Time	Time
Areas	Pop.	Vehs.	Pop.	Vehs.	Capacity	Time	Time	Clear	Adverse	Clear	Adverse	Clear	Adverse	Time	Clear	Adverse
								Within Two Miles								
Region 9	9831	3781	4822	2255	11936	00:40	03:30	03:55	03:55	02:10	02:10	03:35	03:55	00:40	03:35	03:55
								Within Five Miles								
Region 5	51744	19901	8301	4619	29819	00:40	03:30	03:55	03:55	02:10	02:10	03:55	03:55	01:15	03:55	03:55
Region 6	26052	10020	6282	3112	17959	00:40	03:30	03:55	03:55	02:10	02:10	03:55	03:55	00:40	03:55	03:55
Region 7	12304	4732	4921	2324	15316	00:40	03:30	03:55	03:55	02:10	02:10	03:40	03:40	00:40	03:40	03:40
Region 8	33050	12711	6742	3693	22785	00:40	03:30	03:55	03:55	02:10	02:10	03:40	03:40	00:40	03:40	03:40
								Within EPZ Boundary								
Region 1	145427	55934	14037	9086	36389	00:40	03:30	03:55	03:55	02:10	02:10	04:30	06:00	01:15	04:30	06:00
Region 11	88143	33901	10915	6562	24344	00:40	03:30	03:55	03:55	02:10	02:10	04:30	06:00	01:15	04:30	06:00
Region 12	78916	30352	9123	5268	15466	00:40	03:30	03:55	03:55	02:10	02:10	03:55	04:35	01:15	03:55	04:35
Region 13	83558	32137	10597	6494	23885	00:40	03:30	03:55	03:55	02:10	02:10	03:55	04:55	01:15	03:55	04:55

FIGURE 10-2A

TRAFFIC CONGESTION PATTERNS FOR REGION 1,

SCENARIO 1, AT TIME 0:40 AFTER ORDER TO EVACUATE

FIGURE 10-2B

TRAFFIC CONGESTION PATTERNS FOR REGION 1, SCENARIO 1, AT TIME 1:40 AFTER ORDER TO EVACUATE

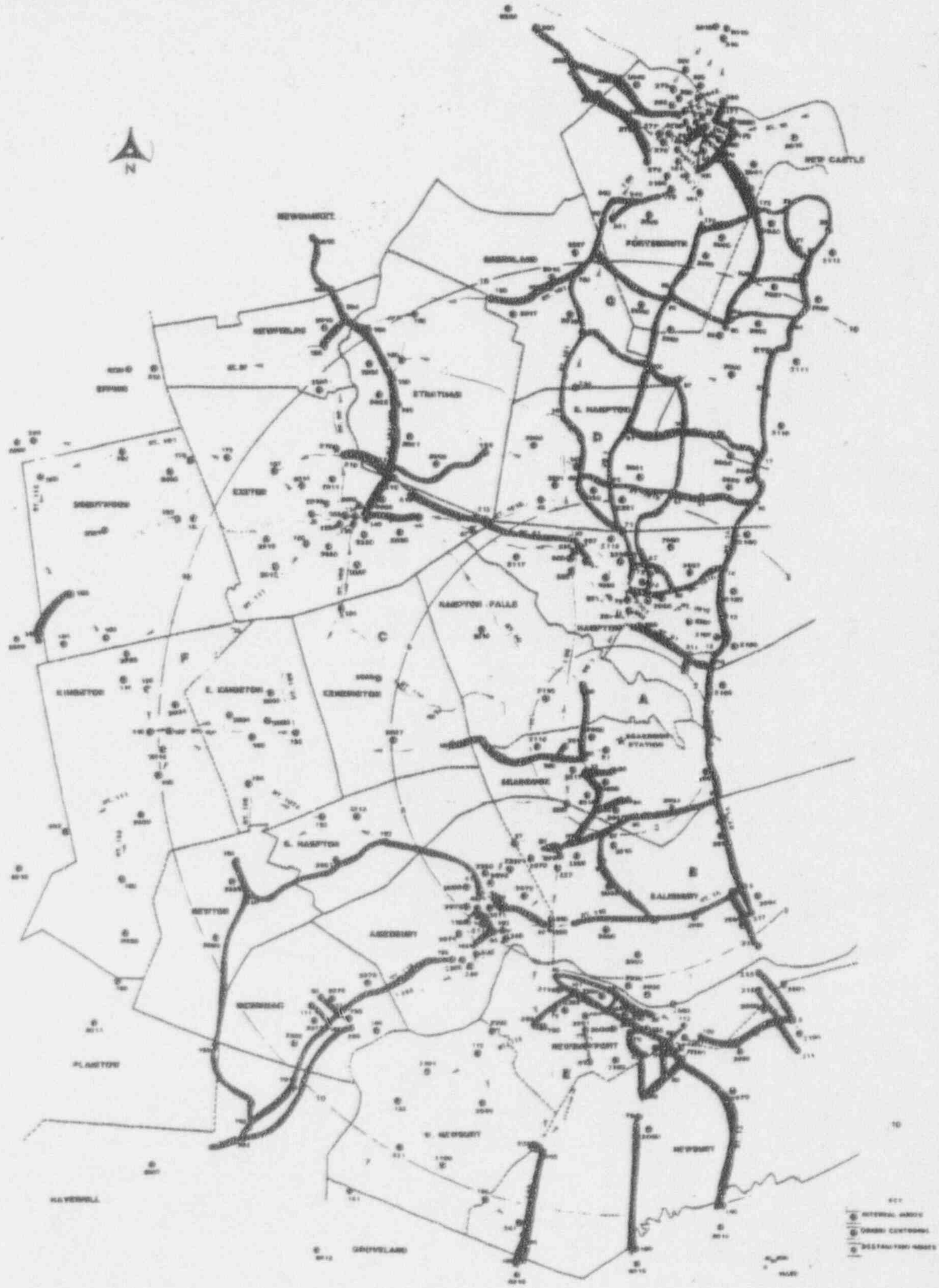


FIGURE 10-2C

TRAFFIC CONGESTION PATTERNS FOR REGION 1, SCENARIO 1, AT TIME 2:40 AFTER ORDER TO EVACUATE

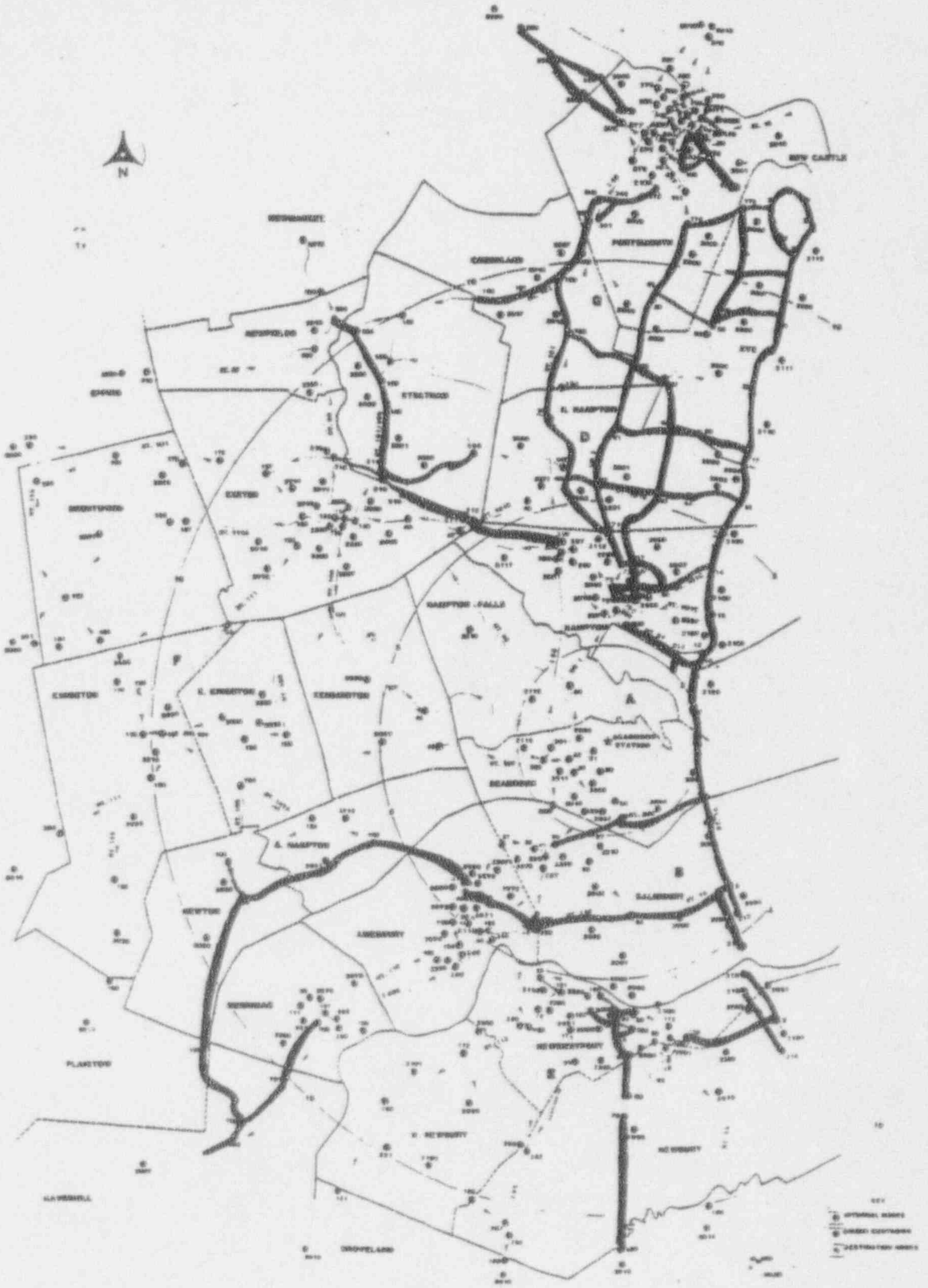
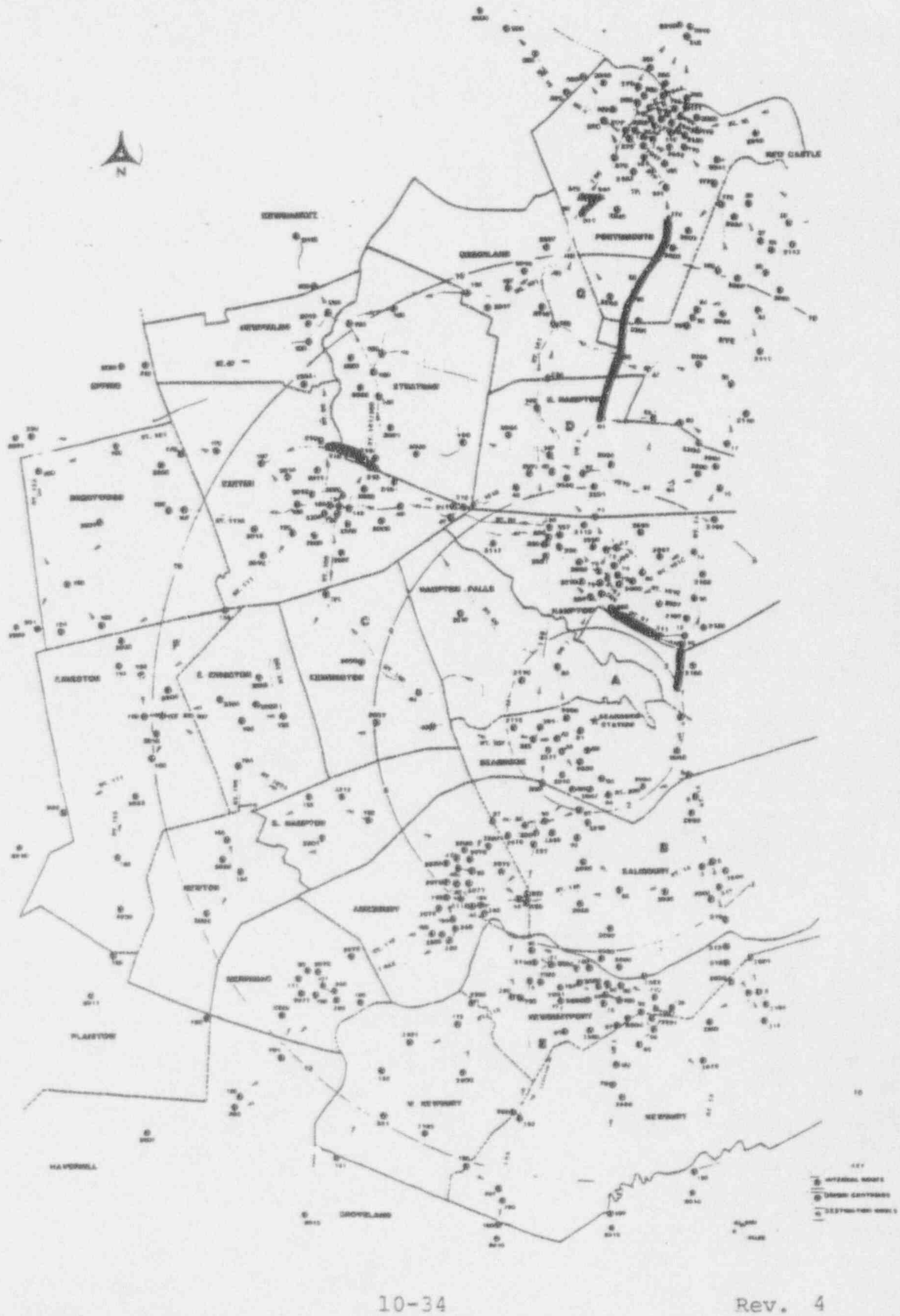


FIGURE 10-2D

TRAFFIC CONGESTION PATTERNS FOR REGION 1,

SCENARIO 1, AT TIME 6:00 AFTER ORDER TO EVACUATE



 Rev. 4

FIGURE 10-3A

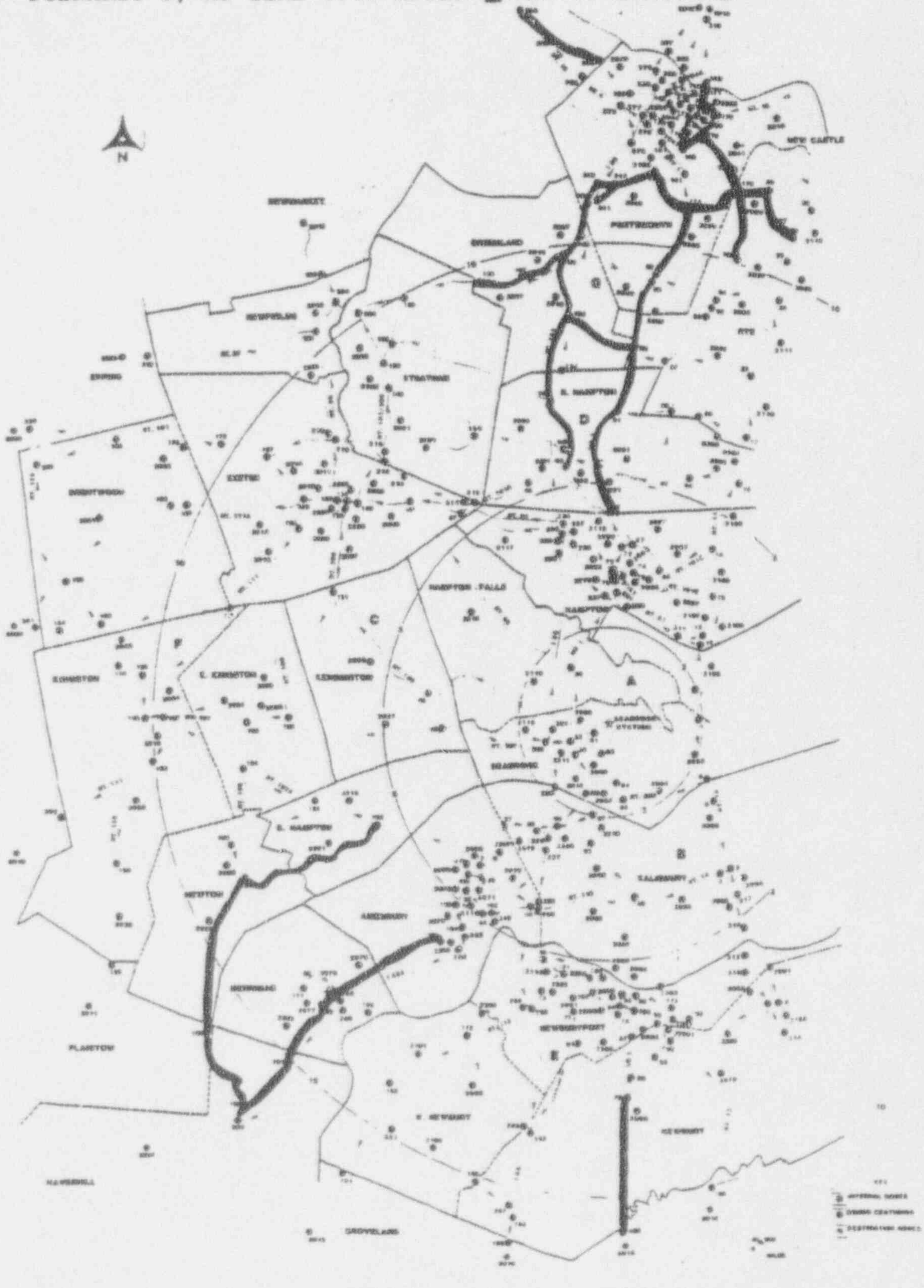
TRAFFIC CONGESTION PATTERNS FOR REGION 1, SCENARIO 5, AT TIME 1:00 AFTER ORDER TO EVACUATE

FIGURE 10-3B

TRAFFIC CONGESTION PATTERNS FOR REGION 1, SCENARIO 5, AT TIME 2:00 AFTER ORDER TO EVACUATE

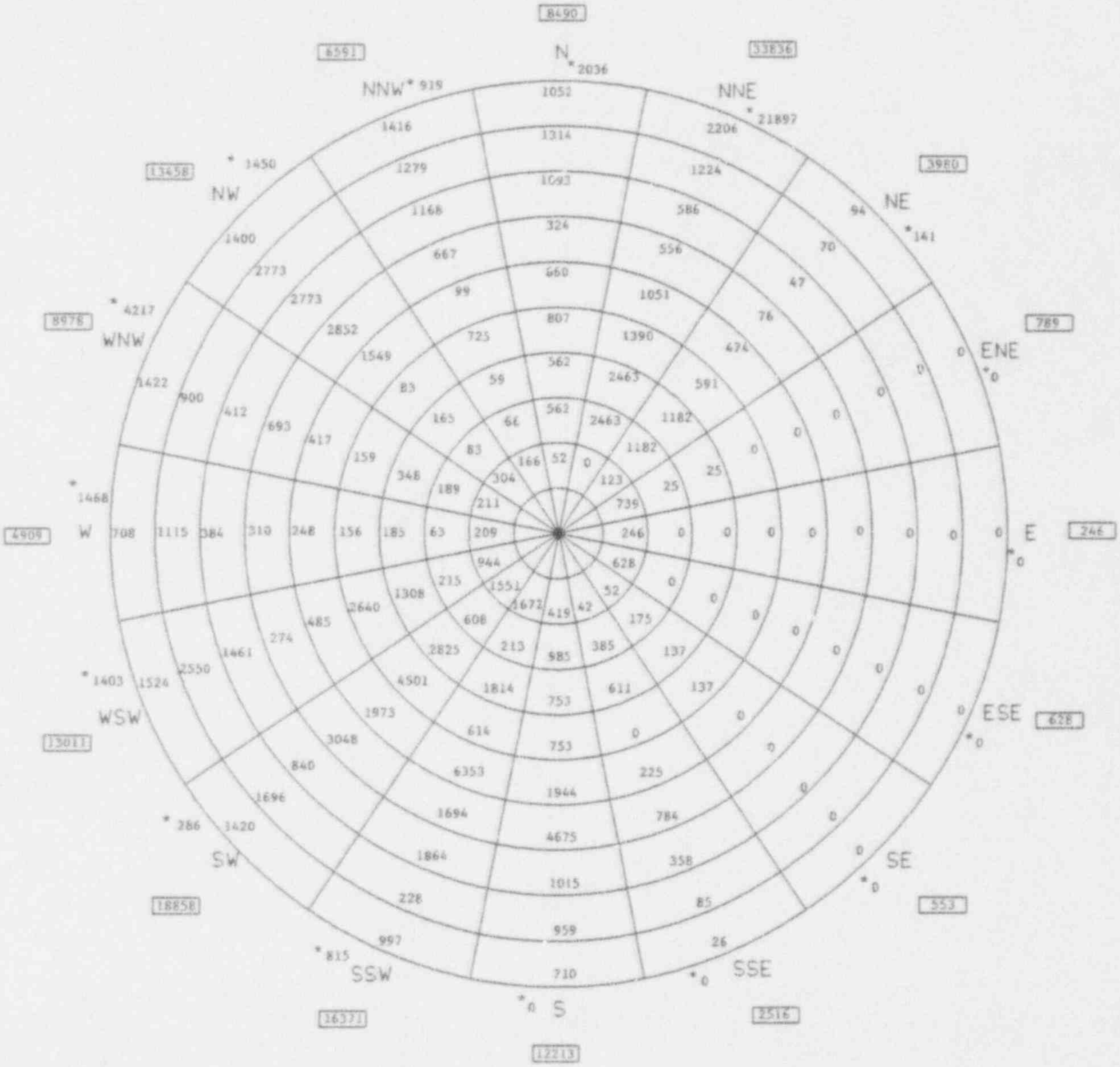
FIGURE 10-3C

TRAFFIC CONGESTION PATTERNS FOR REGION 1, SCENARIO 5, AT TIME 4:00 AFTER ORDER TO EVACUATE



<u>FIGURE 10-4</u>

<u>PERMANENT RESIDENTS</u>

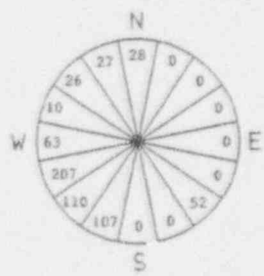


Total Segment Residents 0 To 10 Miles.

* Population between 10 mile ring and EPZ boundary.

PERMANENT RESIDENTS TOTALS			
RING MILES	RING SUBTOTAL	TOTAL MILES	CUMULATIVE TOTAL
0-1	630	0-1	630
1-2	7358	1-2	7988
2-3	7214	2-3	15202
3-4	12437	3-4	27639
4-5	12556	4-5	40195
5-6	15478	5-6	55673
6-7	15953	6-7	71626
7-8	12001	7-8	83627
8-9	14193	8-9	97820
9-10	12975	9-10	110795
10-EPZ	34632	10-EPZ	145427

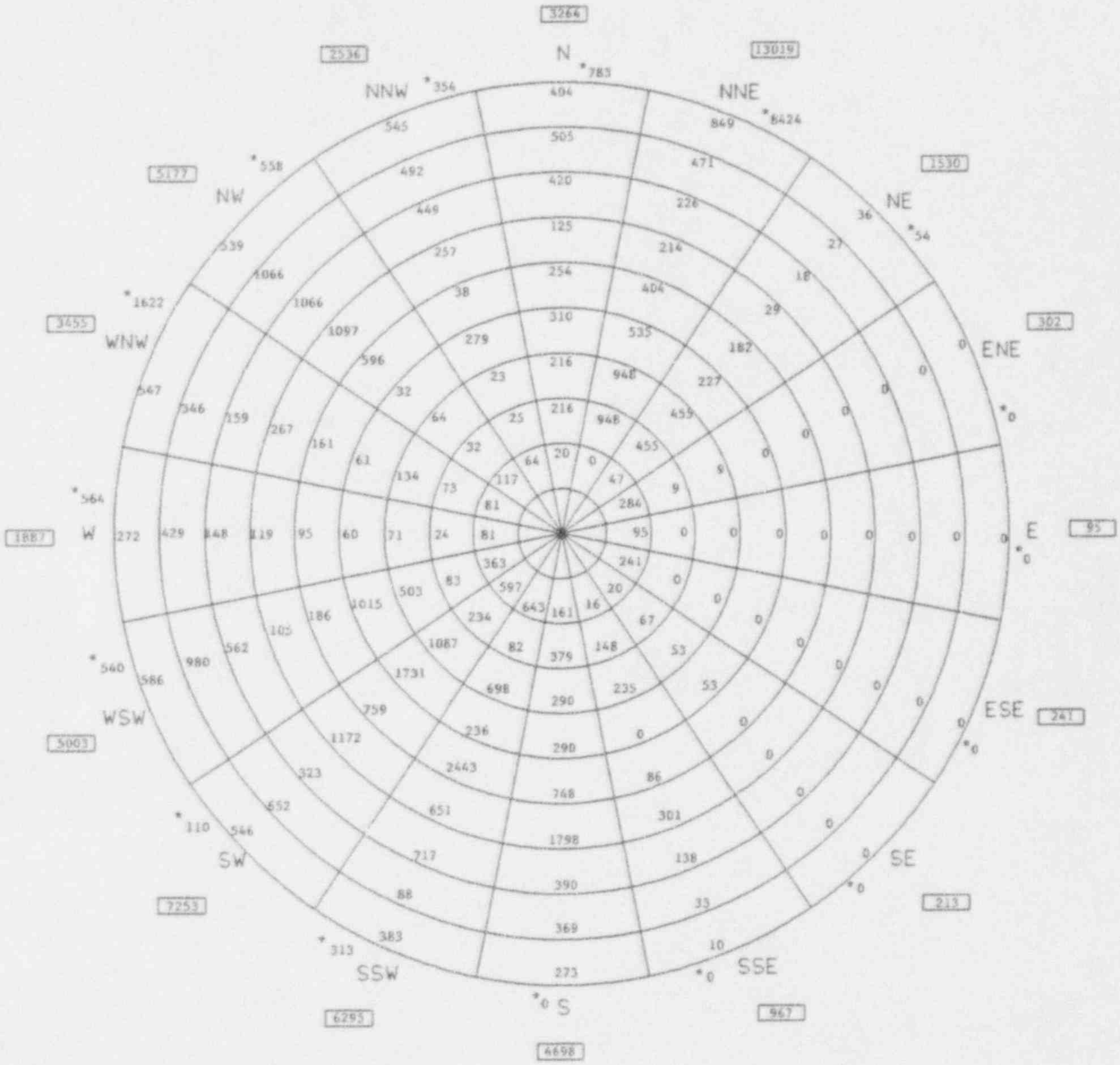
EPLAN\E010236.DGN



DETAIL OF 1 MILE RING

FIGURE 10-5

PERMANENT RESIDENT VEHICLES

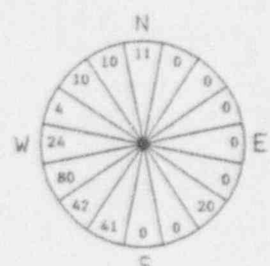


Total Segment Vehicles 0 To 10 Miles.

* Number of Resident Vehicles between 10 mile ring and EPZ boundary.

PERMANENT RESIDENT VEHICLES			
RING MILES	RING SUBTOTAL	TOTAL MILES	CUMULATIVE TOTAL
0-1	242	0-1	242
1-2	2830	1-2	3072
2-3	2775	2-3	5847
3-4	4786	3-4	10633
4-5	4829	4-5	15462
5-6	5952	5-6	21414
6-7	6135	6-7	27549
7-8	4616	7-8	32165
8-9	5458	8-9	37623
9-10	4990	9-10	42613
10-EPZ	13322	10-EPZ	55935

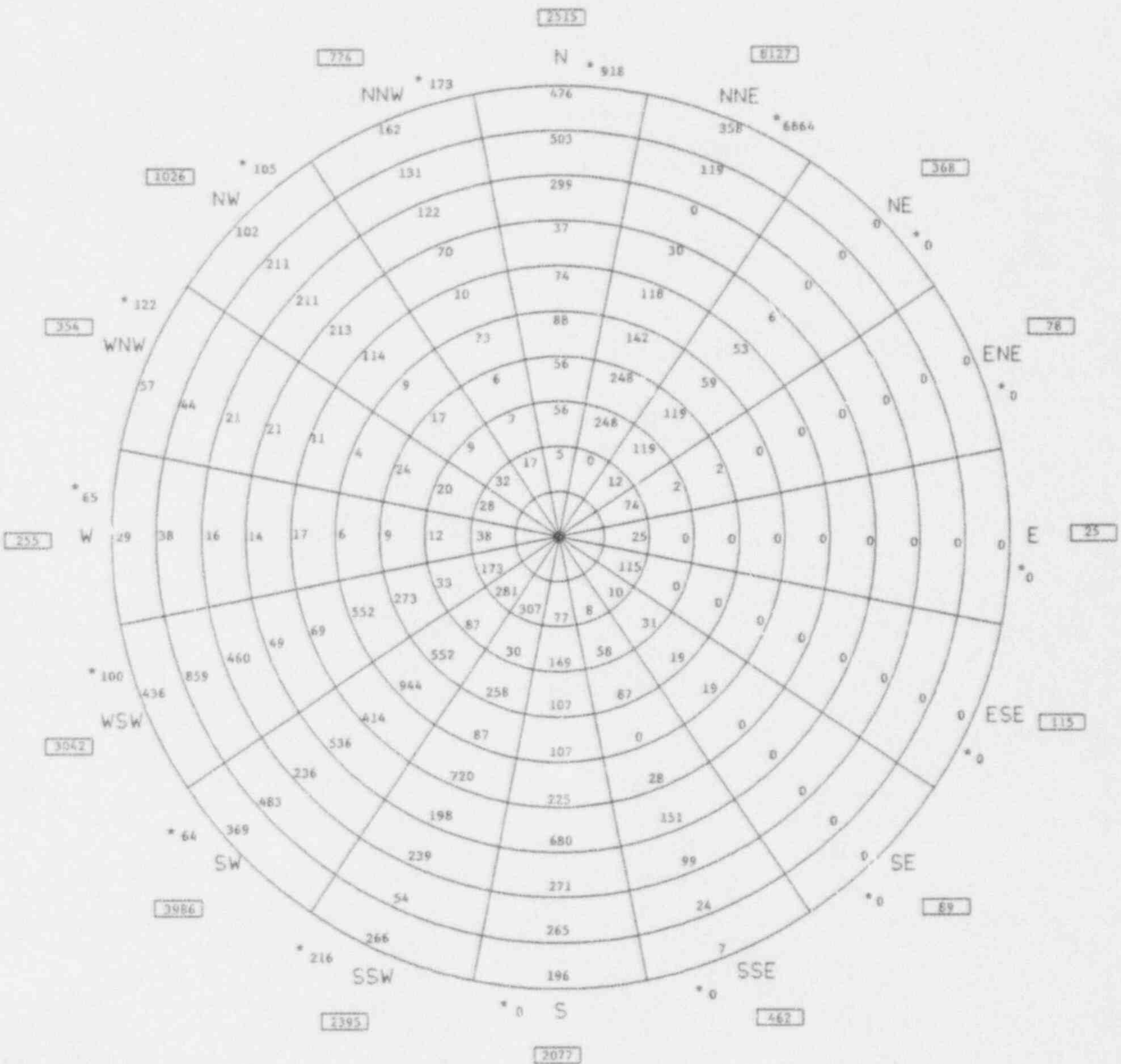
EPLAN\E010236.DGN



DETAIL OF 1 MILE RING

FIGURE 10-6

EMPLOYEES



[ ] Total Employees 0 To 10 Miles.

* Number of Employees between 10 mile ring and EPZ boundary.

TOTAL NUMBER OF EMPLOYEES			
RING MILES	RING SUBTOTAL	TOTAL MILES	CUMULATIVE TOTAL
0-1	110	0-1	110
1-2	1202	1-2	1312
2-3	861	2-3	2173
3-4	1777	3-4	3950
4-5	2090	4-5	6040
5-6	1853	5-6	7893
6-7	2005	6-7	9898
7-8	1974	7-8	11872
8-9	2731	8-9	14603
9-10	2458	9-10	17061
10-EPZ	8627	10-EPZ	25688

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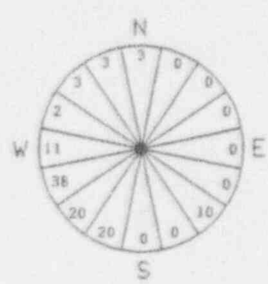
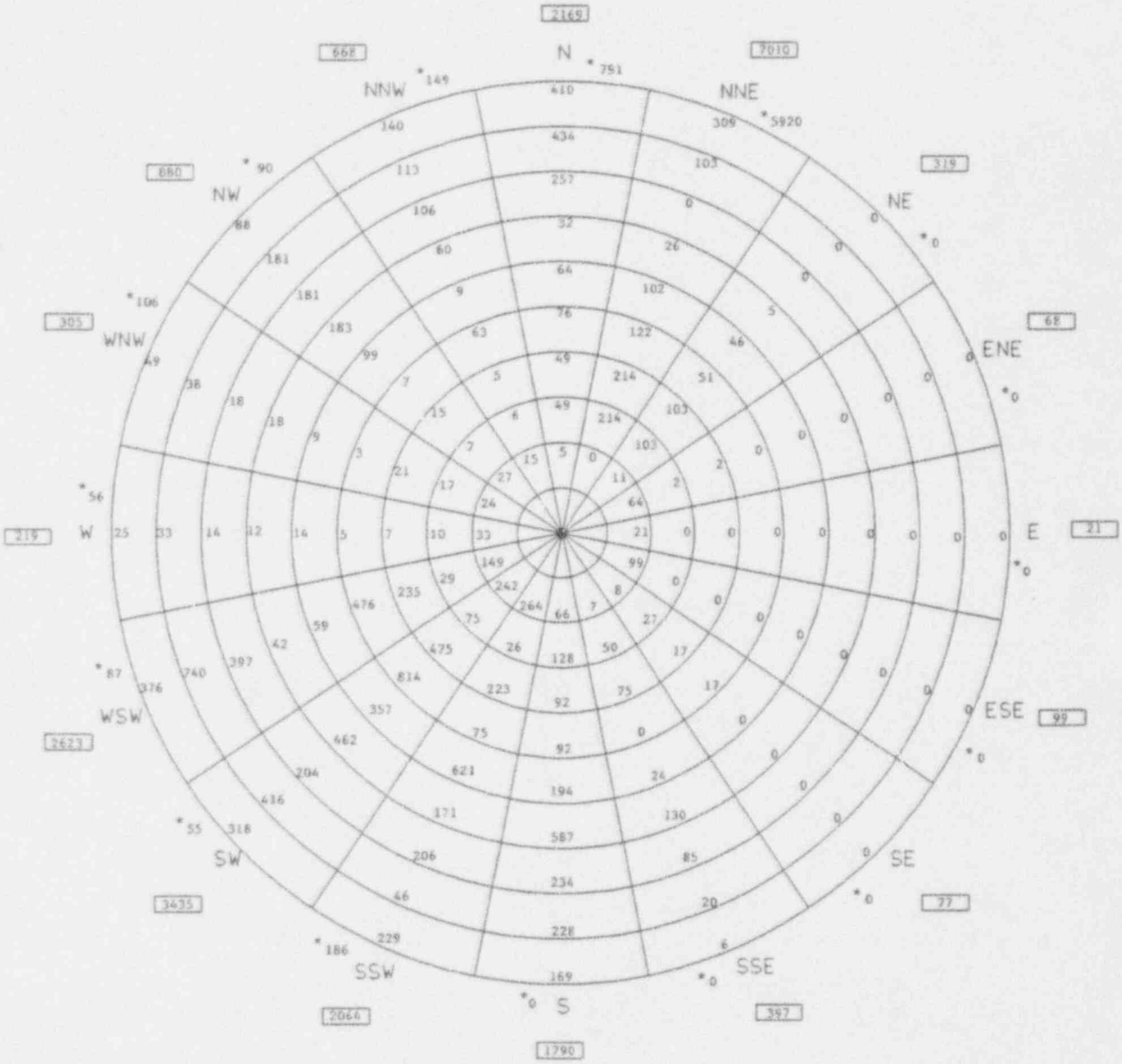


DETAIL OF 1 MILE RING

FIGURE 10-7

EMPLOYEE VEHICLES



[ ] Total Employee Vehicles 0 To 10 Miles.

* Number of Employee Vehicles between 10 mile ring and EPZ boundary.

TOTAL EMPLOYEE VEHICLES			
RING MILES	RING SUBTOTAL	TOTAL MILES	CUMULATIVE TOTAL
0-1	93	0-1	93
1-2	1035	1-2	1128
2-3	743	2-3	1871
3-4	1533	3-4	3404
4-5	1801	4-5	5205
5-6	1598	5-6	6803
6-7	1728	6-7	8531
7-8	1702	7-8	10233
8-9	2352	8-9	12585
9-10	2119	9-10	14704
10-EPZ	7440	10-EPZ	22144

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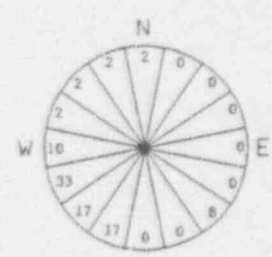
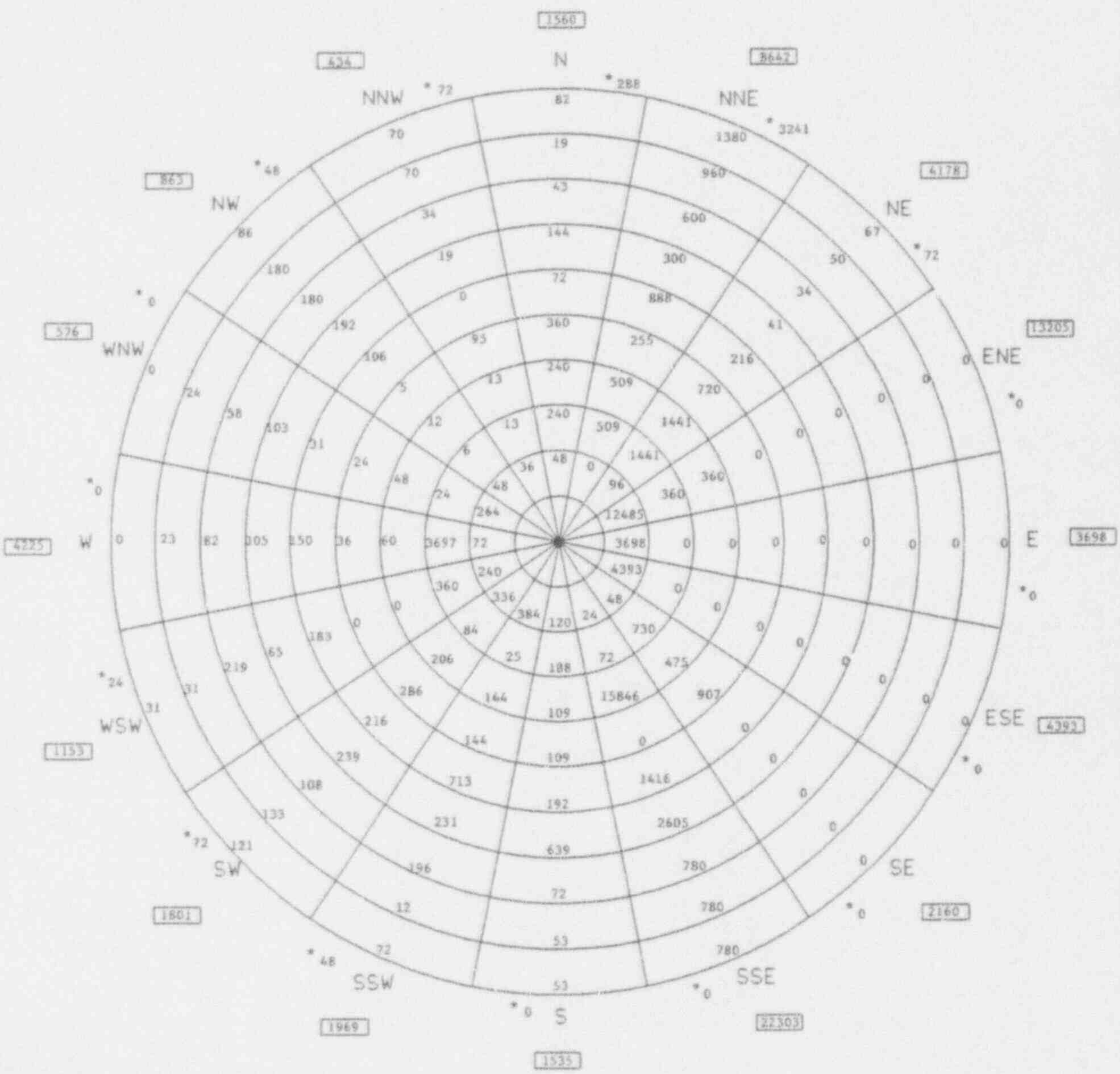


DETAIL OF
1 MILE RING

FIGURE 10-8

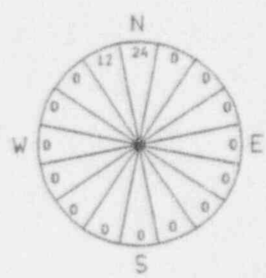
TRANSIENTS



Total Segment Transients 0 To 10 Miles.

* Transient Population between 10 mile ring and EPZ boundary.

TOTAL NUMBER OF TRANSIENTS			
RING MILES	RING SUBTOTAL	TOTAL MILES	CUMULATIVE TOTAL
0-1	36	0-1	36
1-2	22292	1-2	22328
2-3	7749	2-3	30077
3-4	19463	3-4	49540
4-5	2941	4-5	52481
5-6	4183	5-6	56664
6-7	4683	6-7	61347
7-8	2406	7-8	63753
8-9	2335	8-9	66088
9-10	2742	9-10	68830
10-EPZ	3865	10-EPZ	72695

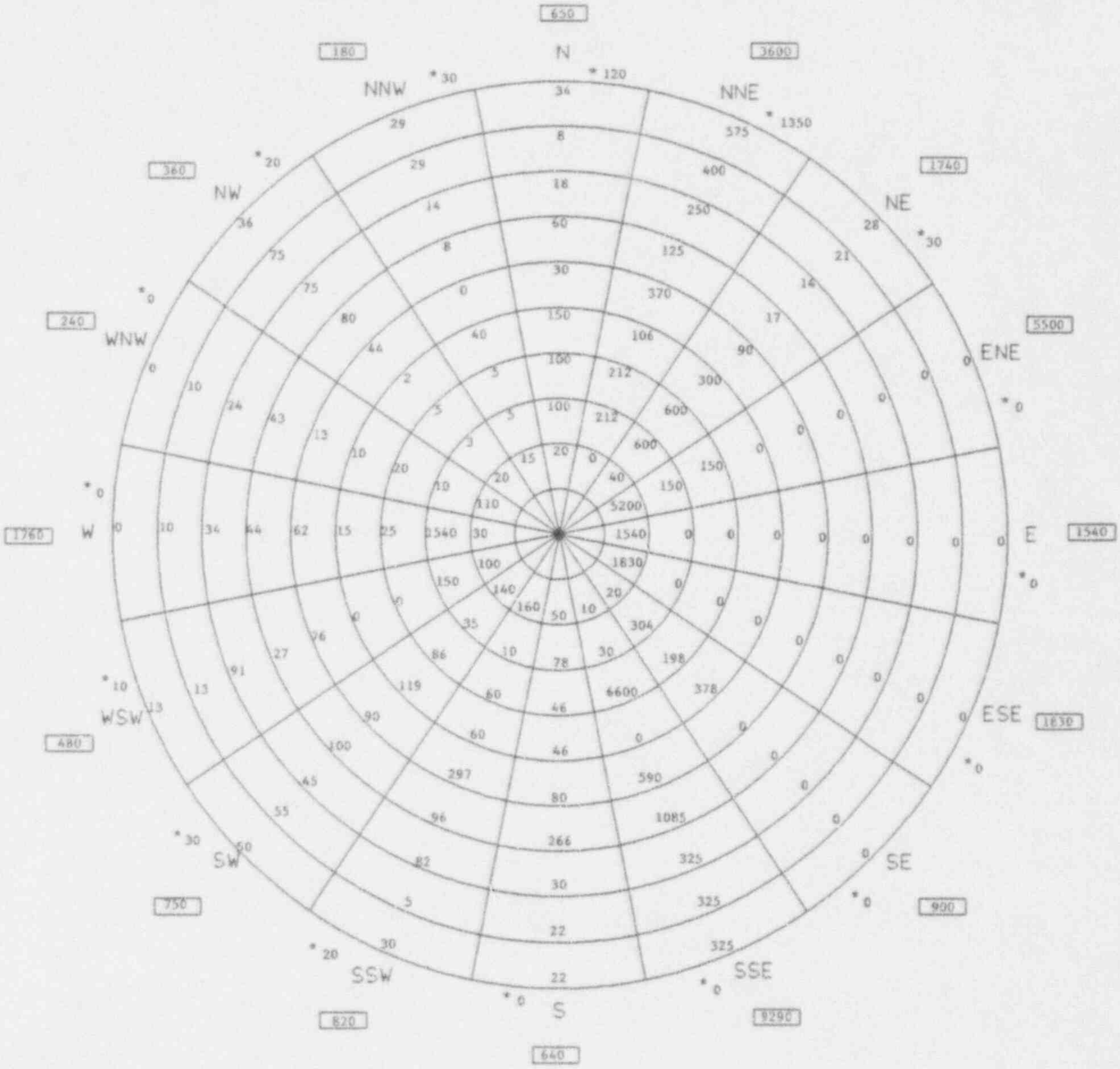


DETAIL OF
1 MILE RING

EPLAN-E010236.DGN

FIGURE 10-9

TRANSIENT VEHICLES



▭ Total Segment Transient Vehicles 0 To 10 Miles.

* Transient Vehicles between 10 mile ring and EPZ boundary.

TOTAL TRANSIENT VEHICLES			
RING MILES	RING SUBTOTAL	TOTAL MILES	CUMULATIVE TOTAL
0-1	15	0-1	15
1-2	9285	1-2	9300
2-3	3227	2-3	12527
3-4	8107	3-4	20634
4-5	1226	4-5	21860
5-6	1742	5-6	23602
6-7	1951	6-7	25553
7-8	1002	7-8	26555
8-9	973	8-9	27528
9-10	1142	9-10	28670
10-EPZ	1610	10-EPZ	30280

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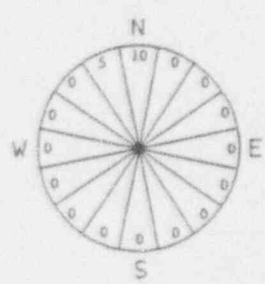

DETAIL OF
1 MILE RING

11. EVACUATION TIME ESTIMATES (ETE) FOR TRANSIT OPERATIONS

This section details the analyses applied and the results obtained, which provide evacuation time estimates for transit vehicles. The procedure is:

- o Estimate demand for transit service
- o Estimate time to perform all transit functions
- o Estimate route travel time
- o Determine how buses should be allocated to routes
- o Develop ETE

Estimates of Demand for Transit Service

Demand for transit service reflects the needs of different "special population" groups:

1. Residents and transients with no vehicles available

2. Special facilities: schools, health-support, child-care, other

3. Private citizens (i.e., those not in health-support facilities) who have special medical needs.

The demand estimates for the groups identified in items 2 and 3 have been developed by the State Emergency Management Agencies and thereby lie outside the scope of this report. The demand associated with item 1 does fall within the scope of this report.

Since the survey results are used in the following analyses, the results of the 1985 survey was compared to the results of the 1992 survey. These comparisons indicated that the two surveys yielded results which were comparable. Since the 1985 survey had a sample size double the 1992 sample size, we continue to use 1985 results for this analysis.

The survey conducted in Autumn of 1985 (see Appendices F and G, and Figure 2-3) acquired a data base which enabled us to estimate the population group of item 1. This group is divided into two subgroups:

- o Those persons in households with no vehicle available

o Those persons in households which normally have at least one vehicle available, but would not have a vehicle available at the time the evacuation is ordered.

The persons belonging to the latter subgroup are in households where the vehicle(s) have been driven away from home for commuting purposes and are therefore not immediately available when the order to evacuate is given and, in addition, the driver(s) of the vehicle(s) refuse to return home to gather the household members. Question 10 of the survey addressed this issue. Other, less important factors, include the possibilities that the vehicle is non-functioning or that the commuter is willing, but unable, to return home.

Tables 11-1 through 11-4 are typical print-outs of the software developed to analyze the survey data base and to provide the empirical basis for quantifying those two subgroups. These data were then multiplied by the sample factor (i.e., ratio of total households within the EPZ, to the number of randomly selected households sampled) to obtain the data for each community within the EPZ. Table 11-5 presents the summary of this data.

There are several factors which influence the accuracy of these estimates in Table 11-5:

1. These figures include school children. On school days, separate transportation is provided for the children in school and the actual need for transit is thereby less than the given estimates.

2. These figures do not take into account the effects of ride-sharing with family, friends and neighbors who do have vehicles available. To the extent that ride-sharing is undertaken, the actual need for transit is less than the given estimates.

3. These figures do not take into account the prospect that vehicles may not be available due to malfunction. To that extent, the actual need for transit is slightly greater than the given estimates.

4. Since the number of surveyed persons in each town who require transit is small relative to the total sample, we are contending with a problem of small sample size when the data is considered at the community level. That is, the confidence interval associated with these estimates is apt to be large. There is thus a statistical uncertainty associated with these estimates (as there is with any estimates obtained using statistical procedures) which should be prudently considered.

We have not included those buses which are located within the EPZ. To this extent we have overestimated the need for transit vehicles from outside the EPZ.

It is possible to quantify these factors in a conservative manner, thus insuring that adequate transit resources will be available:

1. A reduction in estimated demand due to school children being evacuated by bus is justified only if the accident occurs during a school day. Since school is in session 180 days in a year, for about 7 hours, the probability of an accident occurring when school is in session is approximately

$$\frac{180 \ X \ 7}{365 \ X \ 24} = 0.144 \ OR \ 14.4 \ PERCENT$$

   Consequently, since children will not be in school over 85 percent of the time, it is prudent to assume that all school children of transit-dependent families will be at home and will require transit.

2. Ride-sharing does have a pronounced impact on estimating the need for transit. For example, nearly 80 percent of those who evacuated from Mississauga, Ontario and who did not use their own cars, shared rides with neighbors and friends. Other documents also report that approximately 70 percent of transit-dependent persons were evacuated via ride-sharing.

We will adopt the lower figure of 50 percent to calculate the number of transit-dependent persons who will ride-share. The remaining 50 percent will need transit vehicles in order to evacuate.

3. To estimate the number of people who are transit dependent because their vehicles are out of service (i.e , inoperable) due to mechanical problems, a telephone survey was undertaken of fleet operators. The respondents were asked how many days per year the average fleet vehicle was inoperable. Based upon this survey we conservatively adopted an estimate of four days per year or 1.1% of the time.

   Thus, the probability that a household which owns a single car having that car out of service at any time is 0.011. For a household with two cars, the probability that both cars are out of service simultaneously is 0.00012. For households with more than two cars the probabilities of all being out of service is too low to be significant. Using the survey data presented in Figures 2-2 and 2-3, the number of people with out of services vehicles can be calculated as follows:

$$\text{Total number of people in households with "n" cars} = \sum_{p=1}^{6} 6\ H \times A_p \times C_{pn} \times P$$

where:

H = # of households in each town = Town Pop. (Table 2-1) / Avg. Pop. per Hshld. (Figure 2-2)

A_p = % of those households with "P" number of people (from Figure 2-2)

C_{pn} = of those households with "P" number of people the % of with "n" number of cars (from Figure 2-3)

P = Number of people in household

Therefore the estimated # of people whose cars are out of service equals:

# of people in households with one car	x 0.011 +	# of people in households with two cars	x 0.00012

This calculation was done for each town and is listed on Table 11-6, Column 6.

4. It is possible to calculate the confidence interval for a stated level of confidence, α, by applying the binomial distribution. Specifically, the following expression applies:

$$p \pm \frac{d}{2} = \frac{(r+c) + \sqrt{(r+c)^2 - (n+2c)\frac{r^2}{n}}}{(n+2c)}$$

where:

p = Proportion of sampled number of households that have no vehicles available

d = Extent of confidence interval at α percent confidence interval

n = Sample size, households

r = np, sample response indicating the number of persons, in the sample, who require transportation assistance

c = $1/2\ Z^2_{\alpha/2}$, obtained from tables

$Z_{\alpha/2}$ = Normal deviate exceeded with probability, $\alpha 2$

Ref: Crow, E.L., Davis, F.A. and Maxfield, M.W., Statistics Manual, Dover Publications Inc., New York, 1960.

We will select α = 80 percent. From tables, the corresponding value of c is 0.822. This means:

> There is an 80 percent probability that the true proportion, p, of the underlying population from which the sample was drawn, lies between p - d/2 and p + d/2. This is equivalent to stating that there is a 90 percent probability that the true value of p does not exceed p + d/2.

Table 11-6 lists the results. Column 1 is the sample size, n, in each community. The sample responses, r, the number of persons who do not have a vehicle available, are listed in column 2. The proportion, p, the quotient of column 2 by 1, appears in column 3. Column 4 contains the calculated values of (p+d/2). The next column, 5, contains the number of persons within each community who have no vehicles available and require transportation assistance; these estimates have only a 10 percent probability of actually being exceeded. The calculation to obtain these estimates are outlined below:

A. For communities where p > 0, this estimate of persons needing assistance is calculated as:

$$E_T \quad \frac{(p+\frac{d}{2})}{p}$$

where E_T is in the last column of Table 11-5.

B. For communities where p = 0, this estimate of persons needing assistance is calculated as

(No. of households) x (p + d/2)

The number of households is estimated as

Estimated Population • 2.87

where 2.87 is the average number of persons per household.

C. The estimate of the number of persons requiring transportation assistance because their vehicle is not operable is listed in Column 6.

Column 7 contains the estimates of people requiring transportation assistance and who do not share a ride with friends or neighbors ([Column 5 + Column 6]/2). These persons must be provided with transit.

These estimates may be compared with those obtained from two surveys of all residents in New Hampshire, conducted in 1986 and 1988 by the New Hampshire Office of Emergency Management. The total number of persons requiring transportation assistance, as determined from this survey, including those in special facilities, was 2,079 and 2,042, respectively. The calculated estimate for New Hampshire, which excludes those in special facilities, as obtained from Column 6, is 2,249. This close agreement verifies the applicability of the telephone survey (Appendix F) and of the computational methodology presented above.

Table 11-7 presents the transit requirements for all communities, based on the estimates of Table 11-5, and on the number of bus routes identified by State Emergency Management personnel. The number of persons serviced on each bus route within a community may be estimated by dividing the total number of transit-dependent persons by the number of routes. This estimate, however, assumes that people are uniformly distributed over a community, by route -- an assumption which will overestimate the actual demand for some routes and underestimate the actual demand for some routes. To counter the prospect that a non-uniform spatial (i.e., route-specific) distribution of population would yield a higher demand for transit service than estimated on some bus routes, we will increase all route-specific estimates of transit demand, by 20 percent. (This is equivalent to increasing the total estimated demand by 20 percent.)

The number of bus trips needed per route is based on the conservative premise that the average bus occupancy at the conclusion of the bus run will not exceed 30 persons. This figure compares with an actual seated capacity of 40 adults or 60 children. For example, if the passengers are two-thirds adults and one-third children, then the bus capacity is (2/3) 40 + (1/3) 60 = 47 persons. On this basis, we have assumed that bus trips, at most, will be running at an average load factor of (30/47) 100 = 64 percent. Thus, even if the actual demand for service on a bus route exceeds the estimates in column 3 of Table 11-6 by 57 percent, that demand can still be accommodated by the available seating capacity. Any additional demand can be accommodated by standing passengers or by rerouting buses from more lightly loaded routes within the community.

It is recommended that all buses return to the local Transportation Staging Area at the completion of each run. There, partly-filled buses can consolidate their respective occupants, so that only full (or nearly-full) buses leave the community and the EPZ for the relocation center. In this way, some buses can make two or more trips along a route. The recommended number of buses required is determined by the number of buses leaving the EPZ carrying a full passenger manifest (assumed to be 36 persons). If additional buses are provided, excess space will be available.

Development of Bus Routes

Evacuation bus routes were developed for the New Hampshire EPZ Communities by the New Hampshire Office of Emergency Management and for the Massachusetts communities under the direction of the Massachusetts Emergency Management Agency. The routes were designed to start at a designated location (i.e., local transportation staging area/transfer point) and extend through the town to form a closed path while generally adhering to following guidelines:

1. No house would be more than approximately one half mile from a bus route.
2. Buses would not back track on the same route.
3. Buses would follow the directions provided at the traffic control points.

In some cases the current bus routes reflect modifications or improvements to those originally developed.

Calculation of Transit Route Travel Times

The calculation of transit route travel times depends intrinsically on how the buses are allocated to the specified routes in each community.

The allocation of buses to bus routes within a community will be based on the objective of minimizing evacuation time. This is equivalent to stating the following:

> Allocate buses to routes so that the total time needed to evacuate transit-dependent persons is approximately the same for all routes.

The analysis formulation and procedure are presented below:

Let N = Total number of buses needed in a community based on an average occupancy of 36 persons. See column 6 of Table 11-7.

n = Number of bus trips along each route, r, within the community; r = 1, 2, ..., R. See column 4 of Table 11-7.

X_r = Number of buses allocated to route, r.

t_r = Bus travel time, hours, on route, r. This value is determined from the IDYNEV simulation output. For those segments of the bus route which are not on evacuation routes (e.g., local streets or counterflow streets), a mean speed of 10 mph is assumed which takes into account time spent stopping to load passengers.

$T_r(X_r)$ = Total elapsed time, hours, to service transit-dependent evacuees along route, r, using X_r buses to complete an aggregate of n trips.

H_r = Bus headways on route, r, hours.

Definitionally,

$$T_r(X_r) = p_r t_r + (n - (p_r-1)X_r - 1)H_r$$

$$\text{for } (p_r-1)X_r < n \le p_r X_r \; ; \; p_r = 1, 2, \ldots$$

NOTE: p_r = Maximum number of trips made by a bus on Route, r.

where $p_r = n/X_r$. If not an integer, then

$$p_r = Int \; [\frac{n}{x_r} + 1]$$

Clearly, $X_r \le n$. That is, the number of buses assigned to a route cannot exceed the number of trips to be completed.

Also, by definition,

$$H_r = t_r/X_r \quad \text{when } X_r < n$$

When $X_r = n$, we will adopt the following condition in order to provide reasonable spacing of buses:

$$H_r = \min\,[t_r/n,\ 0.2]$$

The objective is to select the X_r such that

$$\max_r\,[T_r(X_r)] \text{ is minimized}$$

subject to the condition,

$$\sum_r X_r = N$$

Procedure

The procedure is trial-and-error which converges rapidly if the proper care is taken.

1. Select the longest route, $r = r_L$. Assign $X_r = n$ for this route.

2. Calculate p_r, H_r and T_r $(X_r = n)$
   Set $N_{rem} = N - X_r = N - n$

3. Select the longest remaining route. Estimate X_r for this Route, r, as follows:

$$X_r = \frac{tr}{t_{r_L}} X_{r_L}$$

4. Calculate p_r, H_r and $T_r(X_r)$.

5. Compare $T_r(X_r)$ with T_{r-1} (X_{r-1}). If these figures are comparable, accept the solution.

   Else, adjust the estimate of X_r, accordingly, and repeat steps 4 and 5.

   When completed, set $N_{rem} = N_{rem} - X_r$

6. If more routes remain to be analyzed, return to step 3. If finished, examine N_{rem}.

   If $N_{rem} < 0$, either request more buses for this community to keep the objective function low, or reduce the number of buses allocated to those routes which exhibit low values of $T_r(X_r)$ relative to other routes and redo the procedure of steps 4, 5 and 6 until $N_{rem} = 0$.

If $N_{rem} > 0$, which is a desirable condition, there is a choice: Add buses to those routes with the longest values of $T_r(X_r)$, subject to $X_r < n$, and/or store these excess buses at the local transportation center for use only to accept people from the route buses and to transport them out of the EPZ.

If $N_{rem} = 0$, procedure is complete.

Example: Greenland; N = 7, n = 3

r =	1	2	3
t_r =	1.1	1.1	1.4

Step 1. Select $r = r_1 = 3$, the longest route. Assign $X_3 = n = 3$

Step 2. $p_3 = 3/3 = 1$; $H_3 = \min[1.4/3, 0.2] = 0.2$
$T_3(X_3) = 1(1.4) + (3 - (1 - 1)3 - 1)0.2 = 1.8$
$N_{rem} = 7 - 3 = 4$

Step 3. Select r = 1, next longest route
$X_1 = (1.1/1.4)(3) = 2.36$. Choose $X_1 = 2$

Step 4. $H_1 = \min[1.1/2, 0.2] = 0.2$; $p_1 = \text{Int}[3/2 + 1]=2$
$T_1(X_1) = 2(1.1) + (3 - (2 - 1)\ 2 - 1)\ 0.2 = 2.2$

Step 5. $T_1(X_1)$ is comparable to $T_3(X_3)$. Accept result.
$N_{rem} = 4 - 2 = 2$

Step 3. Select r = 3, remaining route.
$X_2 = (1.1/1.4)(3) = 2.36$. Choose $X_2 = 2$

Step 4. $H_2 = \min[1.1/2, 0.2] = 0.2$; $p_2 = \text{Int}[3/2 + 1] = 2$
$T_2(X_2) = 2(1.1) + (3 - (2 - 1)\ 2 - 1)\ 0.2 = 2.2$

Step 5. $T_2(X_2)$ is same as $T_3(X_3)$. Accept result.
$N_{rem} = 2 - 2 = 0$ O.K. We are finished.

The results are:

r	X_r	$T_r(X_r)$	
1	2	2.2	= Maximum travel time
2	2	2.2	
3	3	1.8	

Assignment of Buses to Service Schools

It is preferable if the number of buses dispatched to the schools is based upon the actual number of students in school at the time instead of total enrollments. This distinction arises because:

o Actual attendance may be somewhat below enrollment due to absences.

o Many children may have been picked up at school by their parents and by neighbors/friends of the parents before the buses arrive at the local transportation center.

The latter point deserves further discussion. Distribution B listed in Table 4-2 represents the event, "Arrive Home." This distribution is plotted in Figure 11-1.

It is seen that within an hour of the Order to Evacuate (OTE), almost 90 percent of all commuters have returned home from work; this figure expands to 92 percent at 1:15 after the OTE. In addition, households with two commuters, or with one adult at home with a vehicle available, could be in a position to pick up their child(ren) at school even earlier.

Thus, the vast majority of parents will be in a position to pick up their child(ren) at school before the arrival of the buses. (While the EBS messages will notify the public that transportation is being made available to the schools and that there is no need to pick up children, we have to recognize, as a practical matter, that many parents who can do so, will drive to school for that purpose.) Since many -- if not, most -- children will have been picked up by their parents and by their neighbors by the time the buses arrive at the local EOC, the actual number of buses needed will be significantly less than the number mobilized for that purpose.

Evacuation Time Estimates for Transit-Dependent Persons

The Evacuation Time Estimates for transit-dependent persons must be developed for several categories of "special population":

- o Residents and tourists with no cars available

- o Special facilities

    - Schools
    - Health-support facilities
    - Child-care centers
    - Other

- o Special medical needs

Buses will travel from their respective originating locations to the State Transportation Staging Areas (STSA) designated individually for Massachusetts and New Hampshire. In New Hampshire, the STSA is located at the Pease International Tradeport in Newington. In Massachusetts, the STSA is located at the Northern Essex Community College in Haverhill. From these locations, the buses will be sent, as needed, to local TSAs within each community. At that time, the buses will be assigned to specific routes or facilities by the local Transportation Coordinator. In the communities of Amesbury, Hampton, Hampton Falls, Salisbury, and Seabrook, buses may be directed immediately to the local TSAs for precautionary evacuation of schools.

The time elements involved for all vehicles responding to the emergency are outlined below:

1. Mobilization Time

   Elapsed time from the moment that the transit agency is notified of the need for vehicles until the time the vehicles leave their respective points of origin.

2. Inbound Travel Time

   Elapsed time to travel to a staging area or special facility.

3. Time to Load Passengers

   a. For vehicles servicing special facilities, this time includes the travel from the local transportation center to the facility and the time to load passengers.

   b. For vehicles servicing ambulatory transit-dependent persons who are not at special facilities, this includes the travel times along the assigned routes.

4. Outbound Travel Time

Elapsed time from the facility or transportation center to the EPZ boundary.

Mobilization Time

A telephone survey of organizations which own and operate buses was undertaken to obtain estimates of mobilization time. There was a fairly wide variance of estimates among the different organizations. Many indicated that all bus drivers and buses could be mobilized within one hour. Others indicate that anywhere from 20-50 percent could be mobilized in one hour, with the remainder within the second hour. A few indicated that more than 2 hours were needed. In these cases the last 20-30 percent could be mobilized within the third hour after notification.

Another factor is time of year. During the summer and on weekends during the off-season, fewer bus drivers are available in many cases and mobilization time is somewhat longer. Fortunately, school is not in session during these periods so the need for buses is reduced accordingly.

Based on our survey, it is conservatively estimated that overall, 50 percent of the available buses can be mobilized within one hour of notification, another 30 percent within the second hour and the remainder within the third hour. The statistics of primary interest, however, are the mobilization times of required vehicles.

Based upon the information provided by state agencies, an adequate number of buses is available. Therefore, we will assume that 50 percent of all required buses will be mobilized in one hour following notification, with the remainder available during the second and third hours.

Inbound Travel Time

The elapsed time from the time that buses leave their respective points of origin to the time they arrive at the local transportation center may be expressed as:

$$T_I = D/\bar{v} + P$$

where:

T_I = Inbound travel time, hours

D = Distance to be travelled, miles

$\bar{v}$ = Mean speed, mph

P = Any preparation time, enroute. For example, time spent at a staging area would fall in this category.

The travel distance will vary, depending on the point of origin. Some bus depots that are outside the EPZ are located in neighboring communities. Others are as far as 30+ miles from the EPZ.

It is reasonable to expect that there should be little impedance to incoming emergency vehicles for the following reasons:

1. In general, the first few buses won't start leaving their respective points of origin until 30 minutes after the Order to Evacuate. Bus volumes travelling toward the EPZ will increase toward the one-hour mark.

2. At one hour after the order to evacuate, some 70+ percent of returning commuters will already have reached home within the EPZ, and will therefore be off the highways.

3. Other traffic which would normally travel towards the EPZ would be discouraged by EBS and other media messages and by people's concern over the potential risk to their health and safety.

On this basis, it is reasonable to expect that incoming buses would be able to average about 40 mph along at-grade primary highways (e.g., Route 1) and 50 mph along access-controlled highways. While buses would be given priority at all Access Control Points, some delay, say 15 minutes, might be encountered there.

The preparation time depends on how well operations at staging areas are organized, and on the relation between the demand for buses within the EPZ and the supply of buses arriving at the staging area. Assuming a reasonable degree of efficiency at the staging area and a high demand for buses within the EPZ, a total preparation time, P, of 15 minutes (0.25 hr.) is a realistic estimate.

As a planning basis, we will estimate maximum inbound travel time for the ensemble of buses as follows:

$$T_I = 30/40 + 0.25 + 0.25 = 1.25 \text{ hour}$$

Thus, buses should start arriving from close-by points of origin (outside the EPZ) within one and one-half hours after the Order to Evacuate. Buses will continue to arrive, as needed, over the following hour, at which point, a sufficient number of buses necessary to evacuate the schools and the transit-dependent will be on-hand and will have started evacuation activities. (Of course, buses which service the communities within the EPZ and are stored there, will arrive earlier.)

Any additional buses needed for special facilities (other than schools) which are not available 2 hours after the Order to Evacuate, will arrive during the following (i.e., third) hour. If only a portion of the EPZ is evacuated and if fewer buses are needed for schools than have been allocated (based on earlier discussion), then it is likely that all required buses will have arrived at the local transportation center within 2 hours after the Order to Evacuate.

Inclement weather, particularly snow, may increase the response time of buses. We will reduce incoming speed by 20 percent for rain and by 25 percent for snow.

Time to Load Passengers

A. Special Facilities

This includes the time to travel from the local transportation center to the special facilities and then to load the passengers.

Studies have shown that passengers can board a bus at headways of 2-4 seconds (see 1985 Highway Capacity Manual). Thus, if we account for elderly or passengers, and allow additional time to walk to the bus, then we estimate that a bus can be fully loaded in about 10 minutes (15 second mean headway for 40 passengers).

The time to travel to the facility depends on the distance travelled and on whether the bus will be travelling with, or counterflow, the evacuating public. If we assume the former, and apply the mean speed of 5.8 mph obtained for Scenario 1, Region 1, as computed by the IDYNEV simulation, then for a distance of say, 3 miles within the community, the travel time will be about 35 minutes.

Thus the total time to load passengers at special facilities is approximately 45 minutes.

B. Transit-Dependent Persons at Home

The time to load transit-dependent passengers is dependent on the time required to service the longest (in time) bus route. The number of bus trips needed for a particular route is subject to change at the discretion of the personnel locally dispatching the buses. If additional trips are needed, returning buses will be dispatched to repeat the trip. However, this is unlikely because of excess availability of space on the buses. The analysis procedure has already been presented. Results are presented shortly.

Outbound Travel Time

The time to travel out of the EPZ depends on several factors:

- o The location where this trip originates
- o The traffic environment at the time this trip begins.

The discussion above has identified that a reasonable estimate of the elapsed time from the Order To Evacuate to the time that a bus servicing a special facility is loaded, is approximately 3 hours. Reference to Table 10-8 indicates that evacuation will not have been completed for any scenario in that time.

Thus it is seen that the buses and vans used to evacuate special facilities will join, and be embedded within, the overall traffic streams evacuating the EPZ. It follows that the ETE for these transit vehicles will not exceed those estimates already developed for evacuees using private vehicles, regardless of the evacuation scenario.

The outbound travel time for transit-dependent persons who are transported by buses (i.e., do not ride-share) depends on the time required to completely execute all bus trips on all routes. This time depends on the number of buses per route and on the route travel time, as detailed earlier.

When the bus runs mingle with other evacuating traffic, then the route times are impacted by the impedance associated with the level of congestion encountered. If all bus runs have not been completed at the time the other evacuating vehicles have left the area covered by the route, then the remaining trips can be completed quickly since there would be no other -- or relatively few -- vehicles on the highway.

Thus, this analysis for buses servicing transit-dependent persons is more complex than for those servicing special facilities. These transit ETE depend on:

- The evacuation scenario
- The location of the routes
- The details of bus operations. Specifically, whether all runs are completed before, or after, the other evacuees have cleared the area.

Our analysis has identified that those communities in greater need of transit will, not surprisingly, take longer to evacuate. Specifically, the criterion which controls ETE is "Bus Trips per Route," column 4 of Table 11-7, and the route travel times. Tables 11-8A and 11-8B present the results of the analysis for all communities, using the procedure detailed earlier in this section.

Emergency Medical Service (EMS) Vehicles

The previous discussion focused on transit operations for ambulatory persons within the EPZ. It is also necessary to provide transit services to non-ambulatory persons who do not -- or cannot -- have access to private vehicles.

These EMS vehicles are vans equipped for transporting non-ambulatory persons (i.e., those confined to wheel chairs), ambulettes and ambulances. They are generally available on an emergency basis; consequently, it is reasonable to expect that their mobilization would be much less than for bus vehicles. In fact, drivers for EMS are always either "on-station" or can be reached via a telecom pager. It is therefore reasonable to expect that mobilization time for EMS vehicles can be completed within 20 minutes.

On the other hand, many EMS vehicles would have to travel much longer distances to the EPZ than would buses. For example, EMS vehicles from the North Conway area would travel a total of about 90 miles to a community within the EPZ and thence to a facility to pick-up passengers. A mean travel speed of 50 mph is assumed.

Thus the total elapsed time, at worst, from notification to the arrival of an EMS vehicle at its destination within the EPZ, is estimated at:

Mobilization Time:		0.33 hours
Inbound Travel:	90/50 + 0.50	2.30
Loading Passengers:		0.67
		3.30 hours

Outbound travel would be controlled by the speed of other evacuating vehicles if the area is not yet cleared at 3:20; or would take less than 15 minutes if the area is cleared at that time.

Buses for Transit Dependent

In calculating the ETE for transit-dependent people, it is necessary to add the maximum values of $T_r(X_r)$ in a Region, to the estimated time for mobilization and for inbound travel. Based on the previous discussion, it is reasonable to expect that the first buses will arrive at a local transportation center at 1.5 hours after the Order to Evacute or nearly 2 hours after the Site Area Emergency. These first buses would be dispatched on those routes with the longest value of $T_r(X_r)$.

The ETE for Special Population is based on the analysis described earlier. When transit trips are completed before the time that private vehicles can clear the region, then the transit vehicles will mingle with the other evacuating vehicles. In these cases, transit vehicles are subject to the same highway capacity constraints and congested conditions as are the private vehicles. Thus, the ETE for the transit-dependent "special population" are set equal to the ETE for the general population.

For the other scenarios, where some transit vehicles clear the region after the private vehicles, the special population ETE are based on computed values using the procedures described in this section.

To calculate the ETE for the special population, we proceed as follows:

1. Estimate the elapsed time for transit vehicles to start arriving at local transportation center. As noted above, this estimate is 1:30.

2. Assuming the first arriving buses will be assigned to longest routes in each community, add the longest route time to the 1:30 of step 1.

3. Add the free-flow travel time to the EPZ boundary assuming all other vehicles have evacuated.

4. For inclement weather conditions (rain, snow), multiply the estimate given in step 3 by (1.20 and 1.25), respectively.

5. Compare the ETE of step 3 (or step 4) with that for general traffic, for all region/scenario combinations:

   o If this ETE exceeds that for the general population, list this value in either of the last two columns of Table 10-10.

   o If this ETE is less than that for the general population, then list the general population ETE in the last two columns of Table 10-10.

The following table lists the results of this analysis. All times are relative to the Site Area Emergency (SAE):

ERPA	Community with Longest Transit ETE	Longest Elapsed Time for Indicated Weather: Normal	Rain	Snow
A	Seabrook	3:45	4:30	4:40
B	Amesbury	3:40	4:25	4:35
C	Kensington	3:15	3:55	4:05
D	North Hampton	3:50	4:35	4:45
E	Merrimac	4:05	4:55	5:05
F	Newton	3:55	4:40	4:50
G	Rye	4:10	5:00	5:10

Since the Order to Evacuate (OTE) is assumed to take place 25 minutes after the Site Area Emergency (SAE) Classification, then the ETE values are 0:25 less than the above figures. The following table presents the ETE for special populations:

	ETE for Indicated Weather		
Regions	Normal	Rain	Snow
1, 11, 17	3:45	4:30	4:40
5, 6, 15	3:25	4:05	4:15
7, 8, 9, 14	3:20	4:00	4:10
12	3:30	4:10	4:25
13, 16	3:40	4:25	4:35

Step 5 yields the following results:

Conditions Where Special Population ETE
Exceeds General Population ETE

		ETE	
Regions	Scenarios	Special Pop.	General Pop.
1	None		
5	None		
6	None		
7	9	4:00	4:15 Rev. 4
8	None		
9	9	4:00	4:00 Rev. 4
11	None		
12	None		
13	None		
14	None		
15	None		
16	None		
17	None		

It is seen that in all cases the ETE for Special Populations are less than those for the General Population.

TABLE 11-1

NUMBER OF NON-RETURNERS FOR HOUSEHOLDS

WITH 1 CAR AND 1 COMMUTER WHO DRIVES

AMESBURY, MA

Households With One Car & 1 Commuter Who Drives	Size of Such Households											
	1	2	3	4	5	6	7	8	9	10	Unknown	Total
No. of Such Households	4	3	2	4	1	0	0	0	0	0	0	14
No. of Non Returners	1	1	0	0	0	0	0	0	0	0	0	2
No. of Returners	1	2	2	4	0	0	0	0	0	0	0	9
No. of Unsure	2	0	0	0	1	0	0	0	0	0	0	3
Non Returners Pct.	50.0	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.2

Total No. of Persons Requiring Transit: 3

Total No. of Persons at Home Requiring Transit: 2

TABLE 11-2

NUMBER OF NON-RETURNERS FOR HOUSEHOLDS WITH 2 CARS AND 2 COMMUTERS WHO DRIVE

AMESBURY, MA

Households With 2 Cars & at Least 2 Commuters	Size of Such Households											
	1	2	3	4	5	6	7	8	9	10	Unknown	Total
No. of Such Households	0	15	13	10	4	1	0	0	0	0	0	43
No. of Neither Ret.	0	2	0	0	0	1	0	0	0	0	0	3
No. of Either Ret.	0	13	8	9	3	0	0	0	0	0	0	33
No. of Unsure	0	0	4	1	1	0	0	0	0	0	0	5
Non Returners Pct.	0.0	13.3	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	8.3

Total No. of Persons Requiring Transit: 9

Total No. of Persons at Home Requiring Transit: 3

TABLE 11-3

NUMBER OF NON-RETURNERS FOR HOUSEHOLDS

WITH 3 CARS AND 3 COMMUTERS WHO DRIVE

AMESBURY, MA

Households With 3 Cars & at Least 3 Commuters	Size of Such Households											
	1	2	3	4	5	6	7	8	9		10	
Unknown												Total
No. of Such Households	0	0	2	1	0	0	0	0	0	0	0	3
No. of None Returned	0	0	1	0	0	0	0	0	0	0	0	1
No. of at Least 1 Ret.	0	0	1	1	0	0	0	0	0	0	0	2
No. of Unsure	0	0	0	0	0	0	0	0	0	0	0	0
Non Returners Pct.	0.0	0.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3

Total No. of Persons Requiring Transit: 0

Total No. of Persons at Home Requiring Transit: 0

TABLE 11-4

NUMBER OF NON-RETURNERS FOR HOUSEHOLDS
WITH 4 CARS AND 4 COMMUTERS WHO DRIVE

AMESBURY, MA

Households With 4 Cars & at Least 4 Commuters	Size of Such Households											
	1	2	3	4	5	6	7	8	9	10	Unknown	Total
No. of Such Households	0	0	0	1	0	1	0	1	0	0	0	3
No. of None Returned	0	0	0	1	0	0	0	0	0	0	0	1
No. of at Least 1 Ret.	0	0	0	0	0	1	0	1	0	0	0	2
No. of Unsure	0	0	0	0	0	0	0	0	0	0	0	0
Non Returners Pct.	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3

Total No. of Persons Requiring Transit: 0

Total No. of Persons at Home Requiring Transit: 0

TABLE 11-5

ESTIMATES OF AMBULATORY PERSONS REQUIRING TRANSIT
WHO DO NOT RESIDE IN SPECIAL FACILITIES

Persons in H.H. with X Vehicles, None of Which Will Be Available

Community	X: 0	1	2	3	4	Total Persons
Amesbury	312	116	349	0	0	777
Merrimac	78	0	78	0	0	156
Newbury	116	0	116	0	0	233
Newburyport	349	78	116	0	0	544
Salisbury	78	116	0	0	0	194
West Newbury	38	0	0	0	0	38
Brentwood	0	0	38	0	0	38
East Kingston	0	0	0	0	0	0
Exeter	116	38	78	155	0	388
Greenland	0	78	155	0	0	233
Hampton	78	38	155	0	0	271
Hampton Falls	38	0	0	0	0	38
Kensington	0	0	0	0	0	0
Kingston	0	0	0	38	0	38
New Castle	0	0	38	0	0	38
Newfields	0	0	0	0	0	0
Newton	38	0	116	0	0	155
North Hampton	38	0	0	0	0	38
Portsmouth	466	194	271	38	0	970
Rye	0	0	38	0	0	38
Seabrook	194	0	0	0	0	194
South Hampton	0	0	38	0	0	38
Stratham	0	0	38	0	0	38
					Total:	4457

NOTE

(1) Of those responded "NOT SURE" to the question: "Would you return home in an emergency at Seabrook?" we assume 50 percent would return home.

(2) The sample factor is 38.98.

(3) H.H. = Household

TABLE 11-7

ESTIMATED TRANSIT REQUIREMENTS

Community	1 People Requiring Transit	2 No. of Bus Routes	3 Pass. Per Route	4 Trips Per Route	5 Total Bus Trips	6 (1986) Buses Required	7 (1993) Buses Required
Amesbury	504	7	87	3	21	17	18
Merrimac	140	2	84	3	6	5	6
Newbury	186	4	56	2	8	7	7
Newburyport	384	5	93	4	20	13	14
Salisbury	168	5	41	2	10	6	7
West Newbury	63	3	26	1	3	3	3
Brentwood	60	2	36	2	4	2	3
East Kingston	29	0	18	1	1	1	2
Exeter	288	4	87	3	12	10	11
Greenland	169	3	68	3	9	6	7
Hampton	224	8	34	2	16	8	8
Hampton Falls	57	3	23	1	3	3	3
Kensington	31	2	19	1	2	2	2
Kingston	66	5	15	1	5	5	5
New Castle	53	1	64	3	3	2	3
Newfields	28	2	17	1	2	2	2
Newton	137	3	55	2	6	5	4
North Hampton	65	3	26	1	3	3	3
Portsmouth	636	7	110	4	28	22	21
Rye	67	5	17	1	5	5	5
Seabrook	171	4	52	2	8	6	6
South Hampton	49	2	30	2	4	2	2
Stratham	63	4	19	1	4	4	4
TOTALS:	3638				183	139	146

Column	Explanation
1	From column 7 of Table 11-6
2	Given by State CDAs
3	1.2 x Col. 1/Col. 2
4	Col. 3/30
5	Col. 2 X Col. 4
6	1.2 x Col. 1 /36, but ≥ no. of routes
7	Col. 6 adjusted for 1993 population. (See Section 2.)

NOTE

The Town of Exeter will use four pick-up locations, rather than four bus routes. The Town of East Kingston will pick up people at their homes.

12. SURVEILLANCE OF EVACUATION OPERATIONS

There is a need for surveillance of traffic operations during the evacuation. There is also a concomitant need for tow-truck equipment to clear any blockage of roadways arising from accidents or vehicle disablement.

Surveillance can take several forms:

1. Aerial patrol
2. Ground patrol
3. Fixed-point

This plan calls for all forms of surveillance to be applied:

1. Aerial surveillance is effective both day and night, weather permitting. The aircraft must have a communication link to the EOC and the pilots must be trained to utilize dosimetry equipment and be informed so that they can avoid the plume, if any.

2. Ground patrol surveillance is performed by the many emergency workers who travel within the EPZ as part of their emergency response activities. These individuals include: bus drivers, ambulance/van drivers, personnel who notify people who are hearing impaired people and bus dispatchers. These emergency workers would report the presence of road impediments to the appropriate emergency response personnel.

3. Fixed-point surveillance is provided by all traffic guides located at the Traffic Control Posts and at the Access Control Posts.

These concurrent surveillance procedures are designed to provide coverage of the entire EPZ as well as the area around its periphery. With this coverage, any blockage caused by a disabled vehicle should be quickly identified within a matter of minutes:

- From the air, a blockage is identified by a marked discontinuity in traffic density. Upstream of the blockage, evacuating vehicles will exhibit a dense queuing pattern while the highway downstream will exhibit a very low density. Such a discontinuity is easily detected at night, by observing the pattern of head-lights and tail-lights, and by day, directly.

- Emergency response personnel travelling within the EPZ would directly observe road impediments.

- Personnel at the TCP and ACP would recognize that a blockage (beyond visible range) has occurred, when a pronounced and extended decrease in evacuating traffic volume is observed along an evacuation route. While short-term fluctuations in demand are common, any sharp decrease in demand which prevails for more than three minutes should be viewed as a symptom of a possible blockage somewhere on an approach to the TCP location. It is also probable that a passing motorist will inform the traffic guide that a blockage has taken place.

The traffic guide would immediately report to the EOC or staging area that an apparent blockage is taking place. If more than one guide is stationed at the TCP, then one officer can leave the post to investigate the cause.

Tow Vehicles

In a low-speed traffic environment, any vehicle disablement is likely to arise due to mechanical failure or exhausting the fuel supply. In either case, the disabled vehicle can be pushed onto the shoulder, thereby restoring access for the following vehicles.

Based on vehicle-miles of travel during an evacuation of the entire Seabrook EPZ and available accident statistics, the expected number of accidents would be about 4 to 5 in Massachusetts and 5 to 6 in New Hampshire. Most accidents involving vehicles travelling at low speeds* will not result in a vehicle disablement. Most of those that are disabled can be pushed onto the shoulder.

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*For example, the average vehicle speed for the case of Scenario 1 and Region 1, is under 6 miles an hour.

Experience in past emergencies indicate that such activities (i.e., pushing a disabled vehicle to the side of the road) is often undertaken by other evacuees who are anxious to continue their trips.

While the need for tow vehicles is expected to be low under the circumstances described above, it is still prudent to be prepared for such a need. Approximately 12 tow trucks would be more than adequate to perform this function. Locations for tow truck deployment should be selected so that:

- o They permit access to key, heavily loaded, evacuation routes.

- o Tow trucks responding to a need would most likely travel counter-flow relative to evacuating traffic.

Table 12-1 lists locations for stationary tow trucks during an evacuation. All such equipment should be located off the major roads (e.g., in a parking area) so as not to impede traffic movement. The function of such equipment is to clear the roads of any obstruction and to return to their original locations to await any subsequent call for assistance. These tow trucks should all have communication equipment linked, either directly or indirectly, with the EOC. They should also carry a supply of gasoline to assist any motorist who has exhausted his/her fuel supply.

A study was conducted to evaluate the expected response times of the Massachusetts tow trucks to road impediments. An "impediment" is assumed to be a physical blockage of a road that cannot be removed without the assistance of a tow truck. For purposes of the study, impediments were assumed to be at the other tow truck locations.

Travel times were calculated using travel speeds of 20 mph for travel on inbound and non-evacuation routes, 55 mph for inbound highways, and travel speeds as predicted by the IDYNEV model for evacuation routes. The travel time estimates indicate that as many as six of the available tow trucks could respond to an impediment in any Massachusetts community within 15 minutes.

TABLE 12-1

TOW TRUCK LOCATIONS

No.	Town	General Description
1.	Lawrence	Coady's Towing Service
2.	Methuen	Valley Towing
3.	Newington	Mitchell's Exxon Service
4.	Portsmouth	O'Brien's Truck and Tractor
5.	Greenland	National Wrecker Service
6.	Dover	Dupont's Exxon
7.	Newfields	Armand's Auto Body
8.	Exeter	McCoy's Alignment Service
9.	Exeter	Al's Automotive Service Center
10.	Plaistow	Jack's Towing Service
11.	Newton	Estabrook's Garage
12.	Portsmouth	Bob's of Portsmouth
13.	Seabrook	Circle Motors
14.	Rye	Sargent's Service Center
15.	Seabrook	Watt's Garage

APPENDIX A

Glossary of Terms

APPENDIX A: GLOSSARY OF TERMS

Term	Definition
Capacity	Maximum number of vehicles which have a reasonable expectation of passing a given section of roadway in one direction during a given time period under prevailing roadway and traffic conditions. These are estimates which are expressed as vehicles per hour (vph).
Centroid	An origin or destination located in the interior of the network.
Content	Number of vehicles occupying a section of roadway at a particular point in time.
Destination	A location in the network, either within the interior or on the periphery, to which trips are attracted.
Entry Node	A network node, usually located on the periphery of a network, which serves only as an origin. That is, vehicles are generated and move into the network to travel toward their respective destinations.
Exit Node	A network node, usually located on the periphery of a network, which serves only as a destination. That is, vehicles which arrive at an exit node are discharged from the network.
Green-Time to Cycle Time Ratio (G/C Ratio)	The ratio of the duration of a green interval to the cycle length. This ratio denotes the proportion of time available to service a specified traffic movement on a specific approach to an intersection.

Term	Definition
Internal Node	All nodes which are not Entry or Exit nodes. Vehicles travel through these nodes from one link to the next along their respective paths toward their respective destinations.
Level of Service	An index (A, B, ..., E) which is a qualitative descriptor of the operational performance of traffic on a section of roadway, usually expressed in terms of speed, travel time or density. In practice, each Level of Service index is often associated with a range of service volumes. This relation depends on the type of facility (freeway, rural road, urban street).
Link	A network link represents a specific, one-directional section of roadway. A link has both physical (length, number of lanes, topology, etc.) and operational (turn movement percentages, service rate, free-flow speed) characteristics.
Measures of Effectiveness	Statistics describing traffic operations on a roadway network.
Node	A network node generally represents a specific intersection of network links. A node has control characteristics, i.e., the allocation of service time to each approach link.
Origin	A location in the network, either within the interior, or on the periphery, where trips are generated at a specified rate expressed in vehicles per hour (vph). These trips enter the roadway system to travel to their respective destinations.

Term	Definition
Network	A graphical representation of the geometric topology of a physical roadway system, which is comprised of directional links and nodes.
Prevailing roadway and traffic conditions	Relate to the physical features of the roadway, the nature (e.g., composition) of traffic on the roadway and the ambient conditions (weather, visibility, pavement conditions, etc.).
Service Rate	Maximum rate at which vehicles, executing a specific turn maneuver, can be discharged from a section of roadway at the prevailing conditions, expressed in vehicles per second (vps).
Service Volume	Maximum number of vehicles which can pass over a section of roadway in one direction during a specified time period with operating conditions at a specified Level of Service. (The service volume at Level of Service, E, is equal to Capacity.) Service Volume is usually expressed as vehicles per hour (vph).
Signal Cycle, Cycle Time Cycle Length	The total elapsed time to display all or Cycle Length signal indications, in sequence. The or cycle length is ex ressed in seconds.
Signal Interval	A single combination of signal indications. The interval duration is expressed in seconds. In general, several intervals, in sequence, comprise a phase.
Signal Phase	A set of signal indications (and intervals) which services a particular combination of traffic movements on the approaches to the intersection. The phase duration is expressed in seconds.

Term	Definition
Traffic Assignment	A process of assigning traffic to paths of travel in such a way as to satisfy all trip objectives (i.e., the desire of each vehicle to travel from a specified origin in the network to a specified destination) and to optimize some stated objective or combination of objectives. In general, the objective is stated in terms of minimizing a generalized "cost". For example, "cost" may be expressed in terms of travel time.
Traffic Density	The number of vehicles which occupy one lane of a roadway section of specified length at a point of time, expressed as vehicles per lane-mile (vplm or vpm).
Traffic Simulation	A computer model designed to replicate the real-world operation of vehicles on a roadway network, so as to provide statistics describing traffic performance. These statistics are called Measures of Effectiveness.
Traffic Volume	The number of vehicles which pass over a section of roadway in on direction, expressed in vehicles per hour (vph). Where applicable, traffic volume may be stratified by turn movement.
Travel Mode	Distinguishes between private auto, bus, rail and air travel modes.
Trip Table or Origin-Destination Matrix	A rectangular matrix or table, whose entries contain the number of trips which are generated at each specified origin, during a specified time period, which are attracted to (and travel toward) one of the specified destinations. These values are expressed in vehicles per hour (vph) or in vehicles.

APPENDIX B

Traffic Assignment Model

APPENDIX B: TRAFFIC ASSIGNMENT MODEL

This section describes the trip assignment and distribution model expressly designed for use in analyzing evacuation scenarios. This model, named TRAD, which employs equilibrium principles, is embedded within the IDYNEV System.

In prior versions of IDYNEV, the analyst was required to exercise his judgment in specifying a trip distribution which defines the number of trips from each Origin Centroid within the area to be evacuated, that travel to each of the specified Destination Centroids outside this area. Now the analyst need only specify the capacity (i.e. "attraction") of each Destination Centroid -- TRAD will calculate the optimal trip distribution and the optimal trip assignment (i.e., routing) which minimizes evacuee travel times.

Overview of Integrated Distribution and Assignment Model

The underlying premise is that the selection of destinations and routes is intrinsically coupled in an evacuation scenario. That is, to move people, in vehicles, out of an area of potential risk as rapidly as possible, one must attempt to distribute vehicles from origins to destinations and assign them over the highway network, in a consistent and optimal manner.

The approach we will adopt is to extend the basic equilibrium assignment methodology to embrace the distribution process, as well. That is, the selection of destination nodes by travelers from each origin node, and the selection of the connecting paths of travel, are both determined by the integrated mode. This determination is subject to specified constraints, so as to satisfy the stated objective function. This objective function is the statement of the User Optimization Principle by Wardrop.

To accomplish this integration, we will leave the equilibrium assignment model intact, changing only the form of the objective function. It will also be necessary to create a "fictional" augmentation of the highway network. This augmentation will consist of Pseudo-Links and Pseudo-Nodes, so configured as to embed an equilibrium Distribution Model within the fabric of the Assignment Model.

Specification of TRAD Model Inputs

The user must specify, for each origin node, the average hourly traffic volume. There is no specification of destination nodes. The actual number of trips generated at the origin node, which are distributed to each destination node within this set, is determined by the model in such a way as to satisfy the network-wide objective function (Wardrop's Principle).

The user must also specify the total number of trips which can be accommodated by each destination node. We call this number of trips, the "attraction" of the destination node, consistent with conventional practice. Clearly, we require that

$$A_j \ge \sum_i T_{ij} \; A_j \qquad (1)$$

which implies

$$\sum_j A_j \ge \sum_i P_i = \sum_i \sum_j T_{ij} \qquad (1a)$$

where A_j = Total number of trips that can be accommodated by destination, j

P_i = Production (generation) of trips at origin, $i = \sum_j T_{ij}$

T_{ij} = Trips moving from origin, i, to destination, j

Equ. 1 states that the total number of trips travelling to a destination, j, from all origin nodes, i, cannot exceed the attraction of destination node, j. By summing over all destination nodes, this constraint also states that the total trips generated at all origin nodes must not exceed the total capacity to accommodate trips at all destinations.

In summary, the user must specify the total trips generated at each of the origin nodes, the maximum number of trips that can be accommodated by each of the specified destination nodes and the highway network attributes which include the traffic control tactics. The TRAD model includes a function which expresses travel time on each network link in terms of traffic volume and link capacity. This function describes the underlying trip distribution and trip assignment decision-making process. That is, as noted earlier, the selection of destination nodes and of travel paths, by evacuees, is based upon the perceived need to minimize evacuation travel time. As such, this integrated model is classified as a behavioral model.

At the outset, it may appear that we have an intractable problem:

- o If TRAD retains the basic assignment algorithm, it must be provided a Trip Table as input.

- o On the other hand, if the distribution model is embedded within the assignment model, rather than preceding it, the user cannot specify a Trip Table as input.

The resolution of this problem is as follows:

1. We construct an "augmentation" network which allows the user to specify only the volume for each origin node. The allocation of trips from the origin node to each destination node, is not specified and will be determined internally by the model.

2. We construct pseudo-links which enforce the specified values of A_j for all destination nodes, j, by suitably calibrating the relationship of the travel time vs. volume and capacity.

This augmented network is comprised on three subnetworks:

1. The highway subnetwork, which consists of "Class I" Links and Nodes.

2. A subnetwork of "Class II" Pseudo-Links which acts as an interface between the highway subnetwork and the network augmentation.

3. The subnetwork of "Class III" Pseudo-Links and Nodes which comprises the network augmentation described above.

Figure B-1 depicts this configuration. Note that the Class II Links connect each destination node in the highway subnetwork with its counterpart Level I Pseudo-Node in the Class III subnetwork. The need for these Class II links will become clear later. The classifications are described below:

<u>Class I Links and Nodes</u>

These links and nodes belong to the highway subnetwork and represent real sections of highway and intersections. Trips generated at each Origin [Centroid] Node travel to a specified Class I link via a "connector" link. These connector links are transparent to the user and offer no impedance to the traveler -- which represents the aggregation of local streets which service the zonal generated trips and feed them onto the highway subnetwork. The real-world destination nodes are part of this subnetwork. The immediate approaches to these destination nodes are Class I links.

<u>Class II Links</u>

These pseudo-links are constructed so as to connect each specified destination with its Level 1, Class III Pseudo-Node (P-N) counterpart on a one-to-one basis.

<u>Class III Links and Nodes</u>

Class III links and nodes form the augmentation to the basic network. These Pseudo-Links provide paths from the Class II links servicing traffic travelling from the specified [real] destination nodes, to the Super-Nodes which represent the user-specified <u>sets</u> of destination nodes associated with each origin node.

Each Class of links provides a different function:

- o Class I links represent the physical highway network. As such, each link has a finite capacity, a finite length and an estimated travel time for free-flowing vehicles. The nodes generally represent intersections, interchanges and, possibly, changes in link geometry. The topology of the Class I network represents that of the physical highway system.

- o The Class II links represent the interface between the real highway subnetwork and the augmentation subnetwork. These pseudo-links are needed to represent the specified "attractions" of each destination node, i.e., the maximum number of vehicles that can be accommodated by the facilities accessed from each destination node. Instead of assigning a capacity limitation to the destination nodes, we assign this capacity limitation of the Class II Pseudo-Links. For our purposes, this approach is much more suitable, computationally.

- o The topology of the network augmentation (i.e., Class III Links and Nodes) will be designed so that all traffic travels to the Super-Node and can only flow through the set of real destination nodes.

The Class II Pseudo-Links and the network augmentation of Class II Pseudo-Nodes and Links represent logical constructs of fictitious links created internally by the modes, which allows the user to specify the identity of all destination nodes without specifying the distribution of traffic volumes from the origin to each destination.

Calculation of Capacities and Impedances

Since each subnetwork performs a different function, it follows that each class of links will exhibit different properties. Specifically, the relationship between travel impedance (which is expressed in terms of travel time) and both volume and capacity will differ:

- For Class I links, the capacity represents the physical limitation of the highway elements. Travel impedance is functionally expressed by relating travel time with respect to the traffic volume-link capacity relationship.

- For Class II links, link capacity represents the maximum number vehicles that can be accommodated at the [real] destination nodes which form the upstream nodes of each Class II link. Since Class II links are Pseudo-Links, there should be virtually no difference in impedance to traffic along Class II links when the assigned traffic volume on these links is below their respective capacities. That is, the assignment of traffic should not be influenced by differences in travel impedance on those Class II links where the assigned volumes do not exceed their respective capacities.

- For Class III links, both capacity and impedance have no meaning. Since the Class II links limit the number of vehicles entering the Class III subnetwork at all entry points (i.e., at the Level I Pseudo-Nodes) and since all these links are Pseudo-Links, it follows that the Class III network is definitionally an uncapacitated network.

Specification of the Objective Function

It is computationally convenient to be able to specify a single impedance (or "cost") function relating the travel time on a link, to its capacity and assigned traffic volume, for all classes of links. To achieve this, we will adopt the following form based on the original "BPR Formula":

$$T = T_o\{\alpha[1+a_1(\frac{V}{C})^{b_1}]+\beta[1+a_2(\frac{V}{C})^{b_2}]\} + I$$

Where, as for the present traffic assignment model in IDYNEV,
T = Link travel time, sec.
T_o = Unimpeded link travel time, sec.
V = Traffic volume on the link, veh/hr
C = Link capacity, veh/hr
a_i, b_i = Calibration parameters
α, β = Coefficients defined below

I = Impedance term, expressed in seconds, which could represent turning penalties or any other factor which is justified in the user's opinion

The assignment of coefficients varies according to the Class in which a link belongs:

Class	α	β	T_o
I	1	0	L/U_f
II	0	1	W
III	0	0	1

Here, L is a highway link length and U_f is the free-flow speed of traffic on a highway link. The values of a_1 and b_1, which are applicable only for Class I links, are based on experimental data:

$a_1 = 0.8$ $b_1 = 5.0$

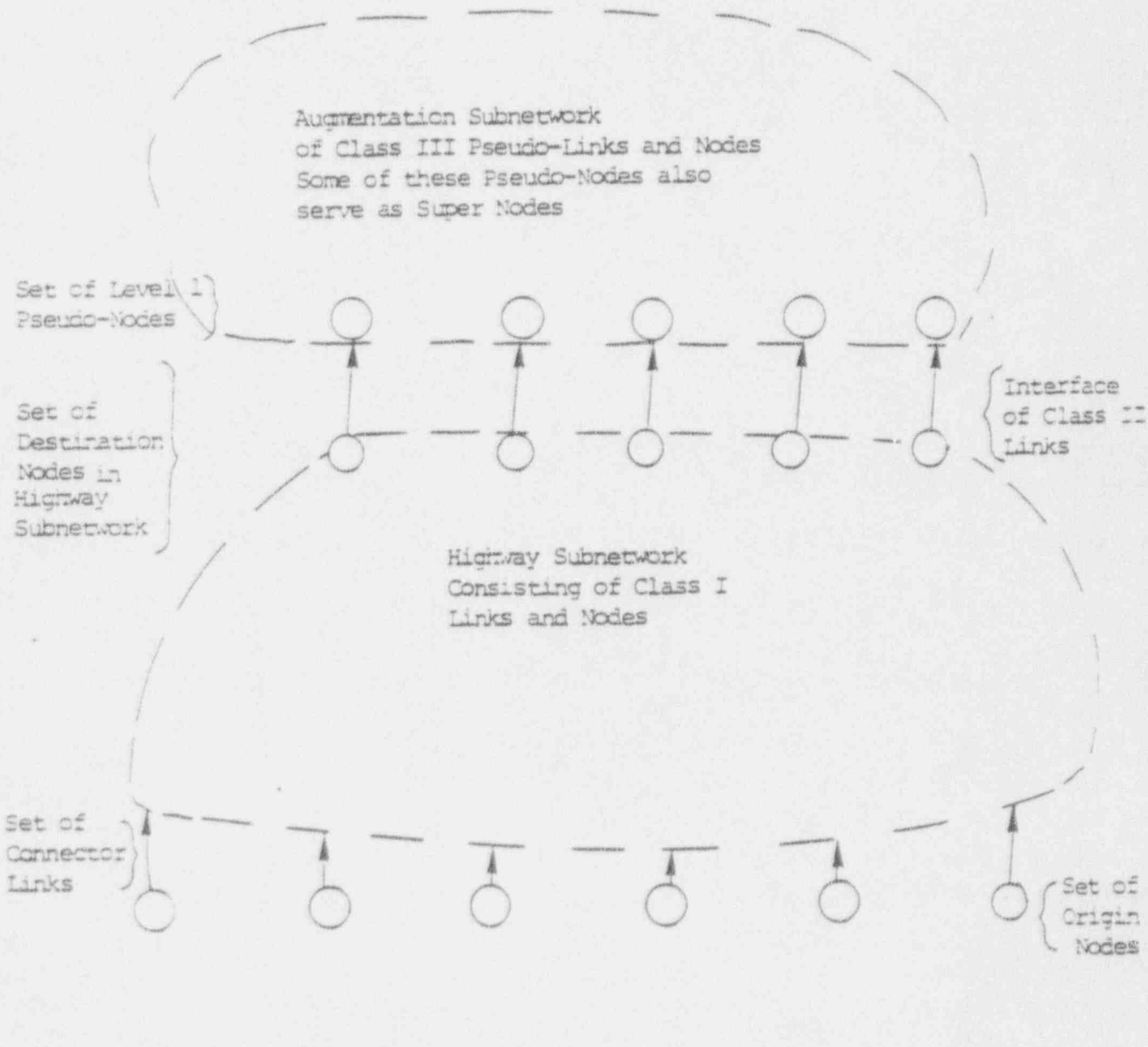
The values of a_2 and b_2, which are applicable for each Class II links, are based upon the absolute requirement that the upstream destination node can service no more traffic than the user-specified value of the maximum "attraction". In addition, these parameters must be chosen so that these Pseudo-Links all offer the same impedance to traffic when their assigned volumes are less than their respective specified maximum attractions.

The weighting factor, W, is computed internally by the software.

Of course, it is still possible for the assignment algorithm within TRAD to distribute more traffic to a destination node than that node can accommodate. For emergency planning purposes, this is a desirable model feature. Such a result will be flagged by the model to alert the user to the fact that some factor is strongly motivating travelers to move to that destination node, despite its capacity limitations. This factor can take many forms: inadequate highway capacity to other destinations, improper specification of candidate destinations for some of the origins, or some other design inadequacy. The planner can respond by modifying the control tactics, changing the origin-destination distribution patter, providing more capacity at the overloaded destinations, etc.

FIGURE B-1

SCHEMATIC OF THE SUBNETWORK STRUCTURE



APPENDIX C

Traffic Simulation Model: I-DYNEV

- Specification of the traffic control devices and their operational characteristics
- Traffic volumes entering and leaving the roadway system
- Traffic composition.

To provide an efficient framework for defining these specifications, the physical environment is represented as a network. The unidirectional links of the network generally represent roadway components: either urban streets or freeway segments. The nodes of the network generally represent urban intersections of points along the freeway where a geometric property changes (e.g., a lane drop, change in grade or ramp).

Figure C-2 is an example of a network representation. The freeway is defined by the sequence of links, (1,2), (2,3), ..., (5,6). Links (8000,1) and (7,8002) are Entry and Exit links, respectively. An arterial extends from node 7 to node 15 and is partially subsumed within a grid network.

The development of the I-DYNEV model followed directly after DYNEV was completed. The perceived need for I-DYNEV was based upon the requirement for a model having all the demonstrated capabilities of DYNEV, but one which consumed less computer time and storage.

The major distinction between DYNEV and I-DYNEV is that the latter model directly calculates the <u>integral</u> of the histograms described earlier (see Figure C-1), instead of computing the amplitudes of each histogram slice, as does DYNEV. One other difference is that in I-DYNEV, vehicles which cannot travel along their assigned evacuation route due to excessive congestion will divert to another, alternative evacuation route if the latter is not congested. In all other respects, the two models are either identical (e.g., the input and output software) or are very similar, with any difference reflecting the major distinction described above.

This major distinction results in software code which consumes significantly less storage for I-DYNEV than for DYNEV, reflecting the elimination of large arrays containing the amplitude values of each histogram slice. The reduced computational burden is reflected in almost a three-fold reduction in computing time.

A thorough comparison was made between the results generated by the two models. It was found that all pairs of results, DYNEV and I-DYNEV, were virtually identical for a wide variety of network configurations and traffic demand levels. Note that the two models require the identical input stream and produce identical output formats.

On the basis of these results, I-DYNEV is used exclusively for the EESF system, to calculate evacuation time estimates.

APPENDIX D

Detailed Description of Study Procedure

APPENDIX D: DETAILED DESCRIPTION OF STUDY PROCEDURE

This appendix describes the activities to be performed in order to produce accurate estimates of evacuation times on the Emergency Planning Zone (EPZ) for a nuclear power plant. The individual steps of this effort are represented as a flow diagram in Figure D-1. Each numbered step in the description which follows corresponds to the numbered element in this flow diagram.

Step 1. The first activity is to obtain data defining the spatial distribution of population within the EPZ. Specifically, obtain the population in each of 160 cells of a polar grid which is centered at the nuclear station, and consists of 22.5° sections and rings spaced one mile apart. Transient population characteristics must also be estimated on the same basis.

Step 2. The next activity is to examine a large-scale map of the EPZ. This map enables one to identify the access roads from each residential development to the adjoining elements of the analysis roadway network. This information is necessary in order to assign generated trips to the correct links of the network. This map also enables one to represent the geometrics of complex intersections properly in terms of their network configuration.

Step 3. With this information absorbed, the next step is to conduct a physical survey of the roadway system within the EPZ. The purpose of this survey is to determine the necessary measurements of roadway length and of the number of lanes on each link, the channelization of these lanes, whether or not there were any turn restrictions or special treatment of traffic at intersections and to gain the necessary insight required for estimating realistic values of roadway capacity. At each major intersection, take note of the traffic control device which was installed. In addition, determine whether or not, under emergency evacuation conditions, it would be possible to employ paved shoulders as an additional lane in the event such additional capacity was required.

Step 4. With this information, develop the evacuation network representation of the physical roadway system.

Step 5. With the network drawn, proceed to estimate the capacities of each link and to locate the centroids where trips would be generated during the evacuation process and then enter the analysis network.

Step 6. With all the information at hand, it is time to perform the effort of creating the input stream for the Traffic Assignment Model. This model was designed to be compatible with the Traffic Simulation Model used later in the project, in the sense that the input format required for one model was entirely compatible with the input format required by the other, thus avoiding duplication of efforts. This step in the procedure is labor-intensive. Fortunately, this input stream need only be developed once. Any changes made can be implemented quickly and at small cost. Thus, it is possible to execute these models on different scenarios with very little effort needed to modify the basic input stream to represent the specific attributes of each scenario.

Step 7. After creating the input stream by using PREDYN, execute the Traffic Assignment Model. This computer program contains upwards of 1,000 diagnostic inconsistencies and any other improper input. This diagnostic software produces messages which assist the user in identifying the source of the problem and guide the user in preparing the necessary corrections.

Step 8. With the input stream free of error, execute the Traffic Assignment Model. The Traffic Assignment program is a very efficient software code.

Step 9. The next activity is to examine critically the statistics produced by the Traffic Assignment program. This is a labor-intensive activity, requiring the direct participation of skilled engineers who possess the necessary practical experience to interpret the results and to determine the causes of any problems reflected in the result.

Essentially, the approach is to identify those "hot spots" in the network which represent locations where congested conditions are extreme. It is then necessary to identify the cause of this congestion. This cause can take many forms, either as excess demand due to improper routing, as a shortfall of capacity, or as a quantitative error in the way the physical system was represented in the input stream.

The examination of the Traffic Assignment output leads to one of two conclusions:

- o The results are as satisfactory as could be expected at this stage of the analysis process, or
- o Treatments must be introduced in order to improve the flow of traffic.

This decision requires, of course, the application of the user's judgment based upon the results obtained in previous applications of the Traffic Assignment Model and a comparison of the results of this last case with the previous ones. In the event the results are satisfactory, in the opinion of the user then the process continues with the exercise of the simulation model in Step 12. Otherwise, proceed to Step 10.

Step 10. There are many "treatments" available to the user in resolving such problems. These treatments range from decisions to reroute the traffic by imposing turn restrictions where they can produce significant improvements in capacity, changing the control treatment at critical intersections so as to provide improved service for one or more movements, or in prescribing specific treatments for channelizing the flow so as to expedite the movement of traffic along major roadway systems or changing the trip table. Such "treatments" take the form of modifications to the original input stream.

We then perform the modifications to the input stream, reflecting the control treatments described above. As indicated previously, such modifications are implemented quickly to the extent that more than one execution of the computer program is possible in a single day.

Step 11. As noted above, the physical changes to the input stream must be implemented in order to reflect the changes in the control treatments undertaken in Step 10. At the completion of this activity, the process returns to Step 8 where the Traffic Assignment Model is once again executed.

Step 12. The output of the Traffic Assignment Model includes the computed turn movements for each link. If the user is executing the Traffic Assignment and the Traffic Simulation models in a single run, then this data is automatically accessed by the latter model. If the simulation model is executed separately, the user must modify the input stream for the Traffic Assignment model by beginning in the turn-movement data, using PREDYN.

Step 13. After the input stream has been debugged, the simulation model is executed to provide the user with detailed estimates, expressed as statistical Measures of Effectiveness (MOE), which describe the detailed performance of traffic operations on each link of the network.

Step 14. In this step, the detailed output of the Traffic Simulation Model is examined in order to identify once again the problems which exist on the network. The results of the simulation model are extremely detailed and are far more accurate in their ability to describe traffic operations than those provided by the Traffic Assignment Model. Thus, it is possible to identify the cause of the problems by carefully studying the output.

Again, one can implement corrective treatments designed to expedite the flow of traffic on the network in the event that the results are considered to be less efficient than is possible to achieve. In the event that changes are needed, the analysis process proceeds to Step 15. On the other hand, if the results were satisfactory, then one can decide whether it is necessary to return to Step 8 to execute the Traffic Assignment Model once again and repeat the whole process, or to accept the final results as being the "best" that can be achieved within the reasonable constraints of budget and time allotments. Generally, if there are no changes indicated by the activities of Step 14, then we can conclude that all results were satisfactory, and we can then proceed to document them in Step 17. Otherwise, we have to return to Step 8 in order to determine the effects of the changes implemented in Step 14 on the optimal routing patterns over the network. This determination can only be ascertained by executing the Traffic Assignment Model.

APPENDIX E

Literature Review and Data Compiled to Date

Weekday traffic was about 75 percent of weekend traffic.

10. Beach Capacity Analysis for Shoreline Areas Around Seabrook, New Hampshire, prepared by HMM Associates, dated June 1982

This study investigated beach usage and capacity characteristics. The coastal area considered lies between the Parker River National Wildlife refuge on Plum Island, MA, north to Concord Point, north of Rye Beach. However, data was presented for both Wallis Sands State Park and Odiorne Point State Park, both of which are north of Concord Point.

Total annual attendance at the four coastal state parks generally ranged between 250,000 and 300,000, with a long-term trend that was essentially flat between 1970 and 1981. The annual attendance at Hampton Beach State Park ranged from about 150,000 to 180,000, in general.

Vehicle parking capacity was estimated at 19,212 vehicles. This capacity included parking lots and on-street curb parking, but may not have included driveways and backyards.

Studies of population on the sandy beach areas yielded observations consistent with ours (see item 8). Specifically, careful analysis indicated that a perfunctory assessment of beach population would yield overestimates of beach density since, at any time, many beach towels are unoccupied. It was also determined that the casino area of Hampton Beach was of particular interest.

The study conducted a "peak day - peak area" analysis of beach density. Specifically, sampling areas, upwards of 3,500 sq. ft. were selected which represented "the most crowded section within the [beach] segment", thus providing an upper bound of beach density. The report cautions the reader not to assume that such peak values are applicable to the entire beach segment (p. 3-13, 14). For example, while the peak density for the major Hampton Beach segment is 44 sq. ft. per person, an average density calculated using six sampling "plots" was 62 sq. ft. per person. (This figure compares with 65 sq. ft. per person measured by KLD -- see item 8.)

The observation is made that even on peak days over a 3-year study period, "several parking lots ... are not filled to capacity". The total parking capacity was estimated at about 19,200 vehicles. On this basis, assuming 3.3 person per vehicle, a "realistic" capacity estimate of 63,400 persons is offered.

11. Roadway Network and Evacuation Study [for] Seabrook, New Hampshire, prepared by Wilbur Smith and Associates, dated December 1974

This report describes the assumptions used, the highway capacities estimated, the traffic management techniques to be applied and the evacuation time estimates (ETE). Several evacuation scenarios are considered.

The analysis methodology is not described in any detail. It appears to be based on an assumed speed of travel for each roadway, the estimated roadway capacities and estimated traffic demands.

In the "controlled sector evacuation" it is assumed that people in some of the designated sectors will wait patiently for other sectors to be evacuated, before beginning to evacuate (Fig. following p. 36). On this basis, an ETE of slightly over 3 hours is predicted. For simultaneous evacuation of the entire EPZ, an ETE of just under 7 hours is predicted.

12. Estimate of Evacuation Times, prepared by Alan M. Voorhees & Associates, dated June 1980 (Final Report, August 1980)

This report describes the estimation of ETE from the Seabrook EPZ. Several scenarios are considered: Summer Sunday, Winter weekday, normal and severe weather. Estimates of ETE are presented (hrs:min):

- o Summer Sunday - 6:10
- o Winter weekday - 3:40 normal weather; 4:30 severe
- o Selective evacuation - 5:10 to 6:10

The population estimates are: 111,000 permanent residents and 78,000 seasonal and transient. These estimates are projections to 1978 from the 1970 census. Highway capacities are set to 1200 veh. per hour for all but the interstate routes; capacities for I95 and I495 are not given.

13. Evacuation Clear Time Estimates for Areas Near Seabrook Station, prepared by HMM Associates, Inc., revised July 1983

This report provides ETE for the Seabrook EPZ, corresponding to five conditions. The ETE (hrs:min) for an evacuation of the entire EPZ are:

Summer Weekend	- 6:05
Summer Weekday	- 4:10
Off-Season Weekday	- 3:10, fair weather
Off-Season Weekday	- 4:10, adverse weather

Highway capacities are calculated internally by the NETVAC model, based on the procedures of the 1965 Highway Capacity Manual. These capacities may be modified, over time, as traffic patterns change. NETVAC is a macroscopic traffic simulation model developed for analyzing traffic operations during an evacuation and for calculating ETE.

The traffic demand volumes used for this study excluded the towns of Portsmouth, Kingston and Newfields. Thus, the total permanent population in 1983 was estimated to be about 122,.00. An average vehicle occupancy of 3.0 persons was assumed; this would yield a demand of about 40,800 vehicles. Total seasonal demand was estimated at 39,500 vehicles for weekends (Figure 6). Daily seasonal transient vehicle counts were estimated at 17,150 for the weekend and 6,870 for weekdays. Manufacturing employment within the EPZ was estimated at 7,500 vehicles. No allowance was made for double-counting; i.e. people who worked within the EPZ or went to the beach, and who also resided within the EPZ. Also, seasonal demand included 2,000 utility employee vehicles at the Station.

It was assumed that all evacuating vehicles enter the highway system at the constant rate of 20 vehicles per minute, throughout the EPZ. This rate was doubled at major employment locations for the weekday scenarios (e.g., at Seabrook Station and at the Greyhound Park).

14. An Independent Assessment of Evacuation Time Estimates for a Peak Population Scenario in the Emergency Planning Zone of the Seabrook Nuclear Power Station, prepared by Pacific Northwest Laboratory, dated October 1982

This report presents the results of an ETE analysis of the entire EPZ under the single scenario of a peak population condition. This report was "not intended for use by decisionmakers during emergencies", but rather as an independent evaluation of other ETEs.

A total of 95,800 evacuating vehicles is estimated for this scenario, including 44,000 for permanent residents and 51,800 for seasonal and transient population. These estimates were derived from an NRC report:

Demographic and Vehicular Demand Estimates for an Evacuation Analysis of the Seabrook Station, prepared by M. Kaltman of the Siting Analysis Branch, dated February 1981

The estimate of seasonal population was approximately 43,000 on the weekend, compared with 30,500 on a typical weekday. These estimates assumed 7.6 persons per dwelling on a weekend and 5.4 on a typical weekday. (The imputed number of seasonal dwellings is about 5,700.)

The PSNH study assumed 2.0 vehicles per dwelling; the NRC argued for a figure of 2.5. (KLD's on-foot survey recorded an average value of 2.6 vehicles per dwelling.)

In addition, overnight accommodations were surveyed to obtain an estimate of about 4,600 rooms within the EPZ. Each occupied room was assumed to generate one vehicle. Campgrounds contained space for about 3,150 vehicles.

Beach area parking -- both lots and on-street -- is estimated at about 17,500 spaces. Weekend bus activity is low -- on the order of 10 trips. (This was confirmed in KLD interviews with local officials.) It was also assumed that some 2,200 vehicles park during the weekend at non-seasonal housing units. About 3,100 vehicles are estimated for the Greyhound Park and another 5,100 vehicle spaces in parking lots along Route 1.

Manufacturing and industrial employment within the EPZ is estimated at about 12,200 persons. (Of course, many of these persons also live within the EPZ.) An assumption of one vehicle per worker was applied.

A very thorough inventory was undertaken of hotels, campgrounds, schools and special facilities.

The ETE were calculated using the CLEAR model which simulates the movement of vehicles along specified "free" networks. Trip generation time was assumed to be one hour for the beach traffic and 1.5 hours elsewhere. No basis was presented to support this approach.

The ETE obtained for this study was 11:40 (hrs:min). The conclusions included the following comment:

> The data presented in this report suggests that an evacuation time of 6 to 7 hours is possible under peak conditions if a high level of effectiveness and traffic optimization are achieved. An evacuation time estimate in the range of 10 to 12 hours represents the time estimate for an evacuation under peak conditions if a relatively unimproved level of traffic control exists.

15. Population Estimates for Towns within the Seabrook EPZ

We have obtained the most recent population projections for the towns within the Seabrook EPZ:

- 1985 Population Estimates for towns in Massachusetts were provided by the Division of Health Statistics and Research, Department of Public Health of the Commonwealth of Massachusetts

- 1984 Population Estimates of New Hampshire Towns were provided by the New Hampshire Office of State Planning.

Both sets of data were provided to us in September 1985. All estimates were projected forward to 1986 using the most recent annual growth rates for each town. We also contacted the Town Clerk's offices to obtain independent estimates based on local census activities. These estimates are also shown below:

Town	1986 Projected Population	Town Clerks Early 1985
<u>Massachusetts</u>		
Amesbury	14,982	14,056
Merrimac	4,760	4,364
Newbury	4,759	5,423
Newburyport	16,615	16,300
Salisbury	6,276	6,645
West Newbury	3,023	3,260
<u>New Hampshire</u>		
Brentwood	1,939	2,000
E. Kingston	1,202	1,250
Exeter	11,828	11,600
Greenland	2,281	2,200
Hampton	11,656	13,000
Hampton Falls	1,514	1,450
Kensington	1,539	1,350
Kingston	5,180	4,890
New Castle	798	625
Newfields	926	850
Newton	3,722	3,625
North Hampton	3,632	3,600
Portsmouth	28,404	26,300
Rye	5,059	5,000
Seabrook	6,649	8,000
South Hampton	653	700
Stratham	3,232	3,300
EPZ TOTAL:	140,629	139,788

16. Emergency Planning Zone Evacuation Time Study - Seabrook Nuclear Power Station, Seabrook, NH, prepared by Costello, Lomasney and deNapoli, Inc. in association with C.E. Maguire, Inc., dated March 1984

This report presents the results of an evacuation study for the Seabrook EPZ. These results included projections to the years 2000 and 2030, in addition to 1985.

The permanent resident population within the EPZ in 1985 is estimated at about 127,700 persons. Summer weekend transient population for 1985 was projected at about 173,100 persons. Institutional population approximated 2,200 patients and 1,300 support staff. School population is estimated at about 29,600 students and 3,300 support staff. Non-car-owning population was estimated using 1970 census data rates.

The ETE estimates for the entire EPZ are presented below:

Scenario	ETE (hrs:mi)
Winter Day	3:00
Summer Weekday	4:30
Summer Weekend	5:50
Winter Day with snow	5:30
Summer Weekend, rain & fog	7:40

(Add 15 minutes to account for notification time.)

17. Telephone Survey of Residents of Seabrook EPZ, conducted by First Market Research using a survey instrument developed by KLD Associates, dated October 1985

On October 3-7, 1985, telephone interviews were conducted among heads of households within the Seabrook EPZ. A total of 10,567 calls were made. Of these, 1,382 interviews were completed.

The survey instrument was designed to obtain up-to-date data on demographic and travel information which is needed to satisfy the input requirements for evacuation study. This information, which should also be of value for other planning agencies, is presented elsewhere in this report.

18. Survey of Traffic Movements on the Beach Access Roads

Merrimac Engineering Services, Inc. was retained to acquire vehicle counts during the last week in August 1985 and over the Labor Day weekend. These counts include vehicle counts, observations of vehicle occupancy (i.e. persons per vehicle), and license plate numbers and State of origin.

The weather over this period of time was not particularly appealing to beach-goers, so the data will not reflect peak conditions. Nevertheless, the counts of vehicle occupancy which were taken are probably representative of beach traffic, albeit there is some uncertainty on this point. Also, the license plate data provides an indication of the points of origin of visitors.

19. 1980 Census Data

Most of the early studies employed population statistics which were projections based on the 1970 census data. KLD reviewed available 1980 census data for the towns within the EPZ, which are relevant to the evacuation study. These data are presented in Appendix H.

20. Aerial Beach Survey - July 18, 1987

On July 18, 1987 Avis Airmap, of Braintree, Massachusetts, took a series of 58 aerial photographs of a one mile wide coastal area ranging from Seabrook Station to 15 miles south on Plum Island to 12 miles north at Odiorne Point. The flight was conducted at noontime Sunday with sunny warm weather in the mid-80's. This weather attracted an attendance at the beach which was comparable to that on the peak day of July 16th, 1983.

The number of parked vehicles and the number of vehicles in transit were counted from the enlarged photographs. The beach population for the seacoast had previously been determined to peak at 2:00 p.m. on summer weekends (see Table 2-3); thus it was necessary to adjust the number of vehicle to account for a projected increase between the time of the aerial survey and 2:00 p.m. This adjustment provided the following results:

	Beach Location (Town)	Observed Parked Vehicles	Projected Parked Vehicles	Observed Vehicles in Transit
a.	Plum Island (Ipswich, Rowley, Newbury, Newburyport)	2,799	3,095	103
b.	Salisbury	5,548	6,119	153
c.	Seabrook	2,785	3,040	123
d.	Hampton	12,210	13,257	750
e.	North Hampton	286	308	109
f.	Rye	3,222	3,474	202
TOTAL			29,293	1,440

This projected estimate of 30,733 vehicles (29,293 + 1,440) plus an estimated 2,085 vehicles in beach area parking spaces hidden from aerial observation represents a reasonably expected peak and is used as an input to IDYNEV model for calculating ETE. This estimate represents an approximate 15% increase over the 1985 estimate detailed in item 7.

APPENDIX F

Telephone Survey Instrument

APPENDIX G

Tabulations of Telephone Survey Data

Results of 1992 Telephone Survey

PERSONS PER HOUSEHOLD VS WEEKEND BEACHGOERS PER HOUSEHOLD

PERSONS PER HOUSEHOLD		NUMBER OF DAYS PER SUMMER					TOTAL
		0	1-5	6-10	11-15	16+	
1	TOTAL:	79	26	9	18	13	145
	PERCENT:	54.5	17.9	6.2	12.4	9.0	100.0
2	TOTAL:	121	66	36	22	42	287
	PERCENT:	42.2	23.0	12.5	7.7	14.6	100.0
3	TOTAL:	54	32	14	13	27	140
	PERCENT:	38.6	22.9	10.0	9.3	19.3	100.0
4	TOTAL:	44	42	11	15	29	141
	PERCENT:	31.2	29.8	7.8	10.6	20.6	100.0
5	TOTAL:	13	14	2	6	3	38
	PERCENT:	34.2	36.8	5.3	15.8	7.9	100.0
6	TOTAL:	9	2	0	1	8	20
	PERCENT:	45.0	10.0	.0	5.0	40.0	100.0
7	TOTAL:	0	1	0	0	2	3
	PERCENT:	.0	33.3	.0	.0	66.7	100.0
8	TOTAL:	0	1	0	0	1	2
	PERCENT:	.0	50.0	.0	.0	50.0	100.0
9	TOTAL:	1	0	0	0	0	1
	PERCENT:	100.0	.0	.0	.0	.0	100.0
10	TOTAL:	0	0	0	0	0	0
	PERCENT:	.0	.0	.0	.0	.0	100.0

PERSONS PER HOUSEHOLD VS COMMUTERS PER HOUSEHOLD

PERSONS PER HOUSEHOLD		NUMBER OF COMMUTERS PER HOUSEHOLD 0	1	2	3	4	TOTAL
1	TOTAL:	80	65	0	0	0	145
	PERCENT:	55.2	44.8	.0	.0	.0	100.0
2	TOTAL:	99	78	115	0	0	292
	PERCENT:	33.9	26.7	39.4	.0	.0	100.0
3	TOTAL:	17	46	60	27	0	150
	PERCENT:	11.3	30.7	40.0	18.0	.0	100.0
4	TOTAL:	12	41	59	16	15	143
	PERCENT:	8.4	28.7	41.3	11.2	10.5	100.0
5	TOTAL:	3	12	17	3	4	39
	PERCENT:	7.7	30.8	43.6	7.7	10.3	100.0
6	TOTAL:	1	7	6	2	5	21
	PERCENT:	4.8	33.3	28.6	9.5	23.8	100.0
7	TOTAL:	0	1	0	1	2	4
	PERCENT:	.0	25.0	.0	25.0	50.0	100.0
8	TOTAL:	0	1	0	0	1	2
	PERCENT:	.0	50.0	.0	.0	50.0	100.0
9	TOTAL:	0	0	0	1	0	1
	PERCENT:	.0	.0	.0	100.0	.0	100.0
10	TOTAL:	0	0	0	0	0	0
	PERCENT:	.0	.0	.0	.0	.0	100.0

COMMUTER TRAVEL TIMES BETWEEN WORK (SCHOOL) AND HOME

TIME RANGE (IN MINUTES)	NUMBER OF COMMUTERS	PERCENT OF COMMUTERS
1 - 5	145	14.2
6 - 10	146	14.3
11 - 15	135	13.2
16 - 20	130	12.7
21 - 25	57	5.6
26 - 30	95	9.3
31 - 35	32	3.1
36 - 40	45	4.4
41 - 45	54	5.3
46 - 50	20	2.0
51 - 55	9	.9
56 - 60	56	5.5
61 - 75	21	2.1
76 - 90	28	2.7
91 - 105	6	.6
106 - 120	2	.2
121+	7	.7
VARIES	33	3.2
UNKNOWN	3	.3

COMMUTER TRAVEL TIMES BETWEEN WORK (SCHOOL) AND HOME FOR HOUSEHOLDS WITH 1 CAR(S)

TIME RANGE (IN MINUTES)	NUMBER OF COMMUTERS	PERCENT OF COMMUTERS
1 - 5	24	16.6
6 - 10	29	20.0
11 - 15	17	11.7
16 - 20	17	11.7
21 - 25	10	6.9
26 - 30	15	10.3
31 - 35	7	4.8
36 - 40	2	1.4
41 - 45	4	2.8
46 - 50	1	.7
51 - 55	0	.0
56 - 60	7	4.8
61 - 75	2	1.4
76 - 90	4	2.8
91 - 105	1	.7
106 - 120	1	.7
121+	0	.0
VARIES	4	2.8
UNKNOWN	0	.0

COMMUTER TRAVEL TIMES BETWEEN WORK (SCHOOL) AND HOME FOR HOUSEHOLDS WITH 2 CAR(S)

TIME RANGE (IN MINUTES)	NUMBER OF COMMUTERS	PERCENT OF COMMUTERS
1 - 5	69	12.7
6 - 10	60	11.1
11 - 15	69	12.7
16 - 20	80	14.8
21 - 25	28	5.2
26 - 30	49	9.0
31 - 35	19	3.5
36 - 40	29	5.4
41 - 45	33	6.1
46 - 50	8	1.5
51 - 55	4	.7
56 - 60	28	5.2
61 - 75	16	3.0
76 - 90	16	3.0
91 - 105	3	.6
106 - 120	1	.2
121+	6	1.1
VARIES	22	4.1
UNKNOWN	2	.4

COMMUTER TRAVEL TIMES BETWEEN WORK (SCHOOL) AND HOME FOR HOUSEHOLDS WITH 3 CAR(S)

TIME RANGE (IN MINUTES)	NUMBER OF COMMUTERS	PERCENT OF COMMUTERS
1 - 5	31	14.6
6 - 10	40	18.9
11 - 15	30	14.2
16 - 20	22	10.4
21 - 25	5	2.4
26 - 30	24	11.3
31 - 35	3	1.4
36 - 40	7	3.3
41 - 45	8	3.8
46 - 50	7	3.3
51 - 55	5	2.4
56 - 60	12	5.7
61 - 75	3	1.4
76 - 90	6	2.8
91 - 105	1	.5
106 - 120	0	.0
121+	1	.5
VARIES	6	2.8
UNKNOWN	1	.5

COMMUTER TRAVEL TIMES BETWEEN WORK (SCHOOL) AND HOME FOR HOUSEHOLDS WITH 4 CAR(S)

TIME RANGE (IN MINUTES)	NUMBER OF COMMUTERS	PERCENT OF COMMUTERS
1 - 5	20	17.1
6 - 10	15	12.8
11 - 15	19	16.2
16 - 20	11	9.4
21 - 25	14	12.0
26 - 30	6	5.1
31 - 35	3	2.6
36 - 40	3	2.6
41 - 45	9	7.7
46 - 50	4	3.4
51 - 55	0	.0
56 - 60	9	7.7
61 - 75	0	.0
76 - 90	2	1.7
91 - 105	1	.9
106 - 120	0	.0
121+	0	.0
VARIES	1	.9
UNKNOWN	0	.0

MINIMUM AND MAXIMUM COMMUTER TRAVEL TIMES FOR HOUSEHOLDS WITH 1 COMMUTER(S)

TIME RANGE (IN MINUTES)	----MINIMUM TIME RANGE--- NUMBER OF COMMUTERS	PERCENT OF COMMUTERS	----MAXIMUM TIME RANGE--- NUMBER OF COMMUTERS	PERCENT OF COMMUTERS
1 - 5	33	13.1	33	13.1
6 - 10	29	11.5	29	11.5
11 - 15	32	12.7	32	12.7
16 - 20	27	10.7	27	10.7
21 - 25	16	6.3	16	6.3
26 - 30	27	10.7	27	10.7
31 - 35	11	4.4	11	4.4
36 - 40	9	3.6	9	3.6
41 - 45	12	4.8	12	4.8
46 - 50	6	2.4	6	2.4
51 - 55	1	.4	1	.4
56 - 60	17	6.7	17	6.7
61 - 75	9	3.6	9	3.6
76 - 90	9	3.6	9	3.6
91 - 105	1	.4	1	.4
106 - 120	1	.4	1	.4
121+	2	.8	2	.8
VARIES	8	3.2	8	3.2
UNKNOWN	2	.8	2	.8

MINIMUM AND MAXIMUM COMMUTER TRAVEL TIMES FOR HOUSEHOLDS WITH 2 COMMUTER(S)

TIME RANGE (IN MINUTES)	----MINIMUM TIME RANGE---		----MAXIMUM TIME RANGE---	
	NUMBER OF COMMUTERS	PERCENT OF COMMUTERS	NUMBER OF COMMUTERS	PERCENT OF COMMUTERS
1 - 5	92	17.9	43	8.4
6 - 10	81	15.8	58	11.3
11 - 15	73	14.2	56	10.9
16 - 20	57	11.1	62	12.1
21 - 25	23	4.5	20	3.9
26 - 30	50	9.7	51	9.9
31 - 35	15	2.9	15	2.9
36 - 40	25	4.9	32	6.2
41 - 45	28	5.5	46	9.0
46 - 50	8	1.6	15	2.9
51 - 55	1	.2	4	.8
56 - 60	19	3.7	35	6.8
61 - 75	10	1.9	17	3.3
76 - 90	8	1.6	16	3.1
91 - 105	2	.4	6	1.2
106 - 120	0	.0	1	.2
121+	3	.6	5	1.0
VARIES	17	3.3	29	5.7
UNKNOWN	1	.2	2	.4

MINIMUM AND MAXIMUM COMMUTER TRAVEL TIMES FOR HOUSEHOLDS WITH 3 COMMUTER(S)

TIME RANGE (IN MINUTES)	----MINIMUM TIME RANGE---- NUMBER OF COMMUTERS	PERCENT OF COMMUTERS	----MAXIMUM TIME RANGE---- NUMBER OF COMMUTERS	PERCENT OF COMMUTERS
1 - 5	30	20.0	9	6.0
6 - 10	47	31.3	19	12.7
11 - 15	13	8.7	13	8.7
16 - 20	26	17.3	22	14.7
21 - 25	4	2.7	9	6.0
26 - 30	9	6.0	16	10.7
31 - 35	2	1.3	3	2.0
36 - 40	1	.7	6	4.0
41 - 45	4	2.7	9	6.0
46 - 50	1	.7	4	2.7
51 - 55	4	2.7	7	4.7
56 - 60	5	3.3	15	10.0
61 - 75	0	.0	0	.0
76 - 90	0	.0	5	3.3
91 - 105	1	.7	3	2.0
106 - 120	0	.0	0	.0
121+	0	.0	2	1.3
VARIES	3	2.0	8	5.3
UNKNOWN	0	.0	0	.0

MINIMUM AND MAXIMUM COMMUTER TRAVEL TIMES FOR HOUSEHOLDS WITH 4 COMMUTER(S)

TIME RANGE (IN MINUTES)	----MINIMUM TIME RANGE---		----MAXIMUM TIME RANGE---	
	NUMBER OF COMMUTERS	PERCENT OF COMMUTERS	NUMBER OF COMMUTERS	PERCENT OF COMMUTERS
1 - 5	42	38.9	20	18.5
6 - 10	22	20.4	9	8.3
11 - 15	10	9.3	13	12.0
16 - 20	12	11.1	11	10.2
21 - 25	10	9.3	14	13.0
26 - 30	1	.9	8	7.4
31 - 35	3	2.8	3	2.8
36 - 40	0	.0	3	2.8
41 - 45	1	.9	4	3.7
46 - 50	0	.0	3	2.8
51 - 55	0	.0	0	.0
56 - 60	4	3.7	5	4.6
61 - 75	0	.0	2	1.9
76 - 90	2	1.9	9	8.3
91 - 105	0	.0	0	.0
106 - 120	0	.0	0	.0
121+	0	.0	0	.0
VARIES	1	.9	4	3.7
UNKNOWN	0	.0	0	.0

COMMUTER PREPARATION TIMES FOR LEAVING WORK (SCHOOL)

TIME RANGE (IN MINUTES)	NUMBER OF COMMUTERS	PERCENT OF COMMUTERS
1 - 5	561	54.8
6 - 10	158	15.4
11 - 15	77	7.5
16 - 20	28	2.7
21 - 25	6	.6
26 - 30	55	5.4
31 - 35	3	.3
36 - 40	2	.2
41 - 45	15	1.5
46 - 50	1	.1
51 - 55	2	.2
56 - 60	21	2.1
61 - 75	1	.1
76 - 90	4	.4
91 - 105	1	.1
106 - 120	2	.2
121+	3	.3
VARIES	2	.2
UNKNOWN	82	8.0

HOME PACKING TIMES NEEDED TO PREPARE FOR DEPARTURE

TIME RANGE (IN MINUTES)	NUMBER OF HOUSEHOLDS	PERCENT OF HOUSEHOLDS
1 - 15	197	24.7
16 - 30	204	25.5
31 - 45	62	7.8
46 - 60	72	9.0
61 - 75	63	7.9
76 - 90	6	.8
91 - 105	3	.4
106 - 120	17	2.1
121 - 135	33	4.1
136 - 150	2	.3
151 - 165	2	.3
166 - 180	7	.9
181 - 195	10	1.3
196 - 210	2	.3
211 - 225	2	.3
226 - 240	4	.5
241 - 255	4	.5
256 - 270	0	.0
271 - 285	0	.0
286 - 300	0	.0
301 - 315	2	.3
316 - 330	0	.0
331 - 345	0	.0
346 - 360	10	1.3
UNKNOWN	97	12.1

PERSONS PER HOUSEHOLD VS CARS PER HOUSEHOLD

PERSONS PER HOUSEHOLD		NUMBER OF CARS PER HOUSEHOLD 0	1	2	3	4	TOTAL
1	TOTAL:	21	113	8	2	1	145
	PERCENT:	14.5	77.9	5.5	1.4	.7	100.0
2	TOTAL:	8	77	184	18	5	292
	PERCENT:	2.7	26.4	63.0	6.2	1.7	100.0
3	TOTAL:	2	21	73	43	11	150
	PERCENT:	1.3	14.0	48.7	28.7	7.3	100.0
4	TOTAL:	1	14	74	40	14	143
	PERCENT:	.7	9.8	51.7	28.0	9.8	100.0
5	TOTAL:	0	3	24	7	5	39
	PERCENT:	.0	7.7	61.5	17.9	12.8	100.0
6	TOTAL:	0	2	7	2	10	21
	PERCENT:	.0	9.5	33.3	9.5	47.6	100.0
7	TOTAL:	0	1	0	1	2	4
	PERCENT:	.0	25.0	.0	25.0	50.0	100.0
8	TOTAL:	0	0	1	0	1	2
	PERCENT:	.0	.0	50.0	.0	50.0	100.0
9	TOTAL:	0	0	0	0	1	1
	PERCENT:	.0	.0	.0	.0	100.0	100.0
10	TOTAL:	0	0	0	0	0	0
	PERCENT:	.0	.0	.0	.0	.0	100.0

PERSONS PER HOUSEHOLD VS SCHOOL CHILDREN PER HOUSEHOLD

PERSONS PER HOUSEHOLD		NUMBER OF SCHOOL CHILDREN PER HOUSEHOLD 0	1	2	3	4	5	6	TOTAL
1	TOTAL:	144	1	0	0	0	0	0	145
	PERCENT:	99.3	.7	.0	.0	.0	.0	.0	100.0
2	TOTAL:	285	7	0	0	0	0	0	292
	PERCENT:	97.6	2.4	.0	.0	.0	.0	.0	100.0
3	TOTAL:	86	56	8	0	0	0	0	150
	PERCENT:	57.3	37.3	5.3	.0	.0	.0	.0	100.0
4	TOTAL:	45	36	60	2	0	0	0	143
	PERCENT:	31.5	25.2	42.0	1.4	.0	.0	.0	100.0
5	TOTAL:	7	5	10	16	0	1	0	39
	PERCENT:	17.9	12.8	25.6	41.0	.0	2.6	.0	100.0
6	TOTAL:	6	3	5	5	2	0	0	21
	PERCENT:	28.6	14.3	23.8	23.8	9.5	.0	.0	100.0
7	TOTAL:	1	2	0	1	0	0	0	4
	PERCENT:	25.0	50.0	.0	25.0	.0	.0	.0	100.0
8	TOTAL:	1	0	0	1	0	0	0	2
	PERCENT:	50.0	.0	.0	50.0	.0	.0	.0	100.0
9	TOTAL:	0	0	1	0	0	0	0	1
	PERCENT:	.0	.0	100.0	.0	.0	.0	.0	100.0
10	TOTAL:	0	0	0	0	0	0	0	0
	PERCENT:	.0	.0	.0	.0	.0	.0	.0	100.0

APPENDIX H

Census Data

New Hampshire

Rockingham County

P1. PERSONS(1)
UNIVERSE: Persons

Total	245,845

P4. FAMILIES(1)
UNIVERSE: Families

Total	66,399

P5. HOUSEHOLDS(1)
UNIVERSE: Households

Total	89,259

P6. URBAN AND RURAL(4)
UNIVERSE: Persons

Urban:	
Inside urbanized area	52,837
Outside urbanized area	55,405
Rural:	
Farm	959
Nonfarm	136,644

P7. SEX(2)
UNIVERSE: Persons

Male	121,923
Female	123,922

P16. PERSONS IN HOUSEHOLD(7)
UNIVERSE: Households

1 person	17,297
2 persons	28,891
3 persons	17,077
4 persons	16,733
5 persons	6,988
6 persons	1,602
7 or more persons	671

P40. GROUP QUARTERS(10)
UNIVERSE: Persons in group quarters

Institutionalized persons:	
Correctional institutions	89
Nursing homes	1,342
Mental (Psychiatric) hospitals	50
Juvenile institutions	8
Other institutions	0
Other persons in group quarters:	
College dormitories	50
Military quarters	931
Emergency shelters for homeless persons	64
Visible in street locations	0
Other noninstitutional group quarters	512

P49. MEANS OF TRANSPORTATION TO WORK(13)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	106,748
Carpooled	15,194
Public transportation:	
Bus or trolley bus	578
Streetcar or trolley car	12
Subway or elevated	50
Railroad	95
Ferryboat	0
Taxicab	120
Motorcycle	180
Bicycle	311
Walked	2,976
Other means	924
Worked at home	4,388

P53. PRIVATE VEHICLE OCCUPANCY(8)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	106,748
In 2-person carpool	12,779
In 3-person carpool	1,350
In 4-person carpool	503
In 5-person carpool	146
In 6-person carpool	59
In 7-or-more person carpool	357
Other means	9,634

P67. SEX(2) BY AGE(2) BY MOBILITY LIMITATION STATUS(2) BY EMPLOYMENT STATUS(3)
UNIVERSE: Civilian noninstitutionalized persons 16 years and over

	Male	Female
16 to 64 years:		
With a mobility limitation:		
In labor force:		
Employed	2,859	2,022
Unemployed	380	282
Not in labor force.	2,240	2,590
No mobility limitation:		
In labor force:		
Employed	65,992	57,407
Unemployed	4,284	3,285
Not in labor force.	4,860	16,173
65 years and over:		
With a mobility limitation:		
In labor force:		
Employed	298	112
Unemployed	8	13
Not in labor force.	2,488	3,671
No mobility limitation:		
In labor force:		
Employed	1,390	1,142
Unemployed	67	59
Not in labor force.	4,666	7,460

Brentwood town

Total Persons 2,590

P5. HOUSEHOLDS(1)
UNIVERSE: Households

Total	752

P16. PERSONS IN HOUSEHOLD(7)
UNIVERSE: Households

1 person	99
2 persons	247
3 persons	156
4 persons	167
5 persons	65
6 persons	14
7 or more persons	4

H1. HOUSING UNITS(1)
UNIVERSE: Housing units

Total	778

P49. MEANS OF TRANSPORTATION TO WORK(13)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	923
Carpooled	115
Public transportation:	
Bus or trolley bus	0
Streetcar or trolley car	0
Subway or elevated	2
Railroad	0
Ferryboat	0
Taxicab	0
Motorcycle	2
Bicycle	3
Walked	42
Other means	2
Worked at home	81

P53. PRIVATE VEHICLE OCCUPANCY(8)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	923
In 2-person carpool	88
In 3-person carpool	19
In 4-person carpool	2
In 5-person carpool	0
In 6-person carpool	0
In 7-or-more person carpool	6
Other means	132

East Kingston town

Total Persons 1,352

P5. HOUSEHOLDS(1)
UNIVERSE: Households

Total	472

P16. PERSONS IN HOUSEHOLD(7)
UNIVERSE: Households

1 person	88
2 persons	132
3 persons	90
4 persons	113
5 persons	36
6 persons	11
7 or more persons	2

P49. MEANS OF TRANSPORTATION TO WORK(13)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	570
Carpooled	60
Public transportation:	
Bus or trolley bus	2
Streetcar or trolley car	0
Subway or elevated	0
Railroad	0
Ferryboat	0
Taxicab	0
Motorcycle	0
Bicycle	2
Walked	6
Other means	6
Worked at home	32

P53. PRIVATE VEHICLE OCCUPANCY(8)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	570
In 2-person carpool	54
In 3-person carpool	4
In 4-person carpool	2
In 5-person carpool	0
In 6-person carpool	0
In 7-or-more person carpool	0
Other means	48

Exeter town

Total Persons.......... 12,481

P5. HOUSEHOLDS(1)
UNIVERSE: Households

Total	5,025

P16. PERSONS IN HOUSEHOLD(7)
UNIVERSE: Households

1 person	1,289
2 persons	1,742
3 persons	835
4 persons	767
5 persons	312
6 persons	72
7 or more persons	8

P49. MEANS OF TRANSPORTATION TO WORK(13)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	5,124
Carpooled	721
Public transportation:	
Bus or trolley bus	21
Streetcar or trolley car	0
Subway or elevated	5
Railroad	0
Ferryboat	0
Taxicab	18
Motorcycle	0
Bicycle	26
Walked	320
Other means	21
Worked at home	224

P53. PRIVATE VEHICLE OCCUPANCY(8)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	5,124
In 2-person carpool	633
In 3-person carpool	64
In 4-person carpool	15
In 5-person carpool	0
In 6-person carpool	0
In 7-or-more person carpool	9
Other means	635

Greenland town

Total Persons.......... 2,768

P5. HOUSEHOLDS(1)
UNIVERSE: Households

Total	1,020

P16. PERSONS IN HOUSEHOLD(7)
UNIVERSE: Households

1 person	157
2 persons	385
3 persons	181
4 persons	196
5 persons	80
6 persons	15
7 or more persons	6

P49. MEANS OF TRANSPORTATION TO WORK(13)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	1,349
Carpooled	105
Public transportation:	
Bus or trolley bus	0
Streetcar or trolley car	0
Subway or elevated	0
Railroad	0
Ferryboat	0
Taxicab	0
Motorcycle	0
Bicycle	12
Walked	16
Other means	12
Worked at home	123

P53. PRIVATE VEHICLE OCCUPANCY(8)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	1,349
In 2-person carpool	90
In 3-person carpool	15
In 4-person carpool	0
In 5-person carpool	0
In 6-person carpool	0
In 7-or-more person carpool	0
Other means	163

Hampton town

Total Persons.......... 12,278

P5. HOUSEHOLDS(1)
UNIVERSE: Households

Total	4,992

P16. PERSONS IN HOUSEHOLD(7)
UNIVERSE: Households

1 person	1,305
2 persons	1,814
3 persons	823
4 persons	706
5 persons	261
6 persons	44
7 or more persons	39

P49. MEANS OF TRANSPORTATION TO WORK(13)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	5,296
Carpooled	814
Public transportation:	
Bus or trolley bus	13
Streetcar or trolley car	0
Subway or elevated	0
Railroad	0
Ferryboat	0
Taxicab	0
Motorcycle	9
Bicycle	18
Walked	157
Other means	98
Worked at home	154

P53. PRIVATE VEHICLE OCCUPANCY(8)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	5,296
In 2-person carpool	702
In 3-person carpool	79
In 4-person carpool	33
In 5-person carpool	0
In 6-person carpool	0
In 7-or-more person carpool	0
Other means	449

Hampton Falls town

Total Persons.......... 1,503

P5. HOUSEHOLDS(1)
UNIVERSE: Households

Total	532

P16. PERSONS IN HOUSEHOLD(7)
UNIVERSE: Households

1 person	65
2 persons	202
3 persons	101
4 persons	113
5 persons	36
6 persons	13
7 or more persons	2

P49. MEANS OF TRANSPORTATION TO WORK(13)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	614
Carpooled	79
Public transportation:	
Bus or trolley bus	2
Streetcar or trolley car	0
Subway or elevated	0
Railroad	0
Ferryboat	0
Taxicab	0
Motorcycle	0
Bicycle	0
Walked	15
Other means	12
Worked at home	36

P53. PRIVATE VEHICLE OCCUPANCY(8)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	614
In 2-person carpool	67
In 3-person carpool	12
In 4-person carpool	0
In 5-person carpool	0
In 6-person carpool	0
In 7-or-more person carpool	0
Other means	65

Kensington town

Total Persons.......... 1,631

P5. HOUSEHOLDS(1)
UNIVERSE: Households

Total	556

P16. PERSONS IN HOUSEHOLD(7)
UNIVERSE: Households

1 person	73
2 persons	181
3 persons	116
4 persons	115
5 persons	52
6 persons	11
7 or more persons	8

P49. MEANS OF TRANSPORTATION TO WORK(13)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	652
Carpooled	88
Public transportation:	
Bus or trolley bus	5
Streetcar or trolley car	0
Subway or elevated	0
Railroad	0
Ferryboat	0
Taxicab	3
Motorcycle	0
Bicycle	4
Walked	25
Other means	4
Worked at home	52

P53. PRIVATE VEHICLE OCCUPANCY(8)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	652
In 2-person carpool	82
In 3-person carpool	4
In 4-person carpool	2
In 5-person carpool	0
In 6-person carpool	0
In 7-or-more person carpool	0
Other means	93

Kingston town

Total Persons.......... 5,591

P5. HOUSEHOLDS(1)
UNIVERSE: Households

Total	1,913

P16. PERSONS IN HOUSEHOLD(7)
UNIVERSE: Households

1 person	308
2 persons	541
3 persons	390
4 persons	446
5 persons	156
6 persons	58
7 or more persons	14

P49. MEANS OF TRANSPORTATION TO WORK(13)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	2,476
Carpooled	254
Public transportation:	
Bus or trolley bus	13
Streetcar or trolley car	0
Subway or elevated	0
Railroad	13
Ferryboat	0
Taxicab	0
Motorcycle	12
Bicycle	6
Walked	21
Other means	5
Worked at home	120

P53. PRIVATE VEHICLE OCCUPANCY(8)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	2,476
In 2-person carpool	211
In 3-person carpool	20
In 4-person carpool	8
In 5-person carpool	6
In 6-person carpool	9
In 7-or-more person carpool	0
Other means	190

New Castle town

Total Persons.......... 840

P5. HOUSEHOLDS(1)
UNIVERSE: Households

Total	341

P16. PERSONS IN HOUSEHOLD(7)
UNIVERSE: Households

1 person	92
2 persons	158
3 persons	52
4 persons	27
5 persons	10
6 persons	2
7 or more persons	0

P49. MEANS OF TRANSPORTATION TO WORK(13)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	252
Carpooled	26
Public transportation:	
Bus or trolley bus	3
Streetcar or trolley car	0
Subway or elevated	0
Railroad	0
Ferryboat	0
Taxicab	0
Motorcycle	0
Bicycle	3
Walked	12
Other means	2
Worked at home	118

P53. .RIVATE VEHICLE OCCUPANCY(8)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	252
In 2-person carpool	22
In 3-person carpool	2
In 4-person carpool	2
In 5-person carpool	0
In 6-person carpool	0
In 7-or-more person carpool	0
Other means	138

Newfields town

Total Persons.......... 888

P5. HOUSEHOLDS(1)
UNIVERSE: Households

Total	300

P16. PERSONS IN HOUSEHOLD(7)
UNIVERSE: Households

1 person	45
2 persons	113
3 persons	52
4 persons	55
5 persons	26
6 persons	7
7 or more persons	2

P49. MEANS OF TRANSPORTATION TO WORK(13)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	339
Carpooled	59
Public transportation:	
Bus or trolley bus	0
Streetcar or trolley car	2
Subway or elevated	0
Railroad	0
Ferryboat	0
Taxicab	0
Motorcycle	0
Bicycle	0
Walked	16
Other means	6
Worked at home	21

P53. PRIVATE VEHICLE OCCUPANCY(8)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	339
In 2-person carpool	53
In 3-person carpool	6
In 4-person carpool	0
In 5-person carpool	0
In 6-person carpool	0
In 7-or-more person carpool	0
Other means	45

Newton town

Total Persons.......... 3,473

P5. HOUSEHOLDS(1)
UNIVERSE: Households

Total	1,233

P16. PERSONS IN HOUSEHOLD(7)
UNIVERSE: Households

1 person	183
2 persons	390
3 persons	271
4 persons	242
5 persons	96
6 persons	30
7 or more persons	21

P49. MEANS OF TRANSPORTATION TO WORK(13)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	1,485
Carpooled	228
Public transportation:	
Bus or trolley bus	0
Streetcar or trolley car	0
Subway or elevated	0
Railroad	6
Ferryboat	0
Taxicab	0
Motorcycle	0
Bicycle	0
Walked	31
Other means	0
Worked at home	69

P53. PRIVATE VEHICLE OCCUPANCY(8)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	1,485
In 2-person carpool	175
In 3-person carpool	53
In 4-person carpool	0
In 5-person carpool	0
In 6-person carpool	0
In 7-or-more person carpool	0
Other means	106

North Hampton town

Total Persons.......... 3,637

P5. HOUSEHOLDS(1)
UNIVERSE: Households

Total	1,374

P16. PERSONS IN HOUSEHOLD(7)
UNIVERSE: Households

1 person	314
2 persons	471
3 persons	263
4 persons	198
5 persons	98
6 persons	26
7 or more persons	4

P49. MEANS OF TRANSPORTATION TO WORK(13)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	1,739
Carpooled	135
Public transportation:	
Bus or trolley bus	12
Streetcar or trolley car	0
Subway or elevated	0
Railroad	0
Ferryboat	0
Taxicab	0
Motorcycle	0
Bicycle	0
Walked	37
Other means	34
Worked at home	86

P53. PRIVATE VEHICLE OCCUPANCY(8)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	1,739
In 2-person carpool	122
In 3-person carpool	0
In 4-person carpool	6
In 5-person carpool	0
In 6-person carpool	0
In 7-or-more person carpool	7
Other means	169

Portsmouth city

Total Persons.......... 25,925

P5. HOUSEHOLDS(1)
UNIVERSE: Households

Total	10,311

P16. PERSONS IN HOUSEHOLD(7)
UNIVERSE: Households

1 person	2,956
2 persons	3,434
3 persons	1,796
4 persons	1,396
5 persons	584
6 persons	106
7 or more persons	39

P49. MEANS OF TRANSPORTATION TO WORK(13)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	10,710
Carpooled	1,672
Public transportation:	
Bus or trolley bus	124
Streetcar or trolley car	10
Subway or elevated	0
Railroad	0
Ferryboat	0
Taxicab	52
Motorcycle	40
Bicycle	95
Walked	923
Other means	46
Worked at home	538

P53. PRIVATE VEHICLE OCCUPANCY(8)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	10,710
In 2-person carpool	1,431
In 3-person carpool	134
In 4-person carpool	50
In 5-person carpool	12
In 6-person carpool	21
In 7-or-more person carpool	24
Other means	1,828

Rye town

Total Persons.......... 4,612

P5. HOUSEHOLDS(1)
UNIVERSE: Households

Total	1,918

P16. PERSONS IN HOUSEHOLD(7)
UNIVERSE: Households

1 person	502
2 persons	730
3 persons	311
4 persons	249
5 persons	117
6 persons	0
7 or more persons	9

P49. MEANS OF TRANSPORTATION TO WORK(13)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	2,042
Carpooled	219
Public transportation:	
Bus or trolley bus	8
Streetcar or trolley car	0
Subway or elevated	0
Railroad	0
Ferryboat	0
Taxicab	0
Motorcycle	0
Bicycle	7
Walked	74
Other means	33
Worked at home	134

P53. PRIVATE VEHICLE OCCUPANCY(8)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	2,042
In 2-person carpool	197
In 3-person carpool	8
In 4-person carpool	0
In 5-person carpool	8
In 6-person carpool	6
In 7-or-more person carpool	0
Other means	256

Seabrook town

Total Persons.......... 6,503

P5. HOUSEHOLDS(1)
UNIVERSE: Households

Total	2,827

P16. PERSONS IN HOUSEHOLD(7)
UNIVERSE: Households

1 person	786
2 persons	1,080
3 persons	487
4 persons	284
5 persons	143
6 persons	47
7 or more persons	0

P49. MEANS OF TRANSPORTATION TO WORK(13)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	2,429
Carpooled	583
Public transportation:	
Bus or trolley bus	0
Streetcar or trolley car	0
Subway or elevated	0
Railroad	0
Ferryboat	0
Taxicab	0
Motorcycle	0
Bicycle	18
Walked	69
Other means	19
Worked at home	89

P53. PRIVATE VEHICLE OCCUPANCY(8)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	2,429
In 2-person carpool	498
In 3-person carpool	65
In 4-person carpool	8
In 5-person carpool	0
In 6-person carpool	0
In 7-or-more person carpool	12
Other means	195

South Hampton town

Total Persons.......... 740

P5. HOUSEHOLDS(1)
UNIVERSE: Households

Total....................................	256

P16. PERSONS IN HOUSEHOLD(7)
UNIVERSE: Households

1 person..................................	31
2 persons.................................	94
3 persons.................................	51
4 persons.................................	53
5 persons.................................	17
6 persons.................................	5
7 or more persons.........................	5

P49. MEANS OF TRANSPORTATION TO WORK(13)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone...............................	311
Carpooled.................................	36
Public transportation:	
Bus or trolley bus........................	5
Streetcar or trolley car..................	0
Subway or elevated........................	0
Railroad..................................	0
Ferryboat.................................	0
Taxicab...................................	0
Motorcycle................................	0
Bicycle...................................	0
Walked....................................	1
Other means...............................	0
Worked at home............................	14

P53. PRIVATE VEHICLE OCCUPANCY(8)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone...............................	311
In 2-person carpool.......................	29
In 3-person carpool.......................	2
In 4-person carpool.......................	5
In 5-person carpool.......................	0
In 6-person carpool.......................	0
In 7-or-more person carpool...............	0
Other means...............................	20

Stratham town

Total Persons.......... 4,995

P5. HOUSEHOLDS(1)
UNIVERSE: Households

Total	1,818

P16. PERSONS IN HOUSEHOLD(7)
UNIVERSE: Households

1 person	315
2 persons	662
3 persons	309
4 persons	340
5 persons	154
6 persons	30
7 or more persons	8

P49. MEANS OF TRANSPORTATION TO WORK(13)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	2,281
Carpooled	186
Public transportation:	
Bus or trolley bus	14
Streetcar or trolley car	0
Subway or elevated	16
Railroad	0
Ferryboat	0
Taxicab	0
Motorcycle	0
Bicycle	6
Walked	25
Other means	35
Worked at home	67

P53. PRIVATE VEHICLE OCCUPANCY(8)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	2,281
In 2-person carpool	155
In 3-person carpool	19
In 4-person carpool	12
In 5-person carpool	0
In 6-person carpool	0
In 7-or-more person carpool	0
Other means	163

Massachusetts

Amesbury town

Total Persons.......... 14,997

P5. HOUSEHOLDS(1)
UNIVERSE: Households

Total	5,536

P16. PERSONS IN HOUSEHOLD(7)
UNIVERSE: Households

1 person	1,267
2 persons	1,721
3 persons	1,048
4 persons	946
5 persons	346
6 persons	173
7 or more persons	35

P49. MEANS OF TRANSPORTATION TO WORK(13)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	5,794
Carpooled	835
Public transportation:	
Bus or trolley bus	45
Streetcar or trolley car	0
Subway or elevated	0
Railroad	14
Ferryboat	0
Taxicab	47
Motorcycle	0
Bicycle	23
Walked	273
Other means	61
Worked at home	198

P53. PRIVATE VEHICLE OCCUPANCY(8)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	5,794
In 2-person carpool	710
In 3-person carpool	44
In 4-person carpool	17
In 5-person carpool	0
In 6-person carpool	0
In 7-or-more person carpool	64
Other means	661

Merrimac town

Total Persons.......... 5,166

P5. HOUSEHOLDS(1)
UNIVERSE: Households

Total	1,897

P16. PERSONS IN HOUSEHOLD(7)
UNIVERSE: Households

1 person	378
2 persons	601
3 persons	381
4 persons	336
5 persons	161
6 persons	31
7 or more persons	9

P49. MEANS OF TRANSPORTATION TO WORK(13)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	2,090
Carpooled	375
Public transportation:	
Bus or trolley bus	15
Streetcar or trolley car	0
Subway or elevated	0
Railroad	7
Ferryboat	0
Taxicab	0
Motorcycle	7
Bicycle	7
Walked	41
Other means	10
Worked at home	104

P53. PRIVATE VEHICLE OCCUPANCY(8)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	2,090
In 2-person carpool	330
In 3-person carpool	14
In 4-person carpool	0
In 5-person carpool	13
In 6-person carpool	0
In 7-or-more person carpool	18
Other means	191

Newbury town

Total Persons.......... 5,623

P5. HOUSEHOLDS(1)
UNIVERSE: Households

Total	2,034

P16. PERSONS IN HOUSEHOLD(7)
UNIVERSE: Households

1 person	431
2 persons	659
3 persons	357
4 persons	398
5 persons	133
6 persons	16
7 or more persons	40

P49. MEANS OF TRANSPORTATION TO WORK(13)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	2,265
Carpooled	332
Public transportation:	
Bus or trolley bus	9
Streetcar or trolley car	0
Subway or elevated	0
Railroad	25
Ferryboat	0
Taxicab	0
Motorcycle	0
Bicycle	8
Walked	92
Other means	0
Worked at home	178

P53. PRIVATE VEHICLE OCCUPANCY(8)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	2,265
In 2-person carpool	278
In 3-person carpool	32
In 4-person carpool	22
In 5-person carpool	0
In 6-person carpool	0
In 7-or-more person carpool	0
Other means	312

Newburyport city

Total Persons.......... 16,317

P5. HOUSEHOLDS(1)
UNIVERSE: Households

Total	6,666

P16. PERSONS IN HOUSEHOLD(7)
UNIVERSE: Households

1 person	2,063
2 persons	2,142
3 persons	1,085
4 persons	884
5 persons	355
6 persons	86
7 or more persons	51

P49. MEANS OF TRANSPORTATION TO WORK(13)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	6,729
Carpooled	1,026
Public transportation:	
Bus or trolley bus	192
Streetcar or trolley car	0
Subway or elevated	0
Railroad	0
Ferryboat	0
Taxicab	60
Motorcycle	20
Bicycle	8
Walked	375
Other means	83
Worked at home	178

P53. PRIVATE VEHICLE OCCUPANCY(8)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	6,729
In 2-person carpool	826
In 3-person carpool	82
In 4-person carpool	22
In 5-person carpool	31
In 6-person carpool	5
In 7-or-more person carpool	60
Other means	916

Salisbury town

Total Persons.......... 6,882

P5. HOUSEHOLDS(1)
UNIVERSE: Households

Total	2,480

P16. PERSONS IN HOUSEHOLD(7)
UNIVERSE: Households

1 person	532
2 persons	732
3 persons	513
4 persons	497
5 persons	120
6 persons	56
7 or more persons	30

P49. MEANS OF TRANSPORTATION TO WORK(13)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	2,792
Carpooled	413
Public transportation:	
Bus or trolley bus	20
Streetcar or trolley car	0
Subway or elevated	9
Railroad	0
Ferryboat	0
Taxicab	13
Motorcycle	0
Bicycle	12
Walked	46
Other means	17
Worked at home	56

P53. PRIVATE VEHICLE OCCUPANCY(8)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	2,792
In 2-person carpool	294
In 3-person carpool	79
In 4-person carpool	8
In 5-person carpool	0
In 6-person carpool	0
In 7-or-more person carpool	32
Other means	173

West Newbury town

Total Persons.......... 3,421

P5. HOUSEHOLDS(1)
UNIVERSE: Households

Total	1,120

P16. PERSONS IN HOUSEHOLD(7)
UNIVERSE: Households

1 person	142
2 persons	325
3 persons	223
4 persons	295
5 persons	105
6 persons	15
7 or more persons	15

P49. MEANS OF TRANSPORTATION TO WORK(13)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	1,524
Carpooled	164
Public transportation:	
Bus or trolley bus	19
Streetcar or trolley car	0
Subway or elevated	0
Railroad	0
Ferryboat	0
Taxicab	0
Motorcycle	0
Bicycle	0
Walked	48
Other means	28
Worked at home	116

P53. PRIVATE VEHICLE OCCUPANCY(8)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	1,524
In 2-person carpool	152
In 3-person carpool	0
In 4-person carpool	0
In 5-person carpool	0
In 6-person carpool	5
In 7-or-more person carpool	7
Other means	211

APPENDIX I

Traffic Management And Control

NOTE

Traffic Control Post descriptions and diagrams are contained in NHRERP Traffic Management Manual, MARERP Traffic Management Manual and Maine Traffic Management Manual.

APPENDIX J

Description of Evacuation Routes

APPENDIX J: DESCRIPTION OF EVACUATION ROUTES

The following are descriptions of evacuation routes for each community in the Emergency Planning Zone (EPZ). Towns are assigned to Emergency Response Planning Areas (ERPA) as defined in Table 10-1.

The route descriptions reflect evacuation paths specified in the IDYNEV model, and, as such, are not limited to the routes to the reception centers provided in the public information materials. The IDYNEV model routings are generally more detailed since they account for the paths taken by those evacuees who do not go to the reception centers but who utilize additional routes permitt d by the traffic management plan.

ERPA A

Seabrook -- Host is Salem

Seabrook Beach - Take the most convenient path to Route 286. Proceed west on Route 286. Cross Route 1 and continue west onto Forest Street, following the directions to I-95 South and enter I-95 southbound. At the junction of I-95 and I-495 bear right and enter I-495. Continue on I-495 and exit either at Route 97 westbound, or Route 213 westbound. If Route 97 is chosen, proceed west to Salem. If Route 213 is chosen, proceed west to Route 28, then north to Route 97 and proceed east to Salem.

If Route 286 is congested at its intersection with Route 1A, continue south along Route 1A into Salisbury Beach, then west along Beach Road (also Route 1A). Continue west through Salisbury Square onto Route 110, toward I-495. Enter I-495 southbound and travel to Salem as described above.

Inland - Take the most convenient path to Route 107, New Zealand Road. Proceed west on Route 107 to I-95. Enter I-95 southbound and proceed as above. Else, travel south on Route 1 to Route 286, then right turn onto Route 286, westbound. Then travel to Salem via I-95 southbound as described above.

Hampton Beach -- Host is Manchester

Proceed north along Route 1A, Ocean Blvd. The preferred route is to turn left onto Highland Avenue to Route 51 and continue traveling westbound on Route 51 until it becomes Route 101. Continue west on Route 101 to Manchester. (If Highland Avenue is congested, continue north on Route 1A and turn left onto Church Street to travel toward Route 51.)

Alternate paths include:

1. Continue north on Route 1A past Church Street and turn left (west) on Route 27; travel west to I-95 northbound. Take I-95 north to Spaulding Turnpike northbound. Leave Spaulding Turnpike and continue west on U.S. 4 to I-93. Travel southbound on I-93 to I-293, then take Route 28 to Manchester.

2. Continue north on Route 1A to Route 111 (101D). Turn left onto Route 111 and travel west to Route 151. Turn right (north) onto Route 151 and travel to the intersection with Route 101. Turn right (east) onto Route 101 and travel to I-95 north. Take I-95 north and proceed to the Spaulding Turnpike and to U.S. Route 4, as above.

3. Continue north along Route 1A and turn left (west) onto South Road or Washington Road. Take either road to U.S. Route 1. From South Road, turn right (north) onto Route 1, then turn left onto Breakfast Hill Road to Route 151. Turn right (north) onto Route 151 and proceed as above for Alternate Route No. 2. From Washington Road, take Lang Road to Route 1, turn right (north) onto Route 1, then bear left onto Route 1 Bypass to Portsmouth Circle. Travel to Spaulding Turnpike (Route 4) and proceed as above to Manchester.

NOTE

Permanent residents who have children in school at the time of the accident, should take Alternate Paths 1, 2 or 3 and travel to Dover via the Spaulding Turnpike, rather than to Manchester.

Hampton Falls -- Host is Dover

Access to Route 84 - Take the most convenient path to Route 84, South Kensington Road. Turn west onto Route 84 and proceed to Lamprey Road and its intersection with Route 150. Proceed north on Route 150 to Route 108 northbound and travel into Exeter. Continue north on Route 108 through Exeter onto High Street and then turn left onto Portsmouth Avenue (Route 108). Continue north on Route 108 to Dover.

Access to Route 88 - Take the most convenient path to Route 88, Hampton Falls Road. Turn west onto Route 88 and travel to the junction with Route 27. Turn left (westbound) onto Route 27 (High Street) and travel to Route 108. Turn right (north) onto Portsmouth Avenue (Route 108). Continue north on Route 108 to Dover.

ERPA B

Amesbury -- Host is Tewksbury

Northern Amesbury -	Take the most convenient path to South Hampton Road (Route 107A). Take Route 107A north to the intersection of Route 107A and Route 108. Proceed south on Route 108 into Haverhill to the intersection with Route 110. Turn left onto Route 110 eastbound and travel to interchange with I-495. Enter I-495 southbound in Haverhill and proceed to Route 38 south (Exit 38) to East Street to Tewksbury State Hospital
East of Market Street -	Take the most convenient path to Elm Street. Move south on Elm Street to the intersection with Route 110. Turn right on Route 110 to the southbound I-495 ramp and travel south on I-495 to Route 38 south (Exit 38) to East Street to Tewksbury State Hospital
South of Elm Street -	Take the most convenient path to Macy Street (Route 110). 1.)Take Route 110 eastbound to the southbound I-495 ramp. Enter I-495 southbound and travel to Route 38 south (Exit 38) to East Street to Tewksbury State Hospital. 2.)Take Route 110 westbound to Hillside Avenue, then proceed as described below.
West of Main Street -	Take the most convenient path to Hillside Avenue. Take Hillside Avenue south, across Route 110 to the I-495 interchange. Enter I-495 southbound and travel to Route 38 south (Exit 38) to East Street to Tewksbury State Hospital.

West of Hillside Avenue - Take the most convenient path south to Haverhill Road (Route 110). Turn right (west) on Route 110 and continue into Merrimac. Continue west on Route 110 or turn left onto Broad Street to the I-495 interchange in Merrimac. Enter I-495 southbound and continue to Route 38 south (Exit 38) to East Street to Tewksbury State Hospital. If continuing west on Route 110, travel to the I-495 southbound ramp in Haverhill. Enter I-495 south and proceed to Route 38 south (Exit 38) to East Street to Tewksbury State Hospital.

<u>Salisbury -- Host is Tewksbury</u>

Salisbury Beach - Proceed south along Route 1A and turn west onto Beach Road (Route 1A). Continue west on Route 1A to the intersection with U.S. Route 1. Both lanes on Route 1A will move west, across Route 1 and proceed to Route 110. Traffic continues west on Route 110 to either the I-95 interchange or to the I-495 interchange to the west. Those who enter I-95 southbound, using either of two entry ramps, proceed south to Route 128 south to Reading, then I-93 North (Exit 37B) to Exit 42. Left onto Dascomb Road (becomes East Street) to Tewksbury State Hospital. Those who travel on I-495 southbound, proceed to Route 38 south (Exit 38) to East Street to Tewksbury State Hospital.

North of Beach Road - Take the most convenient path to U.S. Route 1. Travel south on Route 1 until the intersection with Route 110. Turn west (right) onto Route 110 and travel west to either the I-95 interchange or to the I-495 interchange. Then proceed, as described above, to Tewksbury State Hospital.

South of Beach Road - Take the most convenient path to Route 1 and travel southbound on Route 1 to Route 133, then west on Route 133 to I-95 South. Then proceed as described above to Tewksbury State Hospital.

ERPA C

Kensington -- Host is Manchester

Northern Section - Take the most convenient path to Route 150 northbound. Travel north on Route 150 to the intersection with Route 108. Turn south onto Route 108 and proceed to the inter-section with Route 107. Turn right (north) onto Route 107 and proceed to the intersection with Route 111. Turn left (west) onto Route 111 and proceed to the I-93 interchange. Enter I-93 northbound and proceed to I-293 to Route 28 to Manchester.

Southern Section - Take the most convenient path to Route 107 northbound toward Kingston. Travel on Route 107 to the intersection with Route 111. Turn left (west) onto Route 111 and proceed to the I-93 interchange. Enter I-93 northbound and proceed to I-293 to Route 28 to Manchester.

South Hampton -- Host is Salem

Take the most convenient path to either westbound Hilldale Ave. or northbound Route 107A. Travel on either route to Route 108. Travel south on Route 108 into Haverhill, to the intersection with Route 110. Turn northbound onto Route 110 to the interchange with I-495. Enter I-495 southbound and travel to the exit at Route 97 westbound, or to Route 213 westbound. If Route 97 is chosen, proceed west to Salem. If Route 213 is chosen, proceed west to Route 28, then north to Route 97 and proceed east to Salem.

ERPA D

Hampton -- Host is Dover

Beach Area north of Great Boars Head - Proceed north along Route 1A to the intersection with Route 27. Vehicles will turn west (left) onto Route 27 or continue north along Route 1A.

Path A: Traffic turning west onto Route 27 will travel to the connector road for I-95. Turn right onto access road to I-95 which joins with west bound Route 51. Exit Route 51 at the I-95 interchange. Proceed on I-95 northbound through the toll plaza to the Spaulding Turnpike or continue north on I-95 into Maine. If the Spaulding Turnpike is used, take it to Route 108 and proceed south to Dover. If I-95 is taken into Maine, exit I-95 at Route 236. Travel north on Route 236 to Route 9, then west to West High Street (right at light/sign for Rochester. Then to Route 108 and proceed south into Dover.

Path B: Vehicles that continue north on Route 1A will turn west (left) onto Route 111 (101D). Proceed along Route 111 (101D) to the intersection with Route 1. Continue west on Route 111 (101D) and travel to the intersection with Route 151. Turn north (right) onto Route 151 and travel to the intersection with Route 101. Turn right onto Route 101 and travel to the I-95 northbound ramp. Take I-95 north to the Spaulding Turnpike or, if congested, continue north on I-95 into Maine, and continue as described above for Path A.

Inland Hampton - There are two routes for those east of I-95. Those with access to Route 27, travel west on Route 27 and continue as specified for Path A, above. Those north of Route 27 with better access to U.S. Route 1, take Route 1 north to the intersection with

Breakfast Hill Road. Proceed north along Route 1 or turn left (west) onto Breakfast Hill Road.

On Route 1, continue north onto Route 1 Bypass to Portsmouth Circle. From there, take Spaulding Turnpike to Dover. From Breakfast Hill Road, turn north (right) onto Route 151 and follow Path B, above.

Those who are west of I-95, take the most convenient path to Route 27. Travel west on Route 27 to Route 108 (Portsmouth Avenue). Turn right (north) onto Route 108 and travel to Dover.

<u>North Hampton -- Host is Dover</u>

East of U.S. Rt. 1 - Take most convenient path to either Route 111 (Atlantic Avenue) or to North Road, whichever is closer, and travel westbound toward Route 1. From Route 111, continue west toward Route 151.

Turn right (north) onto Route 151 and travel to Route 101. Turn right (east) onto Route 101 and proceed to the I-95 northbound ramp. Take I-95 northbound to the Spaulding Turnpike northbound and then to Route 108. Proceed south on Route 108 into Dover.

If turning north onto U.S. Route 1 from North Road, travel north to Breakfast Hill Road. Turn left (west) onto Breakfast Hill Road or continue north on Route 1, as directed. On Route 1, continue north to Route 1 Bypass to Portsmouth Circle, then onto Spaulding Turnpike to Dover. From Breakfast Hill Road, turn north (right) onto Route 151 and travel to Rt. 101. Turn right onto Route 101 to the northbound ramp onto I-95. Take I-95 north to Maine, or take Spaulding Turnpike to Route 108 and proceed south on Route 108 to Dover. (See Path A, Hampton).

If more convenient, take Mill Road north to Washington Road, then west to U.S. Route 1. Turn right (north) on Route 1 and travel, via Route 1 Bypass to Portsmouth Circle. Take Spaulding Turnpike from the circle north to Route 108, proceed south on Route 108 to Dover.

West of U.S. Rt. 1 - Take the most convenient path to Route 151. Take Route 151 north and proceed to Dover as described above.

ERPA E

Merrimac -- Host is Tewksbury

East of Church St. - Take the most convenient path to Route 110. Take Route 110 to Broad Street and turn onto Broad Street, southbound. Proceed south to the I-495 interchange. Enter I-495 southbound to Route 38 South (Exit 38) to East Street to Tewksbury State Hospital.

West of Church St. - Proceed to Route 110 westbound. Continue west on Route 110, to ramp onto I-495 southbound. Enter I-495 southbound and proceed to Route 38 South (Exit 38) to East Street to Tewksbury State Hospital.

West Newbury -- Host is Tewksbury

Northern Section - Take the most convenient path to Route 113 westbound. Travel west on Route 113 to Groveland. From there take Routes 97 North/113 West to I-495 South to Route 38 South (Exit 38) to East Street to Tewksbury State Hospital.

Or take Church Street or Bridge Street across Rocks Village Bridge to Route 110 West to I-495 South, then as described above to Tewksbury State Hospital.

Southern Section - Take the most convenient path to South Street. Turn east on South Street and proceed to the I-95 interchange. Enter I-95 southbound to Route 128 south to Reading, then I-93 North (Exit 37B) to Exit 42. Left onto Dascomb Road (becomes East Street) to Tewksbury State Hospital.

Newburyport -- Host is Wellesley

Eastern Section East of State St. - Proceed to High Street westbound. Continue west on High Street (Route 113) to I-95 South. Take I-95 South to Route 128 South to Route 9 West (Exit 20B) Wellesley, MA. Proceed to Massachusetts Highway Department facility on the immediate right.

Central Section Between Broad and State Streets - Take the most convenient path to Route 1 south. Travel south on Route 1 to Route 133, then west on Route 133 to I-95 South, then proceed as described above to Wellesley, MA.

Western Section West of Broad St. - Take the most convenient path to High Street (Route 113) westbound. Travel west on High Street (Route 113) to I-95 South. Take I-95 South to Route 128 South to Route 9 West (Exit 20B) Wellesley, MA. Proceed to Massachusetts Highway Department facility on the immediate right.

Newbury -- Host is Wellesley

Plum Island - Proceed to the Plum Island Turnpike westbound. Take Plum Island Turnpike west to Ocean Avenue. Turn south (left) on Ocean Avenue which becomes Rolfe Lane. Proceed south on Rolfe Lane to the intersection with Route 1A. Turn south (left) onto Route 1A to Route 133 West. Take Route 133 West to I-95 South. Take I-95 South to Route 128 South to Route 9 West (Exit 20B) Wellesley, MA. Proceed to Massachusetts Highway Department facility on the immediate right.

or, Proceed on the Plum Island Turnpike westbound to Ocean Avenue. Turn south (left) on Ocean Avenue which becomes Rolfe Lane. Continue on Rolfe Lane

to Hanover Street. Continue through onto Hanover Street towards Route 1. Take Route 1 south to Route 133 West, then as described above to Wellesley, MA.

Inland - Take the most convenient path to either Route 1 southbound or Route 1A southbound. Proceed along Route 1 or Route 1A south to Route 133 West. Take Route 133 West to I-95 South. Take I-95 South to Route 128 South to Route 9 West (Exit 20B) Wellesley, MA. Proceed to Massachusetts Highway Department facility on the immediate right.

or, Take the most convenient path to the I-95 interchange. Take I-95 South and proceed as described above to Wellesley, MA.

ERPA F

Brentwood -- Host is Manchester

Take the most convenient path to North Road, South Road or Route 111A, westbound. On North Road travel west to Route 125, then north to Route 101, then west to Route 28 to Manchester. Take South Road or Route 111A west to Route 107. Turn north (right) onto Route 107 and proceed to the intersection with Route 101. Turn onto westbound Route 101 and proceed to Route 28 to Manchester.

East Kingston -- Host is Manchester

Take the most convenient path to Route 107, north. Proceed on Route 107 to the intersection with Route 111. Turn west (left) on Route 111 and proceed to the I-93 interchange. Enter I-93 northbound and proceed to I-293 to Route 28 and proceed to Manchester.

Exeter -- Host is Manchester

North Exeter - Take the most convenient path to either Portsmouth Avenue (Route 108) northbound to Route 152, or Newfields Road (Route 85) northbound to Route 87. From Route 85, turn west (left) onto Route 87 and travel to Route 125, then north on Route 125 to Route 152. In either case, turn west (left) on Route 152 and proceed to the intersection with Route 4. Turn west (left) onto Route 4 and proceed to the I-93 interchange in Concord. Enter I-93 southbound and travel to I-293 and then to Route 28 and proceed into Manchester.

West Exeter - Take the most convenient path to Route 111A west. Travel west along Route 111A to the intersection with Route 107. Turn north (right) on Route 107 and travel to the intersection with Route 101. Turn (west) onto westbound Route 101 and then to Route 28 and proceed to Manchester.

South Exeter - Take the most convenient path either to Route 111 westbound or to Route 108 southbound. For the latter, proceed south on Route 108 to the intersection with Route 107. Turn west (right) onto Route 107 and proceed north to the intersection with Route 111. Turn west (left) on Route 111 and proceed to the I-93 interchange. Enter I-93 northbound and proceed to I-293 to Route 28 and proceed to Manchester.

For those who access Route 111 in Exeter, travel west on Route 111 to I-93 northbound and proceed to I-293 to Route 28 and proceed to Manchester.

Newfields -- Host is Manchester

Take the most convenient path to Route 87 west. Travel west along Route 87 to the intersection with Route 125. Turn north (right) onto Route 125 and proceed to the intersection with Route 152. Turn west (left) onto Route 152 and proceed to the intersection with Route 4. Turn west (left) onto Route 4 and proceed to the I-93 interchange in Concord. Enter I-93 southbound and take I-93 to I-293 to Route 28 and proceed to Manchester.

Kingston -- Host is Salem

Take the most convenient path to Route 111 west. Proceed along Route 111 to Route 28, then south to Route 97 and proceed to Salem.

Newton -- Host is Salem

Take the most convenient path to Route 108 south. Proceed south on Route 108 to the intersection with Route 110. Turn north onto Route 110 and travel to the interchange with I-495. Enter I-495 southbound and travel to the interchange with Route 213, then west to Route 28, or stay on I-495 to I-93, then north to Route 213, then east To Route 28. Take Route 28 to Route 97 and proceed to Salem.

ERPA G

Greenland -- Host is Dover

Take the most convenient path to Route 101 eastbound. Proceed east on Route 101 to the northbound I-95 entry ramp. Enter I-95 northbound and proceed to the Spaulding Turnpike north to Route 108 and proceed into Dover.

New Castle -- Host is Dover

Take the most convenient path to Marcy Street. Proceed west along Marcy Street to Pleasant Avenue. Turn left on Pleasant Avenue and proceed to State Street. Turn right on State Street and proceed over the Memorial Bridge into Maine. Continue north on Route 1 to the traffic circle at Remick Corners and proceed to northbound Route 236. Continue north on Route 236 to the intersection with Route 9. Take Route 9 west to West High Street (right at light/sign for Rochester), then to Route 108 and travel south into Dover.

Portsmouth -- Host is Rochester

South Portsmouth - Take the most convenient path to Route 1 north. Travel north on Route 1 onto the Route 1 Bypass, then to the Portsmouth Traffic Circle. Proceed through the circle and exit onto Spaulding Turnpike. Travel north on Spaulding Turnpike to Rochester.

East Portsmouth - Take the most convenient path to Middle Street. Proceed north and west on Middle Street to State Street. Turn north on State Street and proceed across the Memorial Bridge into Maine. Proceed north on Route 1 to the traffic circle at Remick Corners and proceed to northbound Route 236. Take Route 236 to Route 9,then west to West High Street (right at light/sign for Rochester). Turn right at

light/sign and travel north on Route 108 to Rochester.

West Portsmouth - Take the most convenient path to Woodbury Avenue (Route 16). Travel west to Spaulding Turnpike, then north along Spaulding Turnpike into Rochester.

Rye -- Host is Dover

South of Rye Harbor State Park - Proceed west along Grove Road to the intersection with Washington Road. Continue west on Washington Road to the intersection with Route 1. Turn right (north) onto Route 1. Proceed north on Route 1 onto the Route 1 Bypass in Portsmouth. Enter the Portsmouth Traffic Circle and either exit onto Spaulding Turnpike northbound to Route 108 and take Route 108 to Dover, or cross into Maine via I-95. In Maine, take Route 236 westbound to Route 9, then return to New Hampshire and travel to Dover via Route 16 and Route 108.

North of Rye Harbor State Park - Proceed north along Route 1A. Route 1A becomes Sagamore Road in Portsmouth. Cross South Street in Portsmouth and continue on Miller Avenue. At the intersection of Miller Avenue and Middle Street turn right (north) onto Middle Street. Continue north on Middle Street through the intersections of State Street and Congress Street onto Maplewood Avenue. Continue on Maplewood Avenue to Spaulding Turnpike. Enter northbound Spaulding Turnpike and travel north to Route 108 and take Route 108 to Dover. Else cross into Maine and proceed to Dover as described above.

Stratham -- Host is Manchester

Take the most convenient path to Route 108 north. Proceed r·rth on Route 108 to either the intersection with Route 152 or with U.S. Route 4. Turn west on Route 152 or on Route 4 and continue to the junction of Route 4 and Route 152. Continue west on Route 4 to the entry ramp to I-93 southbound. Take I-93 south to I-293 and proceed to Route 28 to Manchester.

APPENDIX K

Evacuation Routes

APPENDIX L

Detailed Sketches of all Access Control Posts (ACP)

NOTE

Detailed sketches of Access Control Points are contained in the New Hampshire RERP Traffic Management Manual, Commonwealth of Massachusetts Traffic Management Manual, and the Maine Traffic Management Manual.

APPENDIX M

Estimated Traffic Demands at
all Origin Centroids, Loading Rates and
Origin - Destination Patterns

(Refer Figure 1-3)

Traffic Demand for Scenarios 1, 2

Community	Centroid	Total Generated Trips Permanent	Transient	Employees	Total
Amesbury	2068	284	424	0	
	2069	733	7	0	
	2070	209	2	0	
	2071	1,072	0	0	
	2072	762	44	0	
	2073	528	41	0	
	2074	528	41	0	
	2075	1,002	129	0	
	2118	785	0	0	
	2207	0	0	555	
	2208	0	0	555	
		5,903	688	1,110	7,701
Merrimac	2076	900	4	0	
	2077	908	0	0	
	2078	255	90	0	
	2206	0	0	762	
		2,063	94	762	2,919
Newbury	2079	1,093	0	0	
	2080	1,093	249	0	
	2082	109	833	0	
	2104	8	1,227	0	
	2200	0	0	499	
	2201	0	0	499	
		2,303	2,309	998	5,610
Newburyport	2081	213	817	0	
	2083	436	0	0	
	2084	436	0	0	
	2085	436	0	0	
	2086	436	0	0	
	2087	327	249	0	
	2088	537	0	0	
	2089	1,012	48	0	
	2090	1,086	0	0	
	2091	757	129	0	
	2102	533	0	0	
	2114	265	245	0	
	2202	0	0	217	
	2203	0	0	217	
	2204	0	0	217	
		6,474	1,488	651	8,613

Traffic Demand for Scenarios 1, 2 (cont.)

Community	Centroid	Total Generated Trips Permanent	Transient	Employees	Total
Salisbury	2092	388	0	0	
	2093	95	2,575	0	
	2094	225	1,690	0	
	2095	225	1,544	0	
	2096	987	0	0	
	2097	199	142	0	
	2098	908	96	0	
	2209	0	0	339	
	2210	0	0	339	
		3,027	6,047	678	9,752
W. Newbury	2099	450	134	0	
	2100	491	46	0	
	2101	455	0	0	
	2205	0	0	279	
		1,396	180	279	1,855
Brentwood	2001	614	0	0	
	2002	432	0	0	
	2240	0	0	8	
		1,046	0	8	1,054
E. Kingston	2003	146	0	0	
	2004	50	88	0	
	2005	357	35	0	
	2241	0	0	19	
		553	123	19	695
Exeter	2006	362	114	0	
	2007	432	0	0	
	2008	432	0	0	
	2009	620	114	0	
	2010	742	0	0	
	2011	566	64	0	
	2012	424	0	0	
	2013	375	44	0	
	2014	255	0	0	
	2032	625	0	0	
	2223	0	0	164	
	2224	0	0	164	
		4,833	336	328	5,497

Traffic Demand for Scenarios 1, 2 (cont.)

		Total Generated Trips			
Community	Centroid	Permanent	Transient	Employees	Total
Greenland	2015	290	52	0	
	2016	384	0	0	
	2017	454	0	0	
	2227	0	0	575	
		1,128	52	575	1,755
Hampton	2056	492	0	0	
	2057	276	229	0	
	2058	609	65	0	
	2059	875	0	0	
	2060	769	72	0	
	2061	193	364	0	
	2062	440	155	0	
	2105	131	5,875	0	
	2106	109	901	0	
	2107	109	377	0	
	2108	218	2,319	0	
	2113	378	29	0	
	2117	137	64	0	
	2121	55	2,448	0	
	2219	0	0	380	
	2220	0	0	380	
	2305	32	1,469	0	
		4,823	14,367	760	19,950
Hampton Falls	2116	601	194	0	
	2218	0	0	99	
		601	194	99	894
Kensington	2026	401	41	0	
	2027	252	33	0	
	2242	0	0	15	
		653	74	15	742
Kingston	2023	556	0	0	
	2024	556	0	0	
	2025	617	0	0	
	2030	558	0	0	
	2215	0	0	94	
		2,287	0	94	2,381
New Castle	2019	316	53	0	369
Newfields	2018	352	26	0	
	2226	0	0	72	
		352	26	72	450

Traffic Demand for Scenarios 1, 2 (cont.)

Community	Centroid	Permanent	Total Generated Trips Transient	Employees	Total
Newton	2028	690	12	0	
	2029	690	12	0	
	2243	0	0	35	
		1,380	24	35	1,439
No. Hampton	2050	116	13	0	
	2051	278	149	0	
	2052	323	105	0	
	2053	231	0	0	
	2054	83	203	0	
	2055	243	0	0	
	2109	142	216	0	
	2221	0	0	251	
		1,416	686	251	2,353
Portsmouth	2038	397	0	0	
	2039	397	0	0	
	2040	372	100	0	
	2041	397	0	0	
	2042	947	100	0	
	2043	1,196	100	0	
	2044	556	100	0	
	2045	832	100	0	
	2046	749	100	0	
	2047	1,504	100	0	
	2048	317	100	0	
	2049	342	100	0	
	2103	556	100	0	
	2228	0	0	888	
	2229	0	0	888	
	2230	0	0	888	
		8,562	1,000	2,664	12,226
Rye	2033	246	0	0	
	2034	220	0	0	
	2035	224	0	0	
	2036	216	1,002	0	
	2037	202	0	0	
	2110	220	899	0	
	2111	220	152	0	
	2112	220	676	0	
	2232	0	0	0	
		1,768	2,729	0	4,479

Traffic Demand for Scenarios 1, 2 (conc.)

Community	Centroid	Total Generated Trips Permanent	Transient	Employees	Total
Seabrook	2063	418	2,669	0	
	2064	636	20	0	
	2065	224	606	0	
	2066	635	0	0	
	2067	613	0	0	
	2115	0	1,500	0	
	2211	0	0	182	
	2212	0	0	363	
	2214	0	0	182	
		2,526	4,795	727	8,048
So. Hampton	2031	298	211	0	
	2213	0	0	42	
		298	211	42	551
Stratham	2020	647	67	0	
	2021	759	0	0	
	2022	820	0	0	
	2222	0	0	209	
		2,226	67	209	2,502
TOTAL:		55,934	35,543	10,376	101,947

Traffic Demand for Scenarios 3, 4

Community	Centroid	Total Generated Trips: Permanent	Transient	Employees	Total
Amesbury	2068	284	318	0	
	2069	733	5	0	
	2070	209	1	0	
	2071	1,072	0	0	
	2072	762	33	0	
	2073	528	31	0	
	2074	528	31	0	
	2075	1,002	97	0	
	2118	785	0	0	
	2207	0	0	1,388	
	2208	0	0	1,387	
		5,903	516	2,775	9,194
Merrimac	2076	900	3	0	
	2077	908	0	0	
	2078	255	68	0	
	2206	0	0	1,904	
		2,063	71	1,904	4,038
Newbury	2079	1,093	0	0	
	2080	1,093	187	0	
	2082	109	624	0	
	2104	8	920	0	
	2200	0	0	712	
	2201	0	0	712	
		2,303	1,731	1,424	5,458
Newburyport	2081	213	612	0	
	2083	436	0	0	
	2084	436	0	0	
	2085	436	0	0	
	2086	436	0	0	
	2087	327	187	0	
	2088	537	0	0	
	2089	1,012	36	0	
	2090	1,086	0	0	
	2091	757	97	0	
	2102	533	0	0	
	2114	265	184	0	
	2202	0	0	548	
	2203	0	0	548	
	2204	0	0	550	
		6,474	1,116	1,646	9,236

Traffic Demand for Scenarios 3, 4 (cont.)

Community	Centroid	Permanent	Transient	Employees	Total
		Total Generated Trips			
Salisbury	2092	388	0	0	
	2093	95	1,931	0	
	2094	225	1,267	0	
	2095	225	1,157	0	
	2096	987	0	0	
	2097	199	107	0	
	2098	908	73	0	
	2209	0	0	483	
	2210	0	0	483	
		3,027	4,535	966	8,528
W. Newbury	2099	450	101	0	
	2100	491	34	0	
	2101	455	0	0	
	2205	0	0	699	
		1,396	135	699	2,230
Brentwood	2001	614	0	0	
	2002	432	0	0	
	2240	0	0	20	
		1,046	0	20	1,066
E. Kingston	2003	146	0	0	
	2004	50	65	0	
	2005	357	26	0	
	2241	0	0	47	
		553	91	47	691
Exeter	2006	362	86	0	
	2007	432	0	0	
	2008	432	0	0	
	2009	620	86	0	
	2010	742	0	0	
	2011	566	48	0	
	2012	424	0	0	
	2013	375	34	0	
	2014	255	0	0	
	2032	625	0	0	
	2223	0	0	411	
	2224	0	0	411	
		4,833	254	822	5,909

Traffic Demand for Scenarios 3, 4 (cont.)

Community	Centroid	Permanent	Transient	Employees	Total
		Total Generated Trips			
Greenland	2015	290	36	0	
	2016	384	0	0	
	2017	454	0	0	
	2227	0	0	1,435	
		1,128	36	1,435	2,599
Hampton	2056	492	0	0	
	2057	276	172	0	
	2058	609	49	0	
	2059	875	0	0	
	2060	769	54	0	
	2061	193	273	0	
	2062	440	115	0	
	2105	131	4,406	0	
	2106	109	675	0	
	2107	109	283	0	
	2108	218	1,739	0	
	2113	378	22	0	
	2117	137	48	0	
	2121	55	1,837	0	
	2219	0	0	543	
	2220	0	0	544	
	2305	32	1,103	0	
		4,823	10,776	1,087	16,686
Hampton Falls	2116	601	146	0	
	2218	0	0	141	
		601	146	141	888
Kensington	2026	401	31	0	
	2027	252	25	0	
	2242	0	0	37	
		653	56	37	746
Kingston	2023	556	0	0	
	2024	556	0	0	
	2025	617	0	0	
	2030	558	0	0	
	2215	0	0	234	
		2,287	0	234	2,521
New Castle	2019	316	40	0	356
Newfields	2018	352	21	0	
	2226	0	0	181	
		352	21	181	554

Traffic Demand for Scenarios 3, 4 (cont.)

Community	Centroid	Total Generated Trips Permanent	Transient	Employees	Total
Newton	2028	690	9	0	
	2029	690	9	0	
	2243	0	0	88	
		1,380	18	88	1,486
No. Hampton	2050	116	11	0	
	2051	278	112	0	
	2052	323	79	0	
	2053	231	0	0	
	2054	83	152	0	
	2055	243	0	0	
	2109	142	162	0	
	2221	0	0	358	
		1,416	516	358	2,290
Portsmouth	2038	397	0	0	
	2039	397	0	0	
	2040	372	75	0	
	2041	397	0	0	
	2042	947	75	0	
	2043	1,196	75	0	
	2044	556	75	0	
	2045	832	75	0	
	2046	749	75	0	
	2047	1,504	75	0	
	2048	317	75	0	
	2049	342	75	0	
	2103	556	75	0	
	2228	0	0	2,218	
	2229	0	0	2,219	
	2230	0	0	2,219	
		8,562	750	6,656	15,968
Rye	2033	246	0	0	
	2034	220	0	0	
	2035	224	0	0	
	2036	216	751	0	
	2037	202	0	0	
	2110	220	674	0	
	2111	220	114	0	
	2112	220	507	0	
	2232	0	0	0	
		1,768	2,046	0	3,814

Traffic Demand for Scenarios 3, 4 (conc.)

Community	Centroid	Permanent	Transient	Employees	Total
		Total Generated Trips			
Seabrook	2063	418	2,001	0	
	2064	636	16	0	
	2065	224	455	0	
	2066	635	0	0	
	2067	613	0	0	
	2115	0	1,500	0	
	2211	0	0	260	
	2212	0	0	518	
	2214	0	0	260	
		2,526	3,972	1,038	7,536
So. Hampton	2031	298	158	0	
	2213	0	0	63	
		298	158	63	519
Stratham	2020	647	50	0	
	2021	759	0	0	
	2022	820	0	0	
	2222	0	0	523	
		2,226	50	523	2,799
TOTAL:		55,934	27,034	22,144	105,112

Traffic Demand for Scenarios 5, 6, 7

Community	Centroid	Permanent	Total Generated Trips Transient	Employees	Total
Amesbury	2068	284	0	0	
	2069	733	0	0	
	2070	209	0	0	
	2071	1,072	0	0	
	2072	762	20	0	
	2073	528	0	0	
	2074	528	0	0	
	2075	1,002	0	0	
	2118	785	0	0	
	2207	0	0	1,388	
	2208	0	0	1,387	
		5,903	20	2,775	8,698
Merrimac	2076	900	0	0	
	2077	908	0	0	
	2078	255	45	0	
	2206	0	0	1,904	
		2,063	45	1,904	4,012
Newbury	2079	1,093	0	0	
	2080	1,093	0	0	
	2082	109	0	0	
	2104	8	0	0	
	2200	0	0	791	
	2201	0	0	792	
		2,303	0	1,583	3,886
Newburyport	2081	213	28	0	
	2083	436	0	0	
	2084	436	0	0	
	2085	436	0	0	
	2086	436	0	0	
	2087	327	0	0	
	2088	537	0	0	
	2089	1,012	0	0	
	2090	1,086	0	0	
	2091	757	0	0	
	2102	533	0	0	
	2114	265	0	0	
	2202	0	0	548	
	2203	0	0	548	
	2204	0	0	550	
		6,474	28	1,646	8,148

Traffic Demand for Scenarios 5, 6, 7 (cont.)

Community	Centroid	Permanent	Transient	Employees	Total
		Total Generated Trips			
Salisbury	2092	388	0	0	
	2093	95	0	0	
	2094	225	80	0	
	2095	225	0	0	
	2096	987	81	0	
	2097	199	23	0	
	2098	908	0	0	
	2209	0	0	536	
	2210	0	0	536	
		3,027	184	1,072	4,283
W. Newbury	2099	450	25	0	
	2100	491	0	0	
	2101	455	0	0	
	2205	0	0	699	
		1,396	25	699	2,120
Brentwood	2001	614	0	0	
	2002	432	0	0	
	2240	0	0	20	
		1,046	0	20	1,066
E. Kingston	2003	146	0	0	
	2004	50	0	0	
	2005	357	0	0	
	2241	0	0	47	
		553	0	47	600
Exeter	2006	362	25	0	
	2007	432	0	0	
	2008	432	0	0	
	2009	620	0	0	
	2010	742	0	0	
	2011	566	31	0	
	2012	424	0	0	
	2013	375	0	0	
	2014	255	0	0	
	2032	625	0	0	
	2223	0	0	411	
	2224	0	0	411	
		4,833	56	822	5,711

Traffic Demand for Scenarios 5, 6, 7 (cont.)

Community	Centroid	Permanent	Transient	Employees	Total
		Total Generated Trips			
Greenland	2015	290	0	0	
	2016	384	0	0	
	2017	454	0	0	
	2227	0	0	1,435	
		1,128	0	1,435	2,563
Hampton	2056	492	0	0	
	2057	276	148	0	
	2058	609	0	0	
	2059	875	0	0	
	2060	769	6	0	
	2061	193	0	0	
	2062	440	51	0	
	2105	131	64	0	
	2106	109	0	0	
	2107	109	70	0	
	2108	218	12	0	
	2113	378	0	0	
	2117	137	0	0	
	2121	55	27	0	
	2219	0	0	725	
	2220	0	0	725	
	2305	32	16	0	
		4,823	394	1,450	6,667
Hampton Falls	2116	601	0	0	
	2218	0	0	141	
		601	0	141	742
Kensington	2026	401	7	0	
	2027	252	9	0	
	2242	0	0	38	
		653	16	38	707
Kingston	2023	556	0	0	
	2024	556	0	0	
	2025	617	0	0	
	2030	558	0	0	
	2215	0	0	234	
		2,287	0	234	2,521
New Castle	2019	316	13	0	329
Newfields	2018	352	0	0	
	2226	0	0	181	
		352	0	181	533

Traffic Demand for Scenarios 5, 6, 7 (cont.)

Community	Centroid	Permanent	Transient	Employees	Total
		Total Generated Trips			
Newton	2028	690	0	0	
	2029	690	0	0	
	2243	0	0	88	
		1,380	0	88	1,468
No. Hampton	2050	116	0	0	
	2051	278	58	0	
	2052	323	0	0	
	2053	231	0	0	
	2054	83	31	0	
	2055	243	0	0	
	2109	142	0	0	
	2221	0	0	358	
		1,416	89	358	1,863
Portsmouth	2038	397	0	0	
	2039	397	0	0	
	2040	372	25	0	
	2041	397	0	0	
	2042	947	25	0	
	2043	1,196	25	0	
	2044	556	25	0	
	2045	832	25	0	
	2046	749	25	0	
	2047	1,504	25	0	
	2048	317	25	0	
	2049	342	25	0	
	2103	556	25	0	
	2228	0	0	2,218	
	2229	0	0	2,219	
	2230	0	0	2,219	
		8,562	250	6,656	15,468
Rye	2033	246	0	0	
	2034	220	0	0	
	2035	224	0	0	
	2036	216	0	0	
	2037	202	0	0	
	2110	220	0	0	
	2111	220	0	0	
	2112	220	0	0	
	2232	0	0	0	
		1,768	0	0	1,768

Traffic Demand for Scenarios 5, 6, 7 (conc.)

Community	Centroid	Permanent	Transient	Employees	Total
		Total Generated Trips			
Seabrook	2063	418	68	0	
	2064	636	12	0	
	2065	224	69	0	
	2066	635	0	0	
	2067	613	23	0	
	2115	0	1,500	0	
	2211	0	0	287	
	2212	0	0	577	
	2214	0	0	287	
		2,526	1,672	1,151	5,349
So. Hampton	2031	298	0	0	
	2213	0	0	63	
		298	0	63	361
Stratham	2020	647	28	0	
	2021	759	0	0	
	2022	820	0	0	
	2222	0	0	0	
		2,226	28	0	2,226
TOTAL:		55,934	2,820	22,886	81,640

Traffic Demand for Scenarios 8, 9, 10

Community	Centroid	Permanent	Total Generated Trips Transient	Employees	Total
Amesbury	2068	284	0	0	
	2069	733	0	0	
	2070	209	0	0	
	2071	1,072	0	0	
	2072	762	20	0	
	2073	528	0	0	
	2074	528	0	0	
	2075	1,002	0	0	
	2118	785	0	0	
	2207	0	0	347	
	2208	0	0	347	
		5,903	20	694	6,617
Merrimac	2076	900	0	0	
	2077	908	0	0	
	2078	255	45	0	
	2206	0	0	476	
		2,063	45	476	2,584
Newbury	2079	1,093	0	0	
	2080	1,093	0	0	
	2082	109	0	0	
	2104	8	0	0	
	2200	0	0	198	
	2201	0	0	198	
		2,303	0	396	2,699
Newburyport	2081	213	28	0	
	2083	436	0	0	
	2084	436	0	0	
	2085	436	0	0	
	2086	436	0	0	
	2087	327	0	0	
	2088	537	0	0	
	2089	1,012	0	0	
	2090	1,086	0	0	
	2091	757	0	0	
	2102	533	0	0	
	2114	265	0	0	
	2202	0	0	136	
	2203	0	0	136	
	2204	0	0	136	
		6,474	28	408	6,910

Traffic Demand for Scenarios 8, 9, 10 (cont.)

Community	Centroid	Total Generated Trips Permanent	Transient	Employees	Total
Salisbury	2092	388	0	0	
	2093	95	0	0	
	2094	225	80	0	
	2095	225	0	0	
	2096	987	81	0	
	2097	199	23	0	
	2098	908	0	0	
	2209	0	0	134	
	2210	0	0	135	
		3,027	184	269	3,480
W. Newbury	2099	450	25	0	
	2100	491	0	0	
	2101	455	0	0	
	2205	0	0	175	
		1,396	25	175	1,596
Brentwood	2001	614	0	0	
	2002	432	0	0	
	2240	0	0	5	
		1,046	0	5	1,0[illegible]
E. Kingston	2003	146	0	0	
	2004	50	0	0	
	2005	357	0	0	
	2241	0	0	12	
		553	0	12	565
Exeter	2006	362	25	0	
	2007	432	0	0	
	2008	432	0	0	
	2009	620	0	0	
	2010	742	0	0	
	2011	566	31	0	
	2012	424	0	0	
	2013	375	0	0	
	2014	255	0	0	
	2032	625	0	0	
	2223	0	0	103	
	2224	0	0	103	
		4,833	56	206	5,095

Traffic Demand for Scenarios 8, 9, 10 (cont.)

Community	Centroid	Total Generated Trips Permanent	 Transient	 Employees	Total
Greenland	2015	290	0	0	
	2016	384	0	0	
	2017	454	0	0	
	2227	0	0	357	
		1,128	0	357	1,485
Hampton	2056	492	0	0	
	2057	276	148	0	
	2058	609	0	0	
	2059	875	0	0	
	2060	769	6	0	
	2061	193	0	0	
	2062	440	51	C	
	2105	131	64	0	
	2106	109	0	0	
	2107	109	70	0	
	2108	218	12	0	
	2113	378	0	0	
	2117	137	0	0	
	2121	55	27	0	
	2219	0	0	181	
	2220	0	0	181	
	2305	32	16	0	
		4,823	394	362	5,579
Hampton Falls	2116	601	0	0	
	2218	0	0	35	
		601	0	35	636
Kensington	2026	401	7	0	
	2027	252	9	0	
	2242	0	0	9	
		653	16	9	678
Kingston	2023	556	0	0	
	2024	556	0	0	
	2025	617	0	0	
	2030	558	0	0	
	2215	0	0	59	
		2,287	0	59	2,346
New Castle	2019	316	13	0	329
Newfields	2018	352	0	0	
	2226	0	0	45	
		352	0	45	397

Traffic Demand for Scenarios 8, 9, 10 (cont.)

		Total Generated Trips			
Community	Centroid	Permanent	Transient	Employees	Total
Newton	2028	690	0	0	
	2029	690	0	0	
	2243	0	0	22	
		1,380	0	22	1,402
No. Hampton	2050	116	0	0	
	2051	278	58	0	
	2052	323	0	0	
	2053	231	0	0	
	2054	83	31	0	
	2055	243	0	0	
	2109	142	0	0	
	2221	0	0	89	
		1,416	89	89	1,594
Portsmouth	2038	397	0	0	
	2039	397	0	0	
	2040	372	25	0	
	2041	397	0	0	
	2042	947	25	0	
	2043	1,196	25	0	
	2044	556	25	0	
	2045	832	25	0	
	2046	749	25	0	
	2047	1,504	25	0	
	2048	317	25	0	
	2049	342	25	0	
	2103	556	25	0	
	2228	0	0	555	
	2229	0	0	559	
	2230	0	0	555	
		8,562	250	1,669	10,481
Rye	2033	246	0	0	
	2034	220	0	0	
	2035	224	0	0	
	2036	216	0	0	
	2037	202	0	0	
	2110	220	0	0	
	2111	220	0	0	
	2112	220	0	0	
	2232	0	0	0	
		1,768	0	0	1,768

Traffic Demand for Scenarios 8, 9, 10 (conc.)

		Total Generated Trips			
Community	Centroid	Permanent	Transient	Employees	Total
Seabrook	2063	418	68	0	
	2064	636	12	0	
	2065	224	69	0	
	2066	635	0	0	
	2067	613	23	0	
	2115	0	1,500	0	
	2211	0	0	76	
	2212	0	0	143	
	2214	0	0	76	
		2,526	1,672	295	4,493
So. Hampton	2031	298	0	0	
	2213	0	0	16	
		298	0	16	314
Stratham	2020	647	28	0	
	2021	759	0	0	
	2022	820	0	0	
	2222	0	0	131	
		2,226	28	131	2,385
TOTAL:		55,934	2,820	5,730	64,484

SCENARIOS 1 AND 2: SUMMER WEEKEND

ORIGIN CENTROID LOADING RATES (VEH/HR) DURING INDICATED TIME PERIODS

CENTROID ORIGIN	TIME PERIOD NUMBERS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
2001	0	0	0	0	0	441	613	344	294	294	73	73	73	24	24	24	0
2002	0	0	0	0	0	153	213	120	102	102	25	25	25	8	8	8	0
2003	0	0	0	0	0	104	145	82	69	69	17	17	17	5	5	5	0
2004	0	0	0	0	0	99	138	77	65	65	16	16	16	5	5	5	0
2005	0	0	0	0	0	282	391	219	187	187	47	47	47	15	15	15	0
2006	0	0	0	0	0	342	475	266	228	228	56	56	56	18	18	18	0
2007	0	0	0	0	0	311	432	241	207	207	51	51	51	17	17	17	0
2008	0	0	0	0	0	311	432	241	207	207	51	51	51	17	17	17	0
2009	0	0	0	0	0	530	736	412	353	353	88	88	88	29	29	29	0
2010	0	0	0	0	0	616	856	479	410	410	102	102	102	34	34	34	0
2011	0	0	0	0	0	455	633	354	303	303	76	76	76	25	25	25	0
2012	0	0	0	0	0	304	423	237	203	203	51	51	51	17	17	17	0
2013	0	0	0	0	0	302	420	235	201	201	51	51	51	17	17	17	0
2014	0	0	0	0	0	73	102	57	49	49	12	12	12	4	4	4	0
2015	0	0	0	0	0	246	342	191	165	165	41	41	41	13	13	13	0
2016	0	0	0	0	0	276	385	216	184	184	46	46	46	15	15	15	0
2017	0	0	0	0	0	327	453	254	217	217	54	54	54	18	18	18	0
2018	0	0	0	0	0	272	378	212	181	181	45	45	45	14	14	14	0
2019	0	0	0	0	0	265	369	207	177	177	44	44	44	15	15	15	0
2020	0	0	0	0	0	513	713	399	342	342	85	85	85	28	28	28	0
2021	0	0	0	0	0	546	759	425	364	364	90	90	90	30	30	30	0
2022	0	0	0	0	0	589	819	458	393	393	99	99	99	33	33	33	0
2023	0	0	0	0	0	400	556	312	266	266	66	66	66	22	22	22	0
2024	0	0	0	0	0	400	556	312	266	266	66	66	66	22	22	22	0
2025	0	0	0	0	0	444	617	346	295	295	73	73	73	24	24	24	0
2026	0	0	0	0	0	318	441	247	212	212	53	53	53	18	18	18	0
2027	0	0	0	0	0	206	286	160	137	137	34	34	34	12	12	12	0
2028	0	0	0	0	0	506	702	394	337	337	85	85	85	28	28	28	0
2029	0	0	0	0	0	506	702	394	337	337	85	85	85	28	28	28	0
2030	0	0	0	0	0	400	556	312	266	266	66	66	66	22	22	22	0
2031	0	0	0	0	0	367	509	285	244	244	61	61	61	20	20	20	0
2032	0	0	0	0	0	449	624	349	299	299	74	74	74	24	24	24	0
2033	0	0	0	0	0	177	246	137	119	119	30	30	30	10	10	10	0

SCENARIOS 1 AND 2: SUMMER WEEKEND

ORIGIN CENTROID LOADING RATES (VEH/HR) DURING INDICATED TIME PERIODS

CENTROID ORIGIN	TIME PERIOD NUMBERS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
2034	0	0	0	0	0	159	220	124	106	106	27	27	27	10	10	10	0
2035	0	0	0	0	0	162	224	126	108	108	28	28	28	10	10	10	0
2036	1	820	446	863	1624	1508	493	308	378	378	147	0	0	0	0	0	0
2037	0	0	0	0	0	146	202	113	98	98	25	25	25	9	9	9	0
2038	0	0	0	0	0	287	398	223	191	191	49	49	49	16	16	16	0
2039	0	0	0	0	0	287	398	223	191	191	49	49	49	16	16	16	0
2040	0	0	0	0	0	340	471	264	226	226	57	57	57	19	19	19	0
2041	0	0	0	0	0	287	398	223	191	191	49	49	49	16	16	16	0
2042	0	0	0	0	0	757	1051	589	505	505	127	127	127	43	43	43	0
2043	0	0	0	0	0	933	1295	725	622	622	156	156	156	52	52	52	0
2044	0	0	0	0	0	473	657	368	316	316	80	80	80	27	27	27	0
2045	0	0	0	0	0	671	932	522	447	447	112	112	112	37	37	37	0
2046	0	0	0	0	0	612	849	475	408	408	102	102	102	34	34	34	0
2047	0	0	0	0	0	1155	1603	898	770	770	193	193	193	65	65	65	0
2048	0	0	0	0	0	301	419	235	201	201	51	51	51	17	17	17	0
2049	0	0	0	0	0	319	442	248	213	213	53	53	53	18	18	18	0
2050	0	0	0	0	0	92	129	72	61	61	15	15	15	5	5	5	0
2051	0	0	0	0	0	307	427	238	205	205	51	51	51	17	17	17	0
2052	0	0	0	0	0	307	427	239	205	205	51	51	51	17	17	17	0
2053	0	0	0	0	0	165	230	129	110	110	27	27	27	9	9	9	0
2054	1	668	88	170	322	299	97	61	74	74	29	0	0	0	0	0	0
2055	0	0	0	0	0	175	242	135	116	116	29	29	29	10	10	10	0
2056	0	0	0	0	0	355	493	276	237	237	59	59	59	20	20	20	0
2057	0	0	0	0	0	363	505	283	243	243	61	61	61	21	21	21	0
2058	0	0	0	0	0	486	674	377	324	324	81	81	81	27	27	27	0
2059	0	0	0	0	0	630	876	490	421	421	106	106	106	36	36	36	0
2060	0	0	0	0	0	605	841	471	404	404	101	101	101	34	34	34	0
2061	0	0	0	0	0	402	558	312	268	268	67	67	67	23	23	23	0
2062	0	0	0	0	0	429	596	334	287	287	72	72	72	24	24	24	0
2063	1	1495	1130	2198	4156	3860	1249	774	953	953	360	0	0	0	0	0	0
2064	0	0	0	0	0	474	658	369	316	316	79	79	79	27	27	27	0
2065	0	0	0	0	0	598	831	466	399	399	100	100	100	33	33	33	0
2066	0	0	0	0	0	471	654	367	314	314	79	79	79	27	27	27	0
2067	0	0	0	0	0	455	631	353	304	304	76	76	76	26	26	26	0

SCENARIOS 1 AND 2: SUMMER WEEKEND

ORIGIN CENTROID LOADING RATES (VEH/HR) DURING INDICATED TIME PERIODS

CENTROID	TIME PERIOD NUMBERS																
ORIGIN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
2068	0	0	0	0	0	509	707	396	339	339	85	85	85	28	28	28	0
2069	0	0	0	0	0	532	739	414	354	354	89	89	89	30	30	30	0
2070	0	0	0	0	0	151	210	118	101	101	25	25	25	8	8	8	0
2071	0	0	0	0	0	771	1071	600	514	514	129	129	129	43	43	43	0
2072	0	0	0	0	0	579	805	451	386	386	96	96	96	32	32	32	0
2073	0	0	0	0	0	409	569	318	272	272	68	68	68	22	22	22	0
2074	0	0	0	0	0	409	569	318	272	272	68	68	68	22	22	22	0
2075	0	0	0	0	0	814	1130	633	543	543	135	135	135	44	44	44	0
2076	0	0	0	0	0	653	906	507	435	435	109	109	109	36	36	36	0
2077	0	0	0	0	0	654	908	508	435	435	109	109	109	36	36	36	0
2078	0	0	0	0	0	254	350	199	171	171	47	47	47	19	19	19	0
2079	0	0	0	0	0	786	1093	612	524	524	131	131	131	43	43	43	0
2080	0	0	0	0	0	792	1100	616	527	527	131	131	131	43	43	43	0
2081	1	570	368	722	1369	1271	407	251	310	310	114	0	0	0	0	0	0
2082	1	574	340	662	1254	1165	375	232	285	285	106	0	0	0	0	0	0
2083	0	0	0	0	0	318	442	248	212	212	53	53	53	17	17	17	0
2084	0	0	0	0	0	318	442	248	212	212	53	53	53	17	17	17	0
2085	0	0	0	0	0	318	442	248	212	212	53	53	53	17	17	17	0
2086	0	0	0	0	0	318	442	248	212	212	53	53	53	17	17	17	0
2087	0	0	0	0	0	414	575	322	276	276	68	68	68	23	23	23	0
2088	0	0	0	0	0	386	537	300	258	258	64	64	64	21	21	21	0
2089	0	0	0	0	0	763	1060	593	508	508	126	126	126	41	41	41	0
2090	0	0	0	0	0	764	1061	594	509	509	127	127	127	42	42	42	0
2091	0	0	0	0	0	632	878	492	421	421	105	105	105	34	34	34	0
2092	0	0	0	0	0	279	388	217	186	186	46	46	46	15	15	15	0
2093	1	864	1031	2033	3868	3589	1142	698	864	864	307	0	0	0	0	0	0
2094	1	592	706	1394	2654	2463	783	477	592	592	209	0	0	0	0	0	0
2095	1	469	559	1101	2094	1943	620	379	469	469	168	0	0	0	0	0	0
2096	0	0	0	0	0	707	982	549	471	471	118	118	118	39	39	39	0
2097	0	0	0	0	0	245	340	191	163	163	40	40	40	13	13	13	0
2098	0	0	0	0	0	723	1004	561	482	482	120	120	120	40	40	40	0
2099	0	0	0	0	0	421	585	328	280	280	69	69	69	23	23	23	0
2100	0	0	0	0	0	386	537	301	257	257	64	64	64	21	21	21	0

SCENARIOS 1 AND 2: SUMMER WEEKEND

ORIGIN CENTROID LOADING RATES (VEH/HR) DURING INDICATED TIME PERIODS

CENTROID	TIME PERIOD NUMBERS																
ORIGIN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
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2101	0	0	0	0	0	326	453	254	217	217	53	53	53	17	17	17	0
2102	0	0	0	0	0	383	533	298	256	256	63	63	63	21	21	21	0
2103	0	0	0	0	0	473	657	368	316	316	80	80	80	27	27	27	0
2104	1	156	465	905	1714	1592	514	318	391	391	146	0	0	0	0	0	0
2105	1	4066	2148	4198	5888	7379	2380	1473	3519	3519	1245	0	0	0	0	0	0
2106	1	766	355	695	1321	1226	393	241	299	299	109	0	0	0	0	0	0
2107	0	0	181	356	677	629	201	123	153	153	55	0	0	0	0	0	0
2108	1	1709	939	1806	3397	3156	1036	651	795	795	313	0	0	0	0	0	0
2109	1	658	115	224	422	392	127	79	97	97	37	0	0	0	0	0	0
2110	1	814	407	786	1480	1374	449	281	344	344	134	0	0	0	0	0	0
2111	1	771	116	227	431	400	128	80	97	97	36	0	0	0	0	0	0
2112	0	0	344	666	1258	1168	380	237	290	290	111	0	0	0	0	0	0
2113	0	0	0	0	0	293	407	229	195	195	49	49	49	17	17	17	0
2114	0	0	0	0	0	367	510	285	245	245	60	60	60	20	20	20	0
2115	0	0	0	0	0	1865	2587	1083	150	150	90	0	0	0	0	0	0
2116	0	0	0	0	0	571	794	445	381	381	95	95	95	31	31	31	0
2117	0	0	0	0	0	139	193	108	93	93	24	24	24	8	8	8	0
2118	0	0	0	0	0	563	783	439	375	375	93	93	93	31	31	31	0
2119	0	0	0	0	0	157	218	122	105	105	26	26	26	9	9	9	0
2120	0	0	0	0	0	172	240	134	115	115	28	28	28	9	9	9	0
2121	1	1686	889	1740	3304	3066	984	605	1456	1456	509	0	0	0	0	0	0
2200	0	0	0	0	0	614	852	357	50	50	29	0	0	0	0	0	0
2201	0	0	0	0	0	614	852	357	50	50	29	0	0	0	0	0	0
2202	0	0	0	0	0	268	371	156	22	22	14	0	0	0	0	0	0
2203	0	0	0	0	0	268	371	156	22	22	14	0	0	0	0	0	0
2204	0	0	0	0	0	268	371	156	22	22	14	0	0	0	0	0	0
2205	0	0	0	0	0	347	481	202	29	29	17	0	0	0	0	0	0
2206	0	0	0	0	0	941	1306	547	75	75	45	0	0	0	0	0	0
2207	0	0	0	0	0	686	952	399	55	55	34	0	0	0	0	0	0
2208	0	0	0	0	0	686	952	399	55	55	34	0	0	0	0	0	0
2209	0	0	0	0	0	421	584	245	34	34	21	0	0	0	0	0	0
2210	0	0	0	0	0	421	584	245	34	34	21	0	0	0	0	0	0

SCENARIOS 1 AND 2: SUMMER WEEKEND

ORIGIN CENTROID LOADING RATES (VEH/HR) DURING INDICATED TIME PERIODS

CENTROID ORIGIN	TIME PERIOD NUMBERS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
2211	0	0	0	0	0	224	310	131	19	19	12	0	0	0	0	0	0
2212	0	0	0	0	0	450	624	262	37	37	23	0	0	0	0	0	0
2213	0	0	0	0	0	52	72	30	5	5	2	0	0	0	0	0	0
2214	0	0	0	0	0	224	310	131	19	19	12	0	0	0	0	0	0
2215	0	0	0	0	0	118	163	68	10	10	6	0	0	0	0	0	0
2218	0	0	0	0	0	124	172	72	11	11	7	0	0	0	0	0	0
2219	0	0	0	0	0	470	653	273	38	38	23	0	0	0	0	0	0
2220	0	0	0	0	0	470	653	273	38	38	23	0	0	0	0	0	0
2221	0	0	0	0	0	312	432	181	26	26	15	0	0	0	0	0	0
2222	0	0	0	0	0	259	359	150	21	21	13	0	0	0	0	0	0
2223	0	0	0	0	0	204	283	119	18	18	11	0	0	0	0	0	0
2224	0	0	0	0	0	204	283	119	18	18	11	0	0	0	0	0	0
2226	0	0	0	0	0	91	124	53	8	8	4	0	0	0	0	0	0
2227	0	0	0	0	0	721	1005	422	58	58	36	0	0	0	0	0	0
2228	0	0	0	0	0	1104	1531	641	90	90	53	0	0	0	0	0	0
2229	0	0	0	0	0	1104	1531	641	90	90	53	0	0	0	0	0	0
2230	0	0	0	0	0	1104	1531	641	90	90	53	0	0	0	0	0	0
2232	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2240	0	0	0	0	0	25	35	15	2	2	1	1	0	0	0	0	0
2241	0	0	0	0	0	59	83	36	4	4	2	2	0	0	0	0	0
2242	0	0	0	0	0	47	66	29	3	3	2	2	0	0	0	0	0
2243	0	0	0	0	0	109	155	67	7	7	4	4	0	0	0	0	0
2300	6000	2200	2200	2200	2200	2200	2200	1100	1100	1100	1100	0	0	0	0	0	0
2301	6000	2200	2200	2200	2200	2200	2200	1100	1100	1100	1100	0	0	0	0	0	0
2305	1	938	489	966	1859	1720	538	322	807	807	273	273	0	0	0	0	0

NUMBER	TIME PERIOD DURATION (MIN.)
1	5
2	5
3	5
4	5
5	10
6	15
7	15
8	15
9	15
10	15
11	15
12	15
13	15
14	15
15	15
16	15
17	45

SCENARIOS 5 AND 6: WINTER MIDWEEK, MIDDAY

ORIGIN CENTROID LOADING RATES (VEH/HR) DURING INDICATED TIME PERIODS

CENTROID	TIME PERIOD NUMBERS																
ORIGIN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
2001	1	122	294	318	330	330	221	221	114	54	37	0	0	0	0	0	0
2002	1	42	102	110	114	114	77	77	40	18	13	0	0	0	0	0	0
2003	1	29	69	76	78	78	52	52	27	13	9	0	0	0	0	0	0
2004	1	9	21	24	25	25	16	16	8	4	3	0	0	0	0	0	0
2005	1	69	168	182	189	189	126	126	65	31	21	0	0	0	0	0	0
2006	1	76	184	198	207	207	137	137	71	34	23	0	0	0	0	0	0
2007	1	86	207	224	233	233	155	155	80	38	25	0	0	0	0	0	0
2008	1	86	207	224	233	233	155	155	80	38	25	0	0	0	0	0	0
2009	1	123	296	321	333	333	222	222	115	56	37	0	0	0	0	0	0
2010	1	171	410	445	462	462	308	308	159	77	51	0	0	0	0	0	0
2011	1	120	287	311	324	324	215	215	111	54	36	0	0	0	0	0	0
2012	1	84	203	220	228	228	153	153	79	38	25	0	0	0	0	0	0
2013	1	74	179	194	201	201	134	134	70	34	22	0	0	0	0	0	0
2014	1	20	49	53	55	55	37	37	19	9	6	0	0	0	0	0	0
2015	1	55	133	143	149	149	99	99	51	25	16	0	0	0	0	0	0
2016	1	76	184	200	208	208	138	138	72	34	23	0	0	0	0	0	0
2017	1	91	217	236	245	245	163	163	84	40	27	0	0	0	0	0	0
2018	1	70	169	183	190	190	127	127	66	31	21	0	0	0	0	0	0
2019	1	63	153	165	172	172	115	115	59	29	19	0	0	0	0	0	0
2020	1	129	312	337	350	350	233	233	121	58	39	0	0	0	0	0	0
2021	1	151	364	394	409	409	273	273	141	68	45	0	0	0	0	0	0
2022	1	164	393	426	443	443	295	295	152	73	48	0	0	0	0	0	0
2023	1	111	266	289	300	300	199	199	104	50	33	0	0	0	0	0	0
2024	1	111	266	289	300	300	199	199	104	50	33	0	0	0	0	0	0
2025	1	123	295	321	333	333	222	222	115	56	37	0	0	0	0	0	0
2026	1	79	190	207	215	215	144	144	74	36	24	0	0	0	0	0	0
2027	1	51	124	133	139	139	93	93	47	22	15	0	0	0	0	0	0
2028	1	139	332	359	373	373	249	249	129	63	42	0	0	0	0	0	0
2029	1	139	332	359	373	373	249	249	129	63	42	0	0	0	0	0	0
2030	1	111	266	289	300	300	199	199	104	50	33	0	0	0	0	0	0
2031	1	57	137	147	154	154	101	101	53	25	16	0	0	0	0	0	0
2032	1	125	299	325	337	337	224	224	116	56	37	0	0	0	0	0	0
2033	1	49	119	128	133	133	89	89	46	22	15	0	0	0	0	0	0

SCENARIOS 5 AND 6: WINTER MIDWEEK, MIDDAY

ORIGIN CENTROID LOADING RATES (VEH/HR) DURING INDICATED TIME PERIODS

CENTROID ORIGIN	TIME PERIOD NUMBERS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
2034	1	45	106	115	119	119	80	80	42	20	14	0	0	0	0	0	0
2035	1	46	108	117	121	121	81	81	42	20	14	0	0	0	0	0	0
2036	1	79	144	154	159	159	116	116	76	53	45	0	0	0	0	0	0
2037	1	41	98	105	110	110	73	73	38	19	12	0	0	0	0	0	0
2038	1	80	191	207	215	215	144	144	75	36	25	0	0	0	0	0	0
2039	1	80	191	207	215	215	144	144	75	36	25	0	0	0	0	0	0
2040	1	78	185	200	208	208	139	139	73	35	24	0	0	0	0	0	0
2041	1	80	191	207	215	215	144	144	75	36	25	0	0	0	0	0	0
2042	1	193	462	501	521	521	347	347	181	87	58	0	0	0	0	0	0
2043	1	243	581	630	654	654	436	436	227	109	73	0	0	0	0	0	0
2044	1	114	275	297	309	309	206	206	107	51	34	0	0	0	0	0	0
2045	1	170	407	441	458	458	305	305	158	76	51	0	0	0	0	0	0
2046	1	153	367	398	413	413	275	275	143	69	46	0	0	0	0	0	0
2047	1	304	730	790	821	821	548	548	284	137	92	0	0	0	0	0	0
2048	1	67	159	173	179	179	120	120	63	31	20	0	0	0	0	0	0
2049	1	71	171	185	192	192	128	128	67	32	22	0	0	0	0	0	0
2050	1	22	54	58	60	60	40	40	21	10	7	0	0	0	0	0	0
2051	1	66	160	174	180	180	120	120	62	30	20	0	0	0	0	0	0
2052	1	64	155	167	174	174	116	116	60	29	19	0	0	0	0	0	0
2053	1	46	110	120	124	124	82	82	43	21	14	0	0	0	0	0	0
2054	1	29	62	66	69	69	48	48	28	16	13	0	0	0	0	0	0
2055	1	48	116	126	131	131	87	87	45	22	14	0	0	0	0	0	0
2056	1	99	237	256	267	267	178	178	92	45	30	0	0	0	0	0	0
2057	1	86	205	223	231	231	154	154	80	39	26	0	0	0	0	0	0
2058	1	123	295	319	332	332	221	221	115	56	38	0	0	0	0	0	0
2059	1	176	421	455	473	473	316	316	163	79	53	0	0	0	0	0	0
2060	1	156	375	406	422	422	281	281	146	71	47	0	0	0	0	0	0
2061	1	41	97	104	108	108	72	72	38	18	12	0	0	0	0	0	0
2062	1	99	239	258	268	268	179	179	93	45	30	0	0	0	0	0	0
2063	1	175	332	356	366	366	265	265	167	113	96	0	0	0	0	0	0
2064	1	130	313	339	352	352	235	235	122	59	40	0	0	0	0	0	0
2065	1	65	156	169	176	176	117	117	61	30	20	0	0	0	0	0	0
2066	1	131	314	340	353	353	236	236	122	59	40	0	0	0	0	0	0
2067	1	130	313	339	352	352	235	235	122	59	40	0	0	0	0	0	0

SCENARIOS 5 AND 6: WINTER MIDWEEK, MIDDAY

ORIGIN CENTROID LOADING RATES (VEH/HR) DURING INDICATED TIME PERIODS

CENTROID ORIGIN	TIME PERIOD NUMBERS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
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2068	1	54	130	141	147	147	97	97	50	24	16	0	0	0	0	0	0
2069	1	146	350	380	394	394	263	263	136	65	44	0	0	0	0	0	0
2070	1	41	101	109	113	113	76	76	39	19	12	0	0	0	0	0	0
2071	1	214	514	557	578	578	386	386	200	96	64	0	0	0	0	0	0
2072	1	156	374	406	421	421	280	280	145	70	47	0	0	0	0	0	0
2073	1	104	252	273	284	284	189	189	98	47	32	0	0	0	0	0	0
2074	1	104	252	273	284	284	189	189	98	47	32	0	0	0	0	0	0
2075	1	199	479	519	538	538	359	359	186	89	59	0	0	0	0	0	0
2076	1	180	432	469	487	487	324	324	168	81	54	0	0	0	0	0	0
2077	1	182	435	472	490	490	326	326	169	81	54	0	0	0	0	0	0
2078	1	63	145	156	162	162	110	110	60	32	23	0	0	0	0	0	0
2079	1	218	524	568	590	590	393	393	204	98	65	0	0	0	0	0	0
2080	1	167	400	434	450	450	300	300	156	75	50	0	0	0	0	0	0
2081	1	54	131	141	146	146	102	102	61	38	30	0	0	0	0	0	0
2082	1	37	65	69	71	71	53	53	36	26	23	0	0	0	0	0	0
2083	1	88	212	230	238	238	159	159	83	39	26	0	0	0	0	0	0
2084	1	88	212	230	238	238	159	159	83	39	26	0	0	0	0	0	0
2085	1	88	212	230	238	238	159	159	83	39	26	0	0	0	0	0	0
2086	1	88	212	230	238	238	159	159	83	39	26	0	0	0	0	0	0
2087	1	64	156	168	175	175	116	116	60	29	19	0	0	0	0	0	0
2088	1	107	258	278	290	290	193	193	100	48	31	0	0	0	0	0	0
2089	1	202	485	526	546	546	364	364	188	91	60	0	0	0	0	0	0
2090	1	212	509	552	572	572	382	382	197	95	63	0	0	0	0	0	0
2091	1	150	360	391	405	405	270	270	139	67	44	0	0	0	0	0	0
2092	1	77	186	202	209	209	140	140	72	35	23	0	0	0	0	0	0
2093	1	45	66	70	71	71	57	57	44	37	35	0	0	0	0	0	0
2094	1	75	153	166	171	171	120	120	72	44	36	0	0	0	0	0	0
2095	1	56	110	118	122	122	87	87	54	35	30	0	0	0	0	0	0
2096	1	215	517	559	581	581	387	387	201	97	64	0	0	0	0	0	0
2097	1	41	100	109	113	113	75	75	39	18	13	0	0	0	0	0	0
2098	1	178	428	465	482	482	321	321	167	80	54	0	0	0	0	0	0
2099	1	92	222	242	250	250	167	167	87	42	28	0	0	0	0	0	0
2100	1	89	216	233	242	242	161	161	84	40	27	0	0	0	0	0	0

SCENARIOS 5 AND 6: WINTER MIDWEEK, MIDDAY

ORIGIN CENTROID LOADING RATES (VEH/HR) DURING INDICATED TIME PERIODS

CENTROID ORIGIN	TIME PERIOD NUMBERS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
2101	1	85	204	222	231	231	154	154	79	38	25	0	0	0	0	0	0
2102	1	106	256	276	288	288	191	191	99	48	31	0	0	0	0	0	0
2103	1	114	275	297	309	309	206	206	107	51	34	0	0	0	0	0	0
2104	1	26	28	28	28	28	27	27	25	25	0	0	0	0	0	0	0
2105	1	150	207	285	219	219	183	183	148	128	122	0	0	0	0	0	0
2106	1	37	70	74	77	77	56	56	36	24	21	0	0	0	0	0	0
2107	1	43	93	101	104	104	72	72	40	23	17	0	0	0	0	0	0
2108	1	121	189	199	204	204	160	160	118	94	87	0	0	0	0	0	0
2109	1	35	74	80	83	83	57	57	33	20	15	0	0	0	0	0	0
2110	1	76	143	153	157	157	114	114	73	50	43	0	0	0	0	0	0
2111	1	51	115	125	129	129	88	88	49	26	20	0	0	0	0	0	0
2112	1	69	135	145	150	150	107	107	66	43	36	0	0	0	0	0	0
2113	1	77	183	198	206	206	137	137	72	35	23	0	0	0	0	0	0
2114	1	52	126	136	141	141	95	95	49	23	16	0	0	0	0	0	0
2115	1	1865	2587	1083	150	150	90	0	0	0	0	0	0	0	0	0	0
2116	1	119	285	308	320	320	213	213	110	53	35	0	0	0	0	0	0
2117	1	26	63	69	71	71	48	48	25	12	8	0	0	0	0	0	0
2118	1	157	375	407	422	422	28:	281	146	71	47	0	0	0	0	0	0
2119	1	42	102	110	114	114	77	77	40	18	13	0	0	0	0	0	0
2120	1	48	115	124	130	130	86	86	44	21	14	0	0	0	0	0	0
2121	1	54	77	81	82	82	67	67	53	45	42	0	0	0	0	0	0
2200	1	980	1360	569	78	78	47	0	0	0	0	0	0	0	0	0	0
2201	1	980	1360	569	78	78	47	0	0	0	0	0	0	0	0	0	0
2202	1	671	930	390	54	54	33	0	0	0	0	0	0	0	0	0	0
2203	1	671	930	390	54	54	33	0	0	0	0	0	0	0	0	0	0
2204	1	671	930	390	54	54	33	0	0	0	0	0	0	0	0	0	0
2205	1	865	1199	502	70	70	42	0	0	0	0	0	0	0	0	0	0
2206	1	2360	3274	1370	189	189	114	0	0	0	0	0	0	0	0	0	0
2207	1	1715	2379	996	139	139	84	0	0	0	0	0	0	0	0	0	0
2208	1	1715	2379	996	139	139	84	0	0	0	0	0	0	0	0	0	0
2209	1	665	922	386	54	54	33	0	0	0	0	0	0	0	0	0	0
2210	1	665	922	386	54	54	33	0	0	0	0	0	0	0	0	0	0

SCENARIOS 5 AND 6: WINTER MIDWEEK, MIDDAY

ORIGIN CENTROID LOADING RATES (VEH/HR) DURING INDICATED TIME PERIODS

CENTROID ORIGIN	TIME PERIOD NUMBERS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
2211	1	357	495	207	30	30	19	0	0	0	0	0	0	0	0	0	0
2212	1	716	993	416	59	59	3[illegible]	0	0	0	0	0	0	0	0	0	0
2213	1	79	109	46	6	6	4	0	0	0	0	0	0	0	0	0	0
2214	1	357	495	207	30	30	19	0	0	0	0	0	0	0	0	0	0
2215	1	291	404	169	24	24	14	0	0	0	0	0	0	0	0	0	0
2218	1	176	243	102	15	15	9	0	0	0	0	0	0	0	0	0	0
2219	1	898	1246	522	72	72	43	0	0	0	0	0	0	0	0	0	0
2220	1	898	1246	522	72	72	43	0	0	0	0	0	0	0	0	0	0
2221	1	443	615	257	36	36	22	0	0	0	0	0	0	0	0	0	0
2222	1	648	899	376	52	52	32	0	0	0	0	0	0	0	0	0	0
2223	1	509	706	296	42	42	25	0	0	0	0	0	0	0	0	0	0
2224	1	509	706	296	42	42	25	0	0	0	0	0	0	0	0	0	0
2226	1	225	312	131	18	18	11	0	0	0	0	0	0	0	0	0	0
2227	1	1340	1857	779	109	109	66	0	0	0	0	0	0	0	0	0	0
2228	1	2746	3810	1595	222	222	134	0	0	0	0	0	0	0	0	0	0
2229	1	2746	3810	1595	222	222	134	0	0	0	0	0	0	0	0	0	0
2230	1	2746	3810	1595	222	222	134	0	0	0	0	0	0	0	0	0	0
2240	1	25	35	15	2	2	1	1	0	0	0	0	0	0	0	0	0
2241	1	59	83	36	4	4	2	2	0	0	0	0	0	0	0	0	0
2242	1	47	66	29	3	3	2	2	0	0	0	0	0	0	0	0	0
2243	1	109	155	67	7	7	4	4	0	0	0	0	0	0	0	0	0
2300	6000	4400	4400	4400	4400	2200	2200	2200	0	0	0	0	0	0	0	0	0
2301	6000	4400	4400	4400	4400	2200	2200	2200	0	0	0	0	0	0	0	0	0
2305	1	10	23	25	26	26	18	18	9	4	3	0	0	0	0	0	0

TIME PERIOD NUMBER	DURATION (MIN.)
1	5
2	15
3	15
4	15
5	15
6	15
7	15
8	15
9	45
10	60
11	20

APPENDIX N

Network Link Attributes

North Atlantic
June 9, 1993

ENCLOSURE 2 TO NYN-93083

REVISION 3 TO THE SEABROOK STATION EVACUATION TIME ESTIMATE HANDBOOK

CHANGE INSTRUCTIONS

ETE HANDBOOK

REVISION 3

REMOVE	INSERT	
Cover	Cover	Rev. 3
Page QR - 1	Page QR - 1	Rev. 3
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Page i	Page i	Rev. 3
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EVACUATION TIME ESTIMATE

HANDBOOK

FOR THE SEABROOK STATION

EMERGENCY PLANNING ZONE

Revision 3

ETE QUICK REFERENCE

This Quick Reference is provided to enable the user to rapidly select an ETE and highlights a few important aspects of the ETEs.

Selecting an ETE - Identify the Region (direction, distance) to be evacuated based upon the wind direction and distance to be evacuated.

*REGION # (ERPAs)

[ETE Scen.1-Scen.8]**

WIND (from) Degrees /Ordinal	DOWNWIND DISTANCE 2 miles	5 miles	10 miles
34 - 101 NE to E	9 (A) [5:45-3:35]	14 (A,B,C) [5:45-3:40]	16 (A-F) [6:35-3:55]
101 - 123 ESE	9 (A) [5:45-3:35]	7 (A,C) [5:45-3:40]	12 (A-D,F) [6:15-3:55]
123 - 168 SE to SSE	9 (A) [5:45-3:35]	15 (A,C,D) [6:15-3:55]	17 (A-D,F,G) [7:05-4:30]
168 - 191.5 S	9 (A) [5:45-3:35]	6 (A,D) [6:15-3:55]	17 (A-D,F,G) [7:05-4:30]
191.5 - 259 SSW to WSW	9 (A) [5:45-3:35]	6 (A,D) [6:15-3:55]	11 (A-D,G) [6:40-4:30]
259 - 281.5 W	9 (A) [5:45-3:35]	6 (A,D) [6:15-3:55]	5 (A-D) [6:15-3:55]
281.5 - 303 WNW	9 (A) [5:45-3:35]	9 (A) [5:45-3:35]	5 (A-D) [6:15-3:55]
303 - 34 NW to NNE	9 (A) [5:45-3:35]	8 (A,B) [5:45-3:40]	13 (A-E) [6:30-3:55]

Notes: *Region 1 (A-G) [7:05-4:30] is for a full EPZ evacuation;
*Region 10 [6:00] is just the EPZ beach areas.
**Scenario 1 - Summer, weekend, mid-day, good weather;
(Scenario 2, sudden rain, increases the ETE).
**Scenario 8 - Off-season, off hours, good weather.

ERPA	COMMUNITY	ERPA	COMMUNITY
A	Hampton Falls, Seabrook Hampton Beach	E	Merrimac, Newbury West Newbury, Newburyport
B	Amesbury, Salisbury	F	Brentwood, East Kingston, Exeter, Kingston, Newfields, Newton
C	Kensington, South Hampton	G	Greenland, New Castle, Rye, Portsmouth, Stratham
D	Hampton, North Hampton		

SCENARIO

After the times shown there will be no congestion but there may continue to be vehicles from other communities quickly passing through. This table should not be used for PAR decision making. Times are provided for Scenario 1 (summer, weekend; ETE is 7:05) and for Scenario 5 (off-season, work hours, good weather; ETE is 5:55).

Community	ERPA	Scen.1	Scen.5	Community	ERPA	Scen.1	Scen.5
MASSACHUSETTS				NEW HAMPSHIRE (continued)			
Amesbury	B	3 to 4	3 to 4	Hampton Beach	A	6 to 7	2 to 3
Merrimac	E	4 to 5	3 to 4	Hampton Falls	A	2 to 3	2 to 3
Newbury	E	4 to 5	3 to 4	Kensington	C	2 to 3	2 to 3
Newburyport	E	4 to 5	4 to 5	Kingston	F	2 to 3	2 to 3
Salisbury	B	4 to 5	4 to 5	New Castle	G	2 to 3	2 to 3
West Newbury	E	2 to 3	2 to 3	Newfields	F	3 to 4	2 to 3
				Newton	F	4 to 5	4 to 5
NEW HAMPSHIRE				North Hampton	D	6 to 7	4 to 5
Brentwood	F	2 to 3	2 to 3	Portsmouth	G	6 to 7	5 to 6
East Kingston	F	2 to 3	2 to 3	Rye	G	6 to 7	4 to 5
Exeter	F	2 to 3	2 to 3	Seabrook	A	5 to 6	4 to 5
Greenland	G	7 to 8	4 to 5	South Hampton	C	4 to 5	3 to 4
Hampton	D	6 to 7	3 to 4	Stratham	G	3 to 4	2 to 3

Cross Reference abbreviations are:

Evacuation Time Study	ETES
NHRERP Traffic Management Manual	NHTMM
MARERP Traffic Management Manual	MATMM
Maine Traffic Management Manual	MTMM

2.2 INPUTS USED IN THE ETE CALCULATION

2.2.1 Purpose

This subsection details the inputs that have been used in the ETE calculation. These variables are based upon Seabrook Station EPZ research and traffic engineering practices. This information is provided for background purposes.

2.2.2 Population Data [ETES App. E,M]

The ETE calculation is concerned with the number of evacuating vehicles as opposed to the actual population. So both the population and the number of people per car have been evaluated. The total population is made up of three groups: permanent residents, transient and employees. These population groups vary greatly for the various scenarios used in the ETEs. Table 2-4 presents a summary of projected 1993 population data.

The permanent population used in the ETE calculation is based upon 1990 census data for Massachusetts and New Hampshire. Both sets of data were extrapolated to 1993 using 1995 MISER projections for Massachusetts and 1991 population estimates for New Hampshire provided by the New Hampshire Office of State Planning. This population is considered constant for the various evacuation scenarios.

Transient population consists of beach area transient and inland transients. The beach area transients are based upon a count of vehicles observed on aerial photographs taken in July 1987. The inland transient population is based on various studies done over a period of years. The Transient population varies greatly between the seasons and day of the week.

Employee population is based upon data provided by the New Hampshire and Massachusetts employment bureaus that was extrapolated to 1993. The employee population varies greatly between weekday and weekend and the beach employment varies greatly with the season.

Massachusetts [MATMM]

Traffic control personnel are mobilized upon declaration of an ALERT if beaches are to be closed or at a SITE AREA EMERGENCY otherwise. Massachusetts State Police receive assignments at the State Police Assembly Area at Northern Essex Community College, and local police are assigned from the local EOCs. During 1992 drills prior to the 1992 FEMA graded exercise, Massachusetts State Police representatives estimated the time that would be required to mobilize State Police officers to the TCPs after the order to evacuate. It was estimated that the State Police officers would be in place at the high priority TCPs within two to three hours from the initial order to implement precautionary actions or to evacuate the EPZ communities. Local police would be available sooner.

New Hampshire [NHTMM]

Traffic control personnel are mobilized at the ALERT if the beaches are to be closed or at a SITE AREA EMERGENCY otherwise. They proceed directly to their TCPs and implement their traffic control strategies for beaches being closed or regions evacuated.

The TCPs are manned by local and State police personnel. It is expected that local police would be available in about 90 minutes. Based upon discussions with State Police personnel, troopers would be available as follows:

4 troopers in 0 - 15 minutes,
3 troopers in 15 - 60 minutes,
6 troopers in 60 - 120 minutes,
100 troopers in 120 - 300 minutes;

2.2.7 Roadway Capacity [ETES Section 3]

Road capacity is measured in vehicles per hour per lane (VPHL). For calculation of the ETEs, the capacity of evacuation routes is reduced to 85% of normal capacity whenever congested conditions prevail. For at-grade (non-limited access) roadways, this capacity reduction represents the potential inefficient traffic operations due to a variety of factors which may prevail under emergency

TABLE 2-1

EVACUATION TIME ESTIMATES

Estimated times (hrs./min.) to evacuate from within the associated area about the Seabrook Station after the order to evacuate from the indicated Regions, for the individual evacuation scenarios.

Scenario	Region													
	1	5	6	7	8	9	10	11	12	13	14	15	16	17
1	7:05	6:15	6:15	5:45	5:45	5:45	6:00	6:40	6:15	6:30	5:45	6:15	6:35	7:05
2	9:10	8:10	8:10	7:15	7:15	7:00	7:45	8:30	8:00	8:15	7:15	8:10	8:30	9:10
3	7:05	5:00	5:00	4:15	4:30	4:15	5:00	7:05	5:30	5:35	4:30	5:00	5:35	7:05
4	9:10	6:15	6:15	5:35	6:10	5:35	6:05	9:05	7:05	7:05	6:10	6:15	7:15	9:10
5	5:55	4:05	4:05	4:00	4:00	3:55		5:55	4:25	4:30	4:00	4:05	5:05	5:55
6	7:35	5:20	5:20	4:00	4:25	3:55		7:35	5:45	5:45	4:25	5:20	6:40	7:35
7	8:00	6:00	6:00	5:10	5:55	5:05		8:00	5:55	6:20	5:55	6:00	7:15	8:00
8	4:30	3:55	3:55	3:40	3:40	3:35		4:30	3:55	3:55	3:40	3:55	3:55	4:30
9	6:00	3:55	3:55	3:40	3:40	3:55		6:00	4:35	4:55	3:40	3:55	5:05	6:00
10	6:30	5:05	4:55	4:45	5:05	4:35		6:30	5:00	5:10	5:05	4:55	5:30	6:30

TABLE 2-4
1993 EPZ POPULATION SUMMARY

MASSACHUSETTS TOWN		SCENARIOS 1, 2	3, 4	5, 6, 7	8, 9, 10
AMESBURY	T.P.	1,651	1,342	48	48
P.P. 15,349	E.P.	1,288	3,219	3,219	805
MERRIMAC	T.P.	226	185	108	108
P.P. 5,365	E.P.	884	2,209	2,209	552
NEWBURY	T.P.	3,756	2,818	0	0
P.P. 5,988	E.P.	1,158	1,652	1,836	459
NEWBURYPORT	T.P.	3,756	2,909	67	67
P.P. 16,832	E.P.	755	1,909	1,909	473
SALISBURY	T.P.	18,809	14,110	442	442
P.P. 7,870	E.P.	786	1,121	1,244	312
WEST NEWBURY	T.P.	432	324	60	60
P.P. 3,629	E.P.	324	811	811	203
MASSACHUSETTS TOTAL P.P.+ T.P.+ E.P. =		88,868	87,642	66,986	58,562

NEW HAMPSHIRE TOWN		SCENARIOS 1, 2	3, 4	5, 6, 7	8, 9, 10
BRENTWOOD	T.P.	0	0	0	0
P.P. 2,721	E.P.	23	23	23	23
EAST KINGSTON	T.P.	295	218	0	0
P.P. 1,438	E.P.	55	55	55	55
EXETER	T.P.	806	610	134	134
P.P. 12,565	E.P.	380	954	954	239
GREENLAND	T.P.	125	86	0	0
P.P. 2,934	E.P.	667	1,665	1,665	414
HAMPTON	T.P.	4,464	3,348	521	521
P.P. 11,405	E.P.	882	1,261	1,682	420
HAMPTON BEACH	T.P.	18,134*	13,601*	425*	425*
P.P. 1,134	* Transient population includes employees				
HAMPTON FALLS	T.P.	466	350	0	0
P.P. 1,562	E.P.	115	164	164	41
KENSINGTON	T.P.	178	134	38	38
P.P. 1,697	E.P.	44	43	44	44

TABLE 2-4
1993 EPZ POPULATION SUMMARY

NEW HAMPSHIRE TOWN (cont.)		SCENARIOS 1, 2	3, 4	5, 6, 7	8, 9, 10
KINGSTON	T.P.	0	0	0	0
P.P. 5,946	E.P.	109	271	271	68
NEW CASTLE	T.P.	127	96	31	31
P.P. 821	E.P.	0	0	0	0
NEWFIELDS	T.P.	62	50	0	0
P.P. 915	E.P.	84	210	210	52
NEWTON	T.P.	58	43	0	0
P.P. 3,587	E.P.	41	102	102	102
NORTH HAMPTON	T.P.	1,452	1,094	214	214
P.P. 3,682	E.P.	291	415	415	214
PORTSMOUTH	T.P.	2,400	1,800	600	600
P.P. 22,260	E.P.	3090	7,721	7,721	1,931
RYE	T.P.	4,471	3,355	0	0
P.P. 4,596	E.P.	0	0	0	0
SEABROOK	T.P.	10,210	8,561	4,013	4,013
P.P. 6,567	E.P.	843	1,241	1,335	342
SOUTH HAMPTON	T.P.	514	379	0	0
P.P. 776	E.P.	49	73	73	19
STRATHAM	T.P.	161	120	67	67
P.P. 5,788	E.P.	242	607	607	152
NEW HAMPSHIRE TOTAL P.P.+ T.P.+ E.P. =		140,389	139,044	111,758	98,199
EPZ TOTAL P.P.+ T.P.+ E.P. =		229,257	226,686	178,744	156,761

DEFINITIONS:

P.P. - Permanent Population - 1993 Projected Population
T.P. - Transient Population
E.P. - Employee Population

SCENARIO SUMMARIES:

1 and 2 - Summer, Weekend and Holidays
3 and 4 - Summer, Midweek
5, 6 and 7 - Off-season, 7 AM - 6 PM Workdays
8,9 and 10 - Off-season, Other times

3.1 PROCEDURE SUMMARY

3.1.1 Purpose

This subsection summarizes how the transit dependent population groups within the Seabrook Station EPZ are evacuated during an emergency. The vehicles used to transport these people are buses and Emergency Medical Service (EMS) vehicles (ambulances and ambulettes).

3.1.2 New Hampshire [ETES Section 11]

Protective actions recommended for all transit dependent populations will be the same as the general population, except that early precautionary evacuation may be recommended for schools. This decision may also differ for individual health care facilities based upon input received from facility managers. In these cases a more detailed evaluation of protective action recommendations is undertaken based upon facility specific sheltering protection factors.

At a SITE AREA EMERGENCY buses and EMS vehicles will travel from their respective originating locations to the State Transportation Staging Area (TSA). The TSA is located at the Pease International Tradeport in Newington. From the State TSA, they will be sent to local TSAs in the communities where they will receive route and facility assignments. The vehicles will be dispatched from the TSAs upon notification of an OTE.

3.1.3 Massachusetts [ETES Section 11]

Protective actions recommended for all transit dependent populations will be the same as the general population, except that early precautionary evacuation may be recommended for schools.

At an ALERT or SITE AREA EMERGENCY buses and EMS vehicles will travel from their respective originating locations to the State Transportation Staging Area (TSA). The Massachusetts TSA is located at Northern Essex Community College in Haverhill. From the State TSA, they will be sent to local TSAs in the communities

where they will receive route and facility assignments. The vehicles will be dispatched from the TSAs upon notification of an OTE.

4.2 STAFFING EXTENSION

4.2.1 Purpose

This subsection discusses means of maintaining resources for a protracted period.

4.2.2 Release/Recall

If the situation has stabilized and it appears that an evacuation recommendation is not immediately forthcoming then personnel may be extended as follows:

- TCP/ACP personnel at field locations should be called back to the Assembly Area where they can be fed and get some rest. At some field positions personnel may be required to stay in the field, such as:

  - High priority TCP/ACP locations
  - ACPs associated with beach closure
  - ACPs associated with shelter implementation

These positions can remain continuously active by rotating personnel to these locations.

It is normally not considered appropriate to feed emergency response workers in the EPZ. If sufficient personnel are available, then emergency workers can be put on a rotation basis with a portion of the workers returning home to return later and relieve those that remained.

* Bus Drivers, EMS personnel and Route Guides may be maintained at either bus yards or staging areas as appropriate. At these locations these personnel can be rotated and or maintained as described above.