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KLD

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Evacuation Time Estimates
And
Traffic Management Plan Update

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November 1998 Rev. 5

KLD Report TR-203A-5

FOREWORD

The Evacuation Time Estimate and Traffic Management Plan for Pilgrim Station presented herein is a document which has undergone extensive reviews since August, 1987 when a draft report was issued. The contents of the report were updated to reflect comments received from a variety of sources; State and local agencies, town RERP committees, and the general public. The contents of the RERPs and Implementation Procedures, developed to date, were used to update the planning assumptions utilized. The Evacuation Time Estimate and Traffic Management Plan remains a "living document" to be revised as planning assumptions change, new information becomes available, or as population and development patterns within the area change over time.

This document references the use of three reception centers; Bridgewater State College, Taunton High School, and Braintree High School. It is important to note that the number and location of reception centers does not effect the ETE as long as the reception centers are located a sufficient distance from the Emergency Planning Zone boundary.

The 1990 Census Data used herein is a base from which some population projections are made. Population projections are based not only on Census Data but upon data supplied by Massachusetts government agencies and various town departments.

The traffic management plans are designed to move evacuees along the recommended evacuation routes and to manage traffic operations under high volume traffic conditions when they occur. The recommended evacuation routes were designed to move evacuees out of an area at risk in a safe and efficient manner.

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1. INTRODUCTION

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

The Evacuation Time Estimate and Traffic Management Plan presented herein is not based on the use of any specific number of reception centers. It should be understood that the number of reception centers does not affect evacuation time estimates as long as the reception centers are located a sufficient distance from the Emergency Planning Zone (EPZ) boundary. The reception centers cited in this document are located more than ten miles from the EPZ boundary.

In the performance of this effort, all available prior documentation relevant to evacuation planning issues was reviewed. In addition, work products developed by other consultants 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 Pilgrim 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.

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 Review of existing reports describing past evacuation studies.

   - o Conducted several field surveys of the EPZ highway system and of beach-area traffic conditions.

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

- Retained a subcontractor to conduct a stratified random-sample telephone survey of the populace within the Pilgrim EPZ.

- Obtained demographic data from State Planning offices.

- Received, and analyzed, aerial photographs of the coastal areas within the Pilgrim EPZ. These photographs were taken on weekends during the Summer, of 1986. Additional Aerial photography was performed during ideal weather conditions on July 5, 1987.

2. After reviewing and analyzing this information, the task of preparing the preliminary input stream for the IDYNEV model was undertaken. Individual activities included:

   - Estimating the traffic demand based on the available information derived from Census data, from prior studies, data provided by local and State agencies and from the telephone survey.

   - Employing the procedures specified in the 1994 Highway Capacity Manual (HCM) and the data acquired during the field survey, to estimate the capacities of all highway segments comprising the evacuation routes.

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

   - Preparing the input stream for the IDYNEV System.

   - Executing 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. A total of ten 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. Partitioned the EPZ into Emergency Response Planning Areas (Subareas), then defined a total of 22 "Regions", where each region consists of a grouping of not necessarily contiguous Subareas. Each region either approximates a circular area or a "keyhole" quadrant within the EPZ, as required by NUREG 0654.

8. Identified Host Communities associated with each community within the EPZ and developed traffic routing patterns for evacuating vehicles.

9. Conducted a 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 8, above) was used as the basis for discussion. All local law enforcement officers contributed valuable recommendations and all recommendations were integrated into the plan.

10. Using the traffic management policies derived in step 9, a complete set of ETE was computed. This set consists of over 220 distinct cases; each case corresponds to the evacuation of a specified region for a specified evacuation scenario. A total of 22 regions and 10 scenarios (see step 4) were considered.

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

12. Identified Access Control Posts (ACP) at locations along the periphery of the EPZ and developed traffic management control to be applied there. Discussed the need for highway signing at these locations.

13. Identified a diversion route circumventing the EPZ.

1.2 Description of the Emergency Planning Zone (EPZ)

The Pilgrim Station site is located on the Atlantic coast in the Town of Plymouth, Massachusetts approximately 40 miles south of Boston. The Emergency Planning Zone (EPZ) for the plume exposure pathway includes all, or part, of 5 communities: Plymouth, Kingston, Duxbury, Marshfield, south of Careswell Street and Carver, east of Route 58.

Figure 1-1 displays the general site area including the location of Pilgrim Station, the EPZ boundary, all communities within the EPZ, and the major highways in the area.

The coastal area extending north from the Plymouth-Bourne Town Line to Marshfield is a popular summer tourist attraction. In addition to the beaches, the town of Plymouth draws significant numbers of visitors to its many historic sites. There are many ponds and streams and cranberry bogs in the area west of the coast. This area also is home to Myles Standish State Forest, a major recreational facility.

The highway system is comprised primarily of two-lane two-way rural roads. The major north-south state routes through the EPZ are Route 3A along the coast; Route 3, a four-lane, limited access highway; and Route 58, in Carver. Route 3 serves as one of the primary access roads to the Cape Cod area from the north; the other major access route to Cape Cod is Interstate 495/State Route 25 which lies outside the EPZ. Major east-west routes in the area are Route 139 in Marshfield, Route 14 in Duxbury, Routes 106 and 27 in Kingston, US Route 44 in Plymouth, and US Route 6 (Cranberry Highway) which lies south of the EPZ in Bourne.

This area enjoys a variable climate with temperature ranging from below zero (F) in the winter to as high as 102 degrees (F) in the summer. Average annual rainfall is about 47 inches while snowfall averages about 37 inches. The monthly variations in temperature and precipitation in Plymouth, Massachusetts 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.

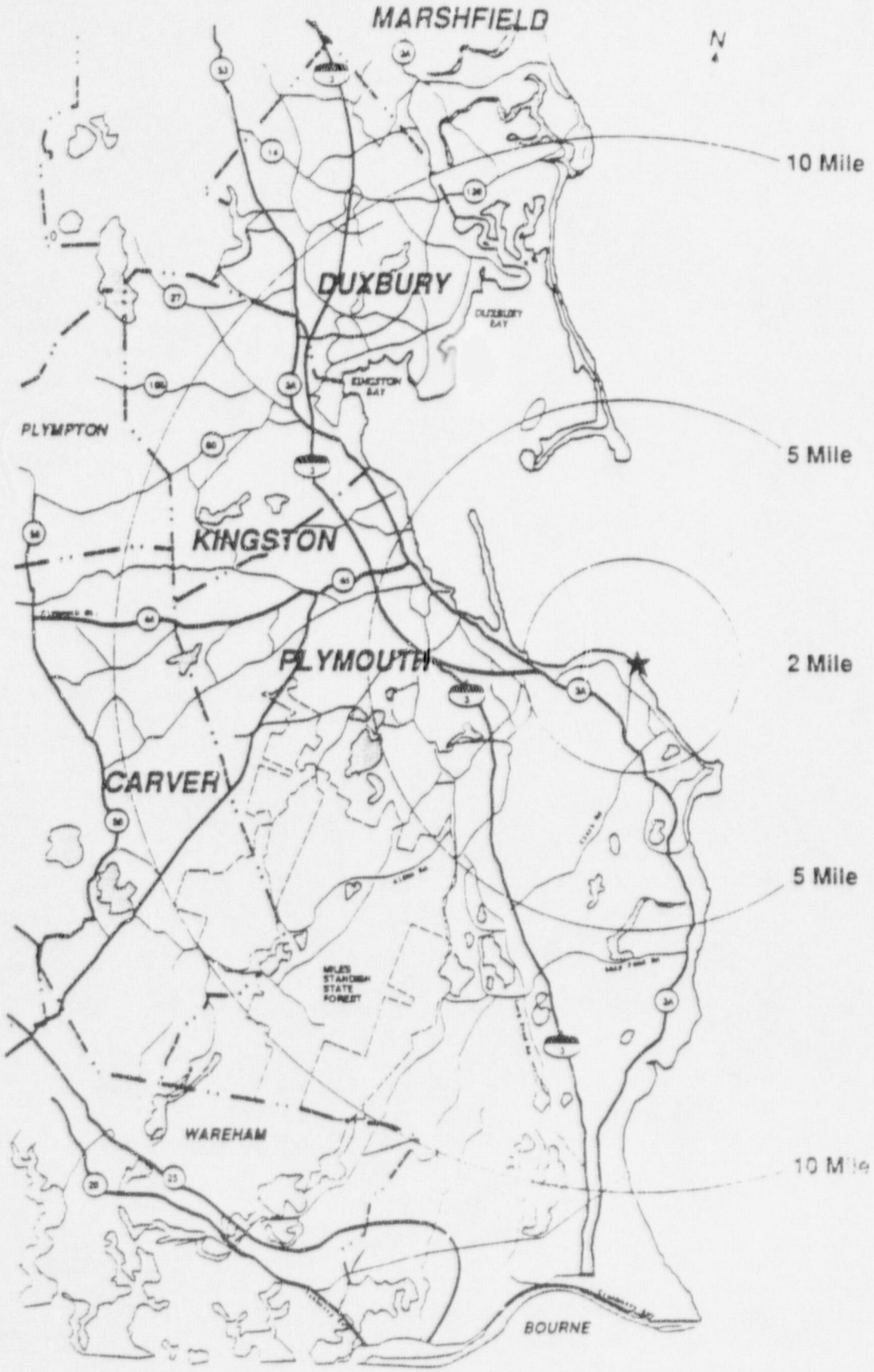

Figure 1-1. General Site Area

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Table 1-1. Climatic Conditions in Plymouth, MA: Year of Record to 1993

	Temperature (°F)			Precipitation (in.)	
	Daily Mean	Daily Maximum	Daily Minimum	Normal Monthly Rain	Normal Monthly Snow
January	28.6	35.7	21.6	3.59	12.0
February	30.3	37.5	23.0	3.62	11.3
March	38.6	45.8	31.3	3.69	7.9
April	48.1	55.9	40.2	3.60	0.9
May	58.2	66.6	49.8	3.25	-
June	67.7	76.3	59.1	3.09	-
July	73.5	81.8	65.1	2.84	-
August	71.9	79.8	64.0	3.24	-
September	64.9	72.8	56.8	3.06	-
October	54.8	62.7	46.9	3.30	-
November	45.3	52.2	38.3	4.22	1.3
December	33.6	40.4	26.5	4.01	7.5

Source: Statistical Abstract of the United States, 1995, US Department of Commerce. Note: Data is given for reporting stations in Boston.

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	Posted speed
Pavement width	Actual free speed
Shoulder type & width	Abutting land use
Intersection configuration	Control devices
Lane channelization	Interchange geometries
Unusual characteristics:	Geometries: curves, grades

Narrow bridges, sharp curves, poor pavement, flood warning signs, inadequate delineations, etc.

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

Telephone Survey

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.

On-Site and Telephone Interviews

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, school superintendents, harbor masters emergency planners, public work supervisors, town managers, elected

officials, chamber of commerce personnel, State planning and highway personnel, regional planning commission personnel, State parks personnel.

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. Ground-based counts of parking capacity were also collected.

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 1994 Highway Capacity Manual (HCM). 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 1-2, with the general directions of evacuating traffic indicated thereon.

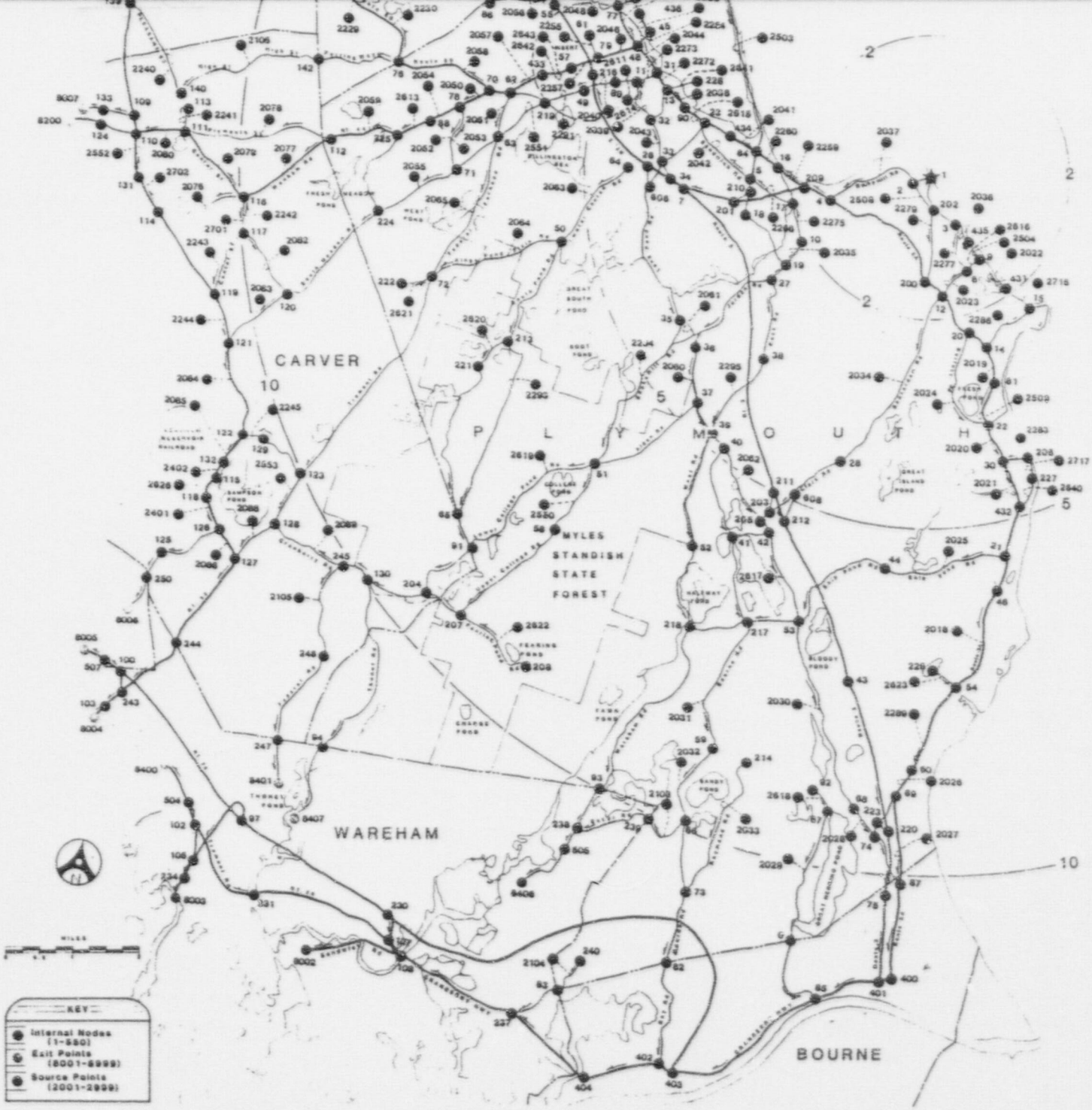
The input stream for the IDYNEV system was then created, checked, and debugged.

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:

- An equilibrium traffic assignment model (for details, see Appendix B)
- A macroscopic traffic simulation model (for details, see Appendix C)
- An intersection capacity model (for details, see Highway Research Record No. 772, Transportation Research Board, 1980, papers by Lieberman and McShane and by Lieberman).

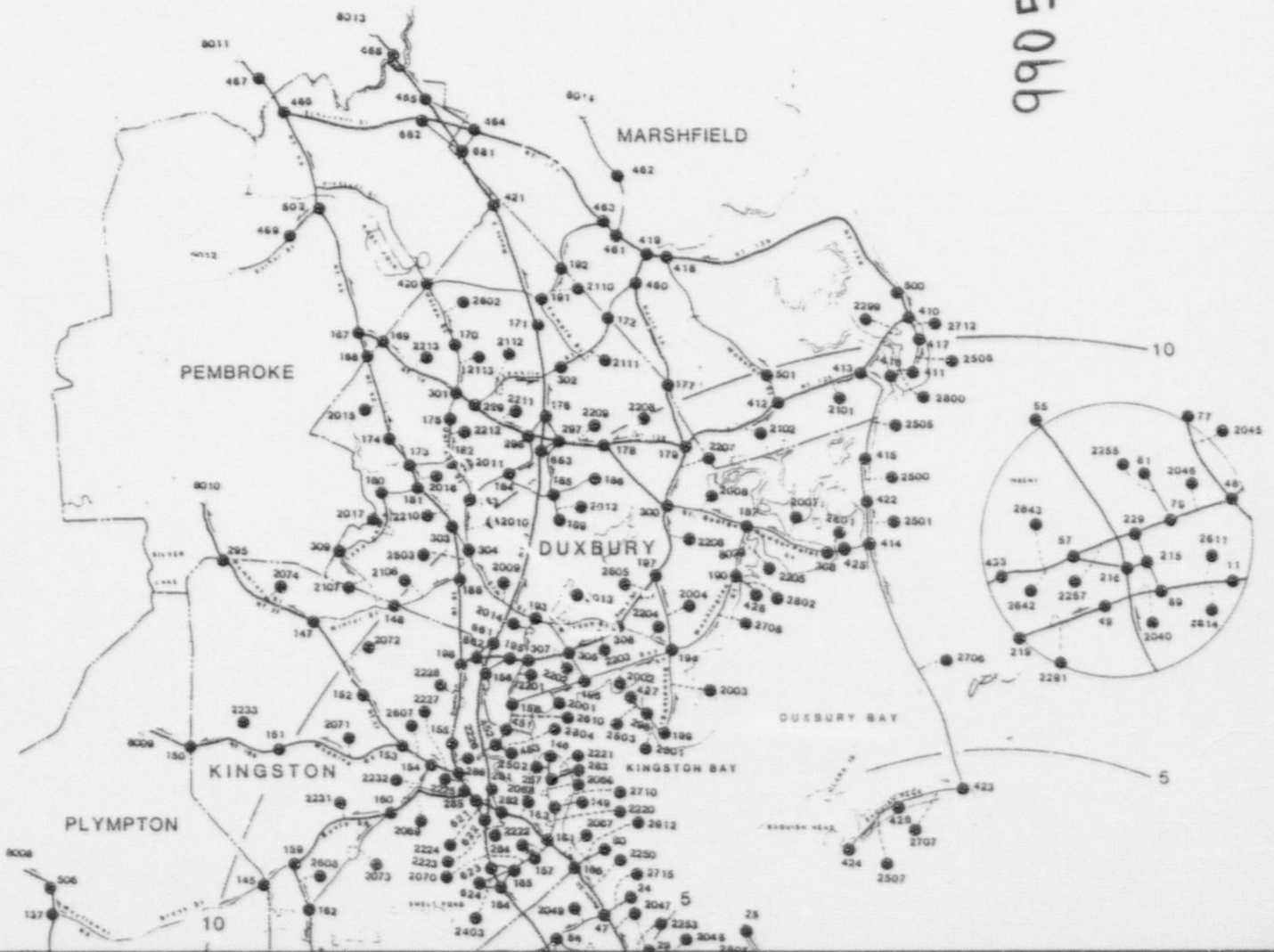


PILGRIM NUCLEAR POWER STATION EMERGENCY PLANNING ZONE

APERTURE CARD
Also Available on Aperture Card

9905190222-1

Figure 1-2. Evacuation Network Schematic



The procedure for applying IDYNEV within the framework of developing an update to the Pilgrim 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:

- 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 Pilgrim Station to the extent practicable
  - disperse traffic demand so as to avoid focusing demand on a limited number of highways
- Satisfy, to the extent possible under emergency conditions, perceived "best" paths out of the EPZ
- Move traffic in outbound directions which are generally radial, relative to the location of Pilgrim 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, consistent with the need for outbound routing patterns described above. 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.

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 tourist and beach area traffic. This was necessary since the majority of this traffic consists of transients, many of whom enter the EPZ from locations outside.

As a result, we relied on empirical observation of the number of vehicles which can physically be accommodated within the beach area and discussions with the proprietors of tourist attractions yielded similar information. This is a valid approach since discussions with public officials confirmed that, with few exceptions, people at these facilities have access to a vehicle. Thus, the evacuation of people from the beach and tourist areas will be primarily reflected in the number of evacuating private vehicles.

By accurately estimating the number of vehicles at these areas, we have satisfied the input requirements for an evacuation plan which addresses these areas. Estimates of population in these areas can be based on accurate estimates of per-vehicle person occupancy. Thus, for these areas, 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 or some other place away from the motel. 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 a directive 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 by the activation of sirens, to the time that the evacuation trip begins, the evacuees may be performing a sequence of preliminary activities, depending on time-of-day and other scenario considerations:

- Commuters will prepare to leave work and secure their places of business, if necessary.
- Commuters will travel home from work.
- 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 directive 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 notification of the emergency 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 most of these distributions; Figure 2-1 displays these distributions.

For each scenario, a series of calculations is performed, using the distributions of Figure 2-1, 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.

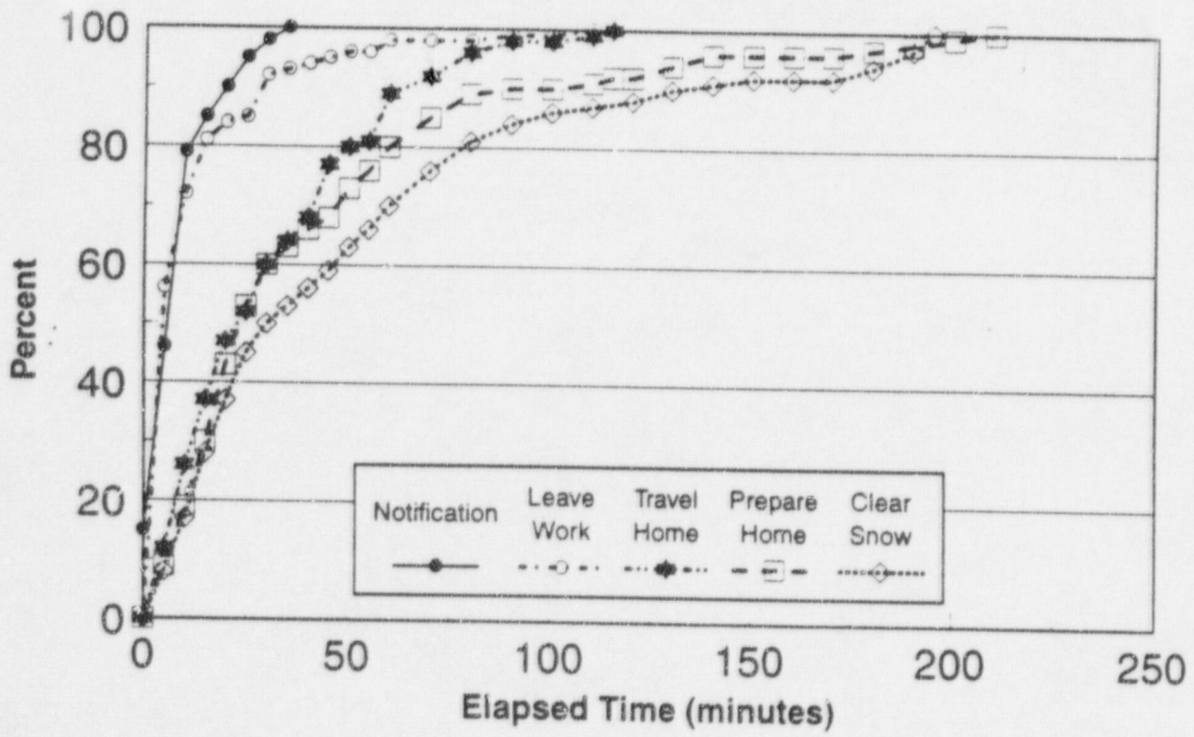
On the other hand, when congestion is absent, or limited in spatial and/or temporal extent, then travel time can be small relative to trip generation time. In these cases, the ETE will directly reflect the trip generation time (i.e. ETE = Trip Generation time + [small] travel time).

Section 4 of this report presents a complete discussion of Trip Generation.

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

- Permanent residents - people who are year round residents of the EPZ.
- Seasonal residents and transients - people who reside in the EPZ for a portion of the year, generally, the peak summer season and people who reside outside of the EPZ who enter the area for a specific purpose (shopping, recreation) and then leave the area.
- Employees - people who reside outside of the EPZ and commute to business within the EPZ on a daily basis.

Figure 2-1. Trip Generation Time Distributions For The General Population



Estimates of the population and number of vehicles to be expected for each of the population groups will now be presented. Estimates will be presented by town, and by polar coordinate representation (population rose).

It is important to note that the population roses displayed herein are for presentation purposes only. The roses are not part of the data base used to estimate evacuation times. Evacuation time estimates are based upon a considerably more detailed representation of the spatial distribution of population. The more detailed representation is seen in Figure 1-2. Node numbers labeled 2000 through 2999 are centroids which represent areas within the EPZ where population groups originate the evacuation trip.

Permanent Residents

An accurate estimate of evacuation time must, of necessity, be based upon an estimate of the current population of the EPZ.

The second step of the estimation process is the determination of the average number of people who may be expected to occupy evacuating vehicles. Exhibit 2-1 presents the methodology used to determine average vehicle occupancy. Supporting data, presented in Figures 2-2 and 2-3, were obtained from the telephone survey (Appendix G).

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.

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

1. Assume 60 percent of the households vacation over the summer, for a two-week period.

EXHIBIT 2-1

Estimation of Persons per Vehicle for the Evacuation of Permanent Residents

Case 1: Assume

(a) All households with 4 or fewer persons will ride in one car, if a car is available.

(b) Households with 5 or more persons will use 2 cars, if 2 cars are available. If not, they will use 1 car, if available.

Household size (Persons)	Number of Households (1)	Number of Vehicles Used For Evacuation (2)	Number of Evacuees using Private Vehicles (3)
1	66	(0.89)(66)(1) = 59	59
2	176	(0.99)(176)(1) = 174	348
3	112	(1.00)(112)(1) = 112	336
4	123	(1.00)(123)(1) = 123	492
5	81	(0.10)(81)(1) + (0.89)(81)(2) = 152	405
6+	41	(0.07)(41)(1) + (0.93)(41)(2) = 79	271 (4)
	599	699	1911

Average vehicle occupancy: 1911/699 = 2.73

(1) Ref. telephone Survey

(2) To calculate the number of vehicles used for each group of households:

a) Multiply the proportion of households (from Figure 2-3) within the group that will use one vehicle, by the number of households in that group.
b) Multiply the proportion of households (from Figure 2-3) within the group that will use two vehicles, by the number of households in that group and by the number of cars used (2).
c) Add the values obtained in a) and b).

(3) Product of Household Size and Number of Households with one or more vehicles available.

(4) Based on average household size of 6.6 persons.

EXHIBIT 2-1 (conc.)

Estimation of Persons per Vehicle for the Evacuation of Permanent Residents

Case 2: Assume

(a) All households with 3 or fewer people will use 1 car, if available.

(b) Half of all households with 4 persons will take 2 cars, if available; the balance will take 1 car.

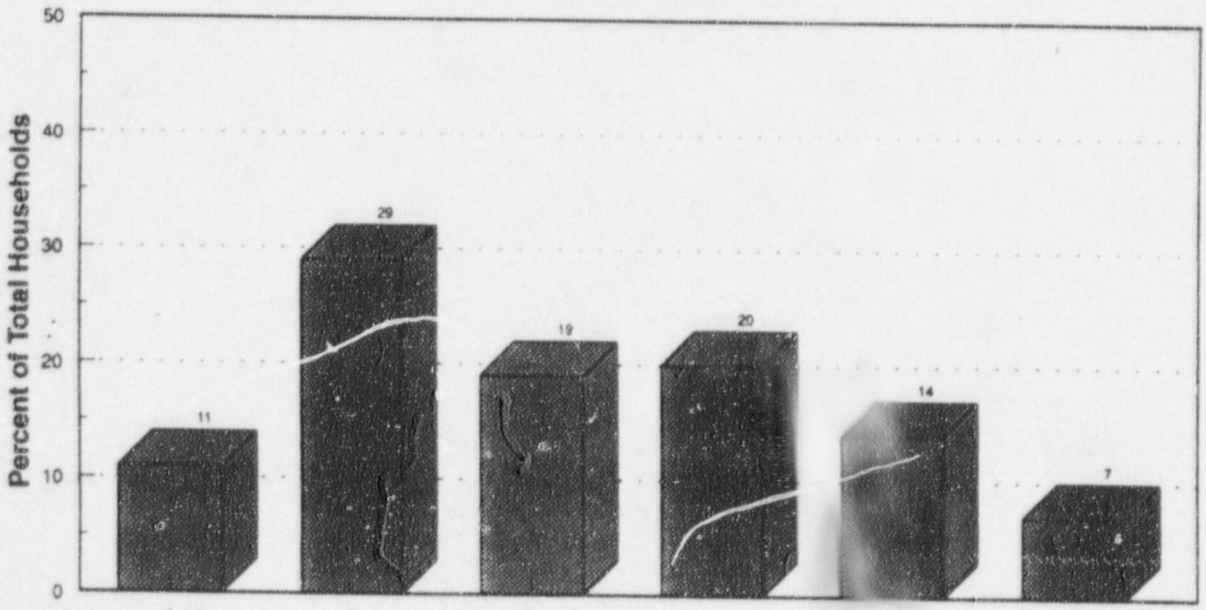
(c) Households with 5 or more persons will use 2 cars, if 2 cars are available. If not, they will use 1 car, if available.

Household size (Persons)	Number of Households (1)	Number of Vehicles Used For Evacuation (2)		Number of Evacuees using Private Vehicles (3)	
1	66	(0.89)(66)(1)	=	59	59
2	176	(0.99)(176)(1)	=	174	348
3	112	(1.00)(112)(1)	=	112	336
4	123	(0.13)(123)(1) +			
		(0.87)(123)(0.5)(1) +			
		(0.87)(123)(0.5)(2)	=	176	492
5	81	(0.10)(81)(1) +			
		(0.89)(81)(2)	=	152	405
6+	41	(0.07)(41)(1) +			
		(0.93)(41)(2)	=	79	271
	599			752	1911

Average vehicle occupancy: 1911/752 = 2.54

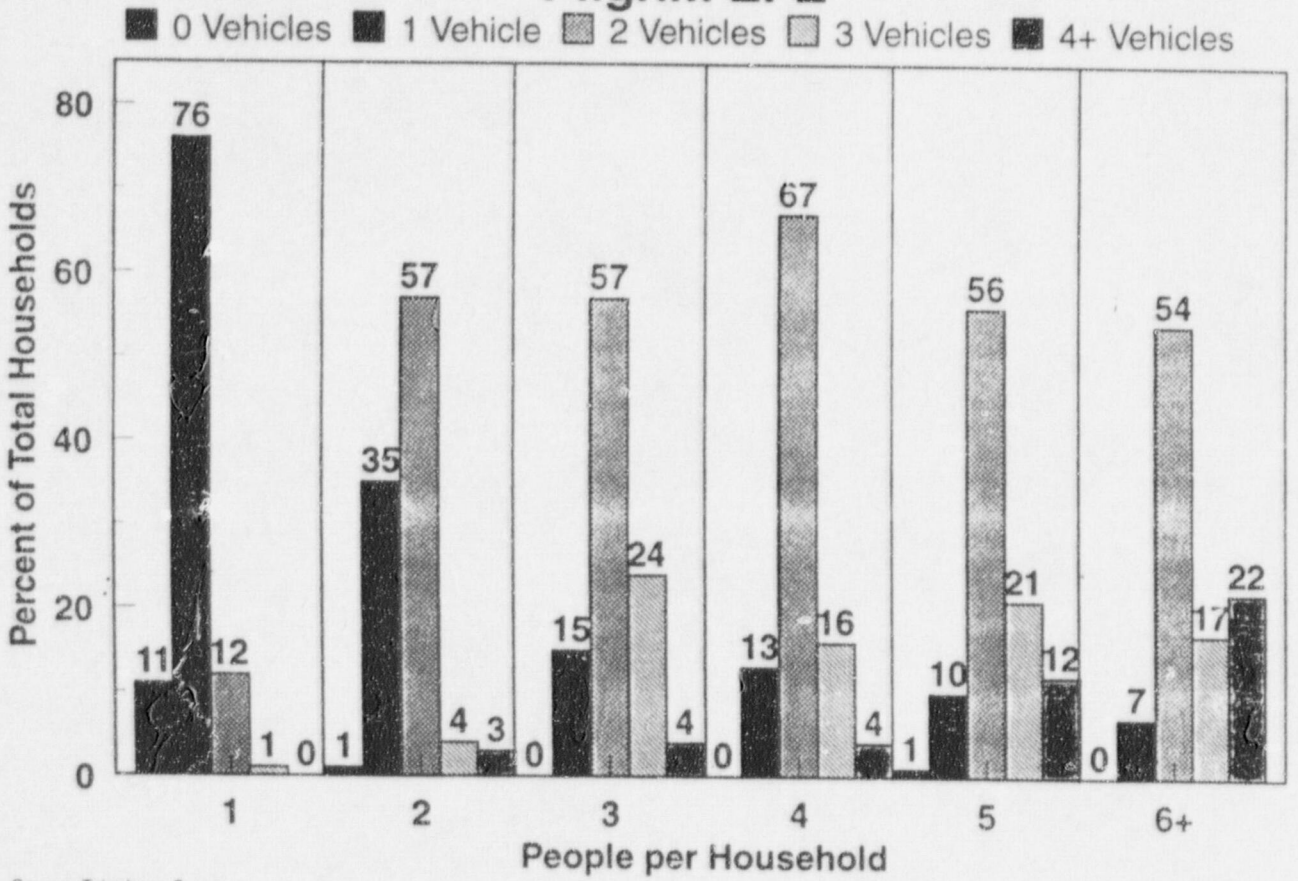
For planning purposes, we will adopt a somewhat conservative estimate of 2.6 persons/car. This yields an average of (1911/2.6)/599 = 1.23 evacuating vehicles per household.

Figure 2-2. Household Size Within Pilgrim EPZ



Source: Telephone Survey
Avg. Household Size = 3.21 Persons

Figure 2-3. Auto Ownership Within The Pilgrim EPZ



Source: Telephone Survey

Examples: The chart indicates that 11 percent of households with one member do not have autos available. Whereas 76 percent of one person households have one car available.

Similarly, all four person households have 1 or more autos available. 67 percent of four person households have 2 autos available.

Table 2-1. Estimated Permanent Resident Population and Number of Evacuating Vehicles

Town	1990 Census Population	1998 Town-Estimated Population	Growth Rate(4)	1999 Population Estimate	1999 No. of Evacuating Vehicles
Plymouth	45,608	49,700	1.08%	50,262(1)	19,332
Kingston	9,045	10,967	2.44%	11,235	4,322
Carver(2)	6,142	6,380	0.48%	6,411	2,466
Duxbury	14,168	14,700	0.46%	14,768	5,680
Marshfield (3)	1,722	1,841	0.84%	1,857	715
			Totals	**84,533**	**32,515**

Notes: (1) An additional 25 people residing on Saquish Neck are included in the Plymouth population

(2) It is estimated that 58 percent of the population of Carver resides within the EPZ.

(3) It is estimated that 8 percent of the population of Marshfield resides within the EPZ.

(4) Growth rates were computed on the basis of 1990 census estimates and 1998 local town population estimates.

2. Assume these vacations, in aggregate, are uniformly dispersed over 10 weeks, i.e. 12 percent of the population is on vacation during each two-week interval.

3. Assume half of these vacationers leave the area.

On this basis, the resident population would be reduced by 6 percent in the summer and by a lesser amount in the off-season. The same rationale will lead to the conclusion that the number of employees who work within the EPZ on a full-time (i.e. non-seasonal) basis would also be reduced by that percentage over the summer. This six percent reduction translates into about 1,876 vehicles. On the other hand, it is also likely that there is some influx of vacationers to this area who stay at the homes of friends and relatives.

Since we do not have any "hard" data at this time, we have decided to make no adjustment in our demand estimates for permanent residents for the summer scenarios which are studied.

Figures 2-4 and 2-5 present estimates of the permanent resident population and evacuating vehicles in the form of "roses". The data includes those portions of the EPZ which extend beyond 10 miles.

Seasonal Residents and Transients

This population group is comprised of the following components: summer residents, tourists at beaches, parks, historical sites and recreation areas, occupants of hotels and motels, campers, and day-trippers. Each of these sources of population will be discussed here. Detailed supporting information is presented in Appendix E.

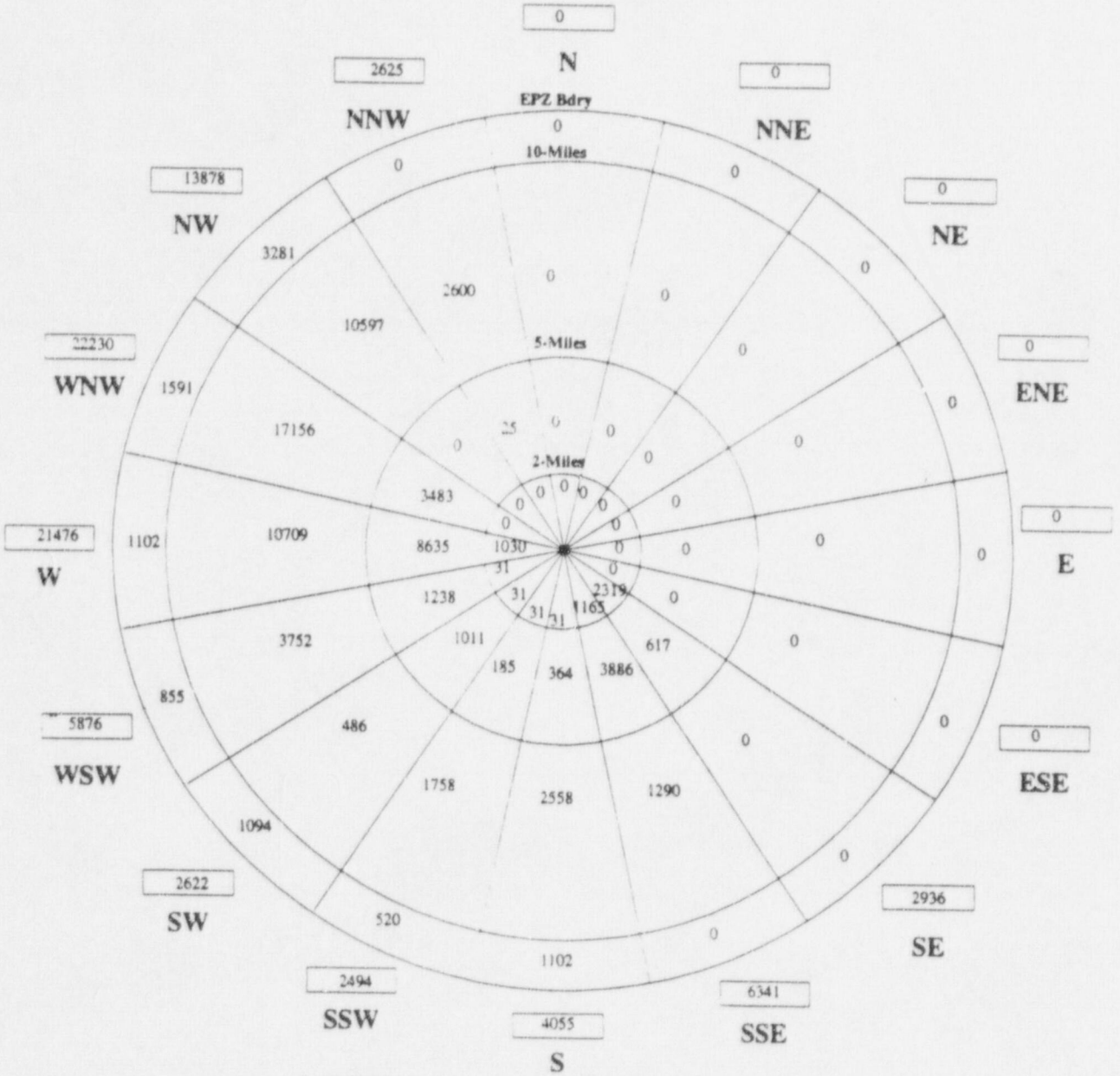
Summer Residents

Table 2-2 presents estimates of the number of summer residents on a town-by-town basis. Where specific estimates of the number of summer homes were not available (Kingston and Carver), the ratio of summer homes to permanent residences in Duxbury was applied to the number of permanent residences in these two towns in order to develop estimates of the number of summer residences there.

Tourists at Beaches, Parks and Historical Sites

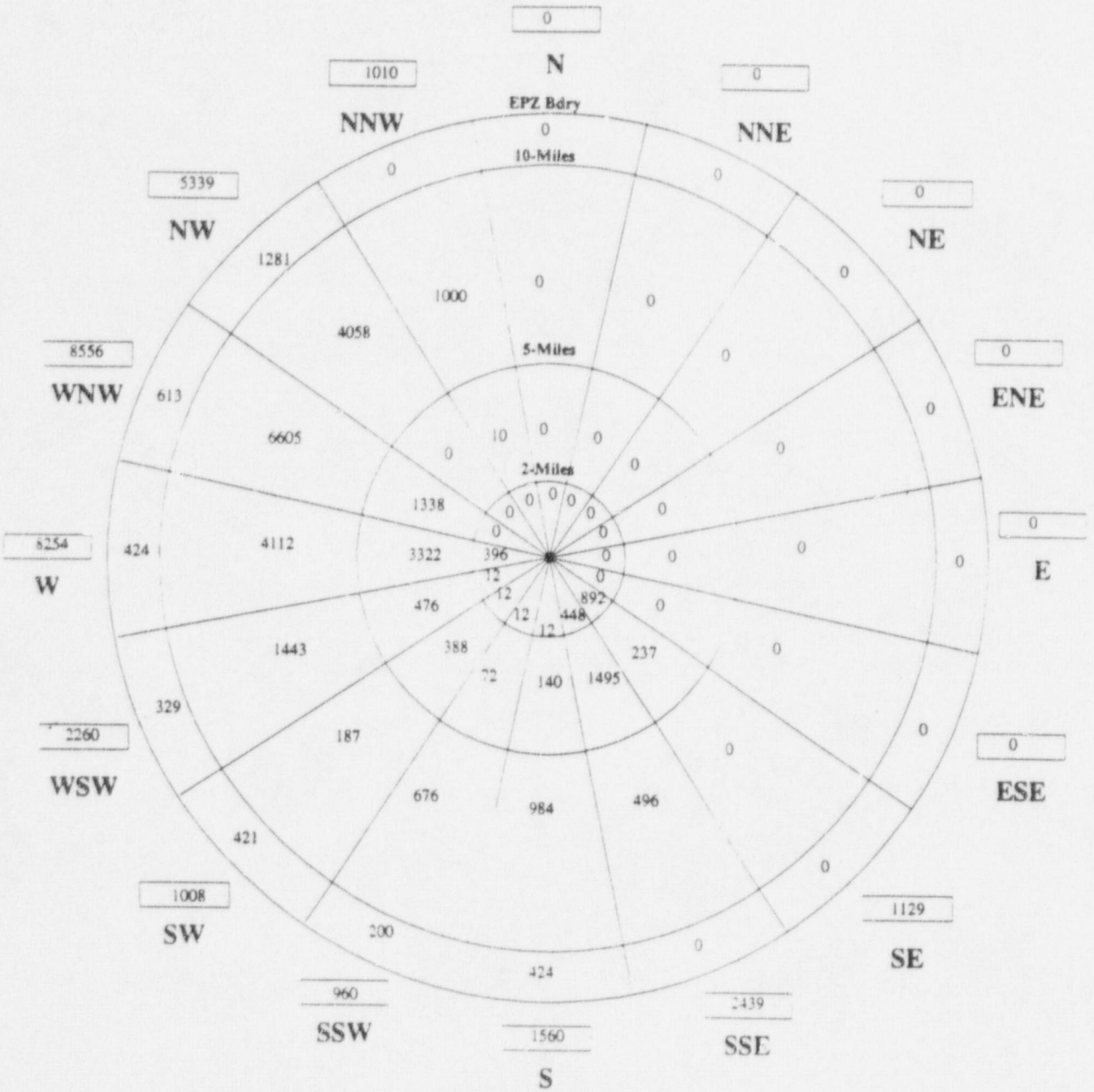
Table 2-3 presents a summary of population for beaches and ponds. The source data for developing these estimates are:

- Aerial photographs of beach areas during summer, 1986 and 1987



Population Totals			
Ring	Ring Population	Total	Cumulative Population
0-2 Mi.	4638	0-2 Mi.	4638
2-5 Mi.	19444	0-5 Mi.	24082
5-10 Mi.	50906	0-10 Mi.	74988
10-EPZ	9545	0-EPZ	84533

Figure 2-4. Permanent Residents



32515

Total Segment Population 0 to EPZ Boundary

Vehicle Totals

Ring	Ring Population	Total	Cumulative Population
0-2 Mi.	1784	0-2 Mi.	1784
2-5 Mi.	7478	0-5 Mi.	9262
5-10 Mi.	19561	0-10 Mi.	28823
10-EPZ	3692	0-EPZ	32515

Figure 2-5. Permanent Resident Vehicles

Table 2-2. Estimated Population - Summer Residents

Town	Estimated Number of Summer Homes (1)	Average Vehs. Per (2) Summer Home	Evacuating Vehicles	Vehicle Occupancy (Per.)(H.H.)	No. of People
Plymouth	530	2.2	1166	2.6	3032
Kingston	70	2.2	154	2.6	400
Carver	104	2.2	229	2.6	595
Duxbury	216	2.2	475	2.6	1235
Marshfield	561	2.2	1234	2.6	3208
TOTAL	1481		3258		8470

Notes: (1) Source material was obtained through discussions with local utility offices (Water Authority) or through discussions with local home-delivery newspapers (see Appendix E).

(2) It is estimated that the average number of evacuating vehicles per household is 1.23 (see Exhibit 2-1). The telephone survey (see Appendix G) yields an estimate of 1.96 vehicles per household for communities within the EPZ. Thus, the proportion of vehicles used in an evacuation is 1.23/1.96 = 0.63. Aerial photographs revealed that on average there are 2.7 vehicles per summer home within the EPZ. Hence, the estimated number of evacuating vehicles per summer home is 0.63 x 2.7 = 1.7. However, based upon discussion with Town Building Inspectors or Zoning Departments in 1989, multiple households (group rentals) are permitted. Since it is less likely that members of different households will unify, an estimate of 2.2 evacuating vehicles per summer home is more realistic.

(3) Summer resident population increased by less than 1 percent between 1989 and 1990, hence no changes were made.

Table 2-3. Estimated Population - Beaches and Ponds

Beach	Estimated No. of Vehicles	Source of Data	Vehicle Occupancy (Persons/veh.)	No. of People
Whitehorse Beach	940	Aerial Photos	2.54	2387
Morton Park	200	Non-Resident Ticket Sales	3	600
Plymouth Beach	772	Aerial Photos	2.54	1960
Saquish Neck	257	Aerial Photos	2.54	654
Priscilla Beach	169	Aerial Photos	2.54	430
Manomet Beach	258	Aerial Photos	2.54	655
Gray's Beach	41	Aerial Photos	2.54	103
Sampson Pond	120	Carver Recreation Comm.	2.5	300
John's Pond	120	Carver Recreation Comm.	2.5	300
Duxbury Beach	1804	Aerial Photos	2.54	4583
Green Harbor	1027	Aerial Photos	2.54	2609
Brant Rock	477	Aerial Photos	2.54	1211
TOTALS	6185			15792

Notes: (1) Aerial Photography was performed on July 5, 1987 under ideal beach weather conditions.

(2) Population estimates derived from aerial photographs include EPZ residents at the beach.

- Discussions with town recreation supervisors on the issuance of annual beach non-resident permits.

- Vehicular occupancy was observed to be on the order of 2.54 persons per vehicle. However, where discussions with local officials yielded other values of vehicle occupancy, these values were used for the specific site.

Beach and pond population estimates are based, for the most part, on counts taken from aerial photographs. Consequently, the numbers of people seen include EPZ residents at the beach. Strictly speaking, these persons are already included in the permanent resident population group. It was decided to accept the double counting of these people for evacuation simulation in order to properly replicate the traffic conditions on beach access roads. However, transient population "roses" reflect only day-trippers in the beach population.

During the July 4, 1988 holiday weekend, a survey was conducted on beaches within the EPZ. The purpose of this effort was to ascertain the point of origin, and transportation modes of people on the beach. The survey was conducted on the approach to the beach areas; people were questioned as they entered the beach.

Results of the survey are presented in Exhibit 2-2. Several conclusions may be drawn from this data:

- The majority of people surveyed are either residents of EPZ communities, or are staying overnight within the local area. The percentage of day trippers range from about 30% of the people surveyed at Duxbury to 8% of the people surveyed at Plymouth Beach.

- People who stay overnight in the local area do so primarily in the same community as is the beach.

- The primary mode of transportation to the beach is by car. In general, less than 3% of the people surveyed indicated they were "dropped off" at the beach. Significantly, where the beach areas are close to permanent or summer residences (Green Harbor, Brant Rock, Whitehorse, Prisilla, and Manomet Beaches), a significant fraction of the people surveyed indicates they walked to the beach.

- Vehicular occupancy ranged from 2.26 to 3.31 persons per vehicle with an overall average of 3.06. Vehicle occupancy was found to be somewhat higher in 1988 than in 1987 (2.54 persons per vehicle).

Exhibit 2-2: Results of Beach Utilization Survey
Beach: Green Harbor and Brant Rock

Q1: In what town and state do you live?

Responses:	Plymouth	Kingston	Carver	Duxburry	Marshfield	Within EPZ	Other				No Answer
							Mass	US	Foreign	Total	
number	1	0	0	1	30	32	36	7	1	76	0
percent	1.3%	0.0%	0.0%	1.3%	39.5%	42.1%	47.4%	9.2%	1.3%		

Q2: Are you staying overnight locally?
(Only responses from non-EPZ residents are included)

Responses:	Yes	No	Total
number	28	16	44
percent	63.6%	36.4%	

Q2a: If so, In what town?

Responses:	Plymouth	Kingston	Carver	Duxbury	Marshfield	Within EPZ	Other	Total
number	0	0	0	0	25	25	2	27
percent	0.0%	0.0%	0.0%	0.0%	92.6%	92.6%	7.4%	

Q2b: Are you staying at a:
(Only responses from non EPZ residents staying overnight within the EPZ are included)

Responses:	Summer Home	Campsite	Hotel/Motel *(1)	Other	Total
number	11	0	0	14	25
percent	44.0%	0.0%	0.0%	56.0%	

Q3: How did you get here?

Responses:	Car (Parked)	Dropped Off (Car)	Bicycle	Motorcycle	Walk *(2)	Total
number	39	0	0	0	37	76
percent	51.3%	0.0%	0.0%	0.0%	48.7%	

Q3a: If you came by car, how many people where in the car?
(Only residents who parked their car at the beach are included)

Responses:	Total		
	Persons	Cars	Persons/Car
number	88	39	2.26

*Notes: (1) "Other" accommodations include overnight visits with friends and relatives
(2) Note that a single respondent can report more than one vehicle in his/her party
The Survey Data was Normalized to Distribute "No Answer" and Unusable Responses

Exhibit 2-2: Results of Beach Utilization Survey (cont.)
Beach: Duxbury

Q1: In what town and state do you live?

Responses:	Plymouth	Kingston	Carver	Duxburry	Marshfield	Within EPZ	Other: Mass	Other: US	Other: Foreign	Other: Total	No Answer
number	5	0	1	96	3	105	77	17	3	202	0
percent	2.5%	0.0%	0.5%	47.5%	1.5%	52.0%	38.1%	8.4%	1.5%		0

Q2: Are you staying overnight locally?
(Only responses from non-EPZ residents are included)

Responses:	Yes	No	Total
number	38	58	96
percent	39.6%	60.4%	

Q2a: If so, In what town?

Responses:	Plymouth	Kingston	Carver	Duxbury	Marshfield	Within EPZ	Other	Total
number	3	0	0	21	4	285	9	37
percent	8.1%	0.0%	0.0%	56.8%	10.8%	75.7%	24.3%	

Q2b: Are you staying at a:
(Only responses from non-EPZ residents staying overnight within the EPZ are included)

Responses:	Summer Home	Campsite	Hotel/Motel *(1)	Other	Total
number	7	0	1	19	27
percent	25.9%	0.0%	3.7%	70.4%	

Q3: How did you get here?

Responses:	Car (Parked)	Dropped Off (Car)	Bicycle	Motorcycle	Walk	Total *(2)
number	178	5	8	2	9	202
percent	88.0%	2.5%	4.0%	1.0%	4.5%	

Q3a: If you came by car, how many people where in the car?
(Only residents who parked their car at the beach are included)

Responses:	Total: Persons	Total: Cars	Persons/Car
number	564	178	3.17

*Notes: (1) "Other" accommodations include overnight visits with friends and relatives
(2) Note that a single respondent can report more than one vehicle in his/her party
The Survey Data was Normalized to Distribute "No Answer" and Unusable Responses

Exhibit 2-2: Results of Beach Utilization Survey (cont.)
Beach: Plymouth

Q1: In what town and state do you live?

Responses:	Plymouth	Kingston	Carver	Duxbury	Marshfield	Within EPZ	Other: Mass	Other: US	Other: Foreign	Other: Total	No Answer
number	76	1	3	0	0	80	15	4	1	100	
percent	76.0%	1.0%	3.0%	0.0%	0.0%	80.0%	15.0%	4.0%	1.0%		0

Q2: Are you staying overnight locally?
(Only responses from non-EPZ residents are included)

Responses:	Yes	No	Total
number	12	8	20
percent	60.0%	40.0%	

Q2a: If so, In what town?

Responses:	Plymouth	Kingston	Carver	Duxbury	Marshfield	Within EPZ	Other	Total
number	10	0	0	0	0	10	0	10
percent	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	

Q2b: Are you staying at a:
(Only responses from non-EPZ residents staying overnight within the EPZ are included)

Responses:	Summer Home/Campsite	Hotel/Motel *(1)	Other	Total
number	2	3	2	3	10
percent	20.0%	30.0%	20.0%	30.0%	

Q3: How did you get here?

Responses:	Car (Parked)	Dropped Off (Car)	Bicycle	Motorcycle	Walk	Total *(2)
number	88	0	2	0	0	90
percent	97.8%	0.0%	2.2%	0.0%	0.0%	

Q3a: If you came by car, how many people where in the car?
(Only residents who parked their car at the beach are included)

Responses:	Total: Persons	Total: Cars	Persons/Car
number	271	88	3.08

*Notes: (1) "Other" accommodations include overnight visits with friends and relatives
(2) Note that a single respondent can report more than one vehicle in his/her party
The Survey Data was Normalized to Distribute "No Answer" and Unusable Responses

Exhibit 2-2: Results of Beach Utilization Survey (conc.)
Beach: Whitehorse, Priscillo and Hanowet

Q1: In what town and state do you live?

Responses:	Plymouth	Kingston	Carver	Duxburry	Marshfield	Within EPZ	Other				No Answer
							Mass	US	Foreign	Total	
number	9	1	0	0	10	10	59	9	0	78	
percent	11.5%	1.3%	0.0%	0.0%	0.0%	12.8%	75.7%	11.5%	0.0%		0.0%

Q2: Are you staying overnight locally?
(Only responses from non-EPZ residents are included)

Responses:	Yes	No	Total
number	59	9	68
percent	86.8%	13.2%	

Q2a: If so, In what town?

Responses:	Plymouth	Kingston	Carver	Duxbury	Marshfield	Within EPZ	Other	Total
number	47	0	0	0	0	47	0	47
percent	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	

Q2b: Are you staying at a:
(Only responses from non-EPZ residents staying overnight within the EPZ are included)

Responses:	Summer Home	Campsite	Hotel/Motel *(1)	Other	Total
number	35	1	5	6	47
percent	74.5%	2.1%	10.6%	12.8%	

Q3: How did you get here?

Responses:	Car (Parked)	Dropped Off (Car)	Bicycle	Motorcycle	Walk	Total *(2)
number	49	1	0	1	28	79
percent	62.0%	1.3%	0.0%	1.3%	35.4%	

Q3a: If you came by car, how many people where in the car?
(Only residents who parked their car at the beach are included)

	Total		
Responses:	Persons	Cars	Persons/Car
number	162	49	3.31

*Notes: (1) "Other" accommodations include overnight visits with friends and relatives
(2) Note that a single respondent can report more than one vehicle in his/her party
The Survey Data was Normalized to Distribute "No Answer" and Unusable Responses

Table 2-4 presents population estimates for Parks and Historic Sites. Where parking capacity was available, it was used to estimate peak auto occupancy. Where values of average number of annual, or daily, visitors were obtained, the number of visitors present at any one time during the peak day was estimated.

Vehicular occupancy of 2.5 persons per vehicle was used at all sites except Myles Standish State Park where a value of 3.5 persons per vehicle was obtained from the Park Manager.

Tourists at Hotels and Motels

Each of the hotels and motels which could be identified within the EPZ was contacted and the following information elicited:

- Number of rooms
- Peak period occupancy rate
- Proportion of business travelers.

For each establishment, the number of occupied rooms was estimated by applying the peak period occupancy to the number of available rooms. A factor of 0.85 vehicles per occupied room was used to estimate the maximum number of vehicles at each location. This factor is justified by the fact that major motels in Plymouth rent blocks of rooms to bus tours during the peak season. A single bus tour may reserve from 18 to 20 hotel rooms. The number of people staying at hotels and motels was estimated using a vehicle occupancy factor of 2.4 persons per vehicle. The results of these analyses are presented on a town-by-town basis in Table 2-5.

Tourists at Camps and Campsites

In addition to the public and private campsites which exist within the Pilgrim EPZ, the area is home to a number of children's summer camps. The following procedure was utilized to determine the children's camp estimates:

- Camps identified were contacted and the number of campers ascertained.
- The number of buses required to transport children was estimated using an occupancy rate of 44 and 65 children per bus.
- Buses were assigned a "passenger car equivalency" factor of 2.0.

Table 2-4. Estimated Population
Parks, Historic Sites

Location	Est. No. of Vehs.	Source of Data	Vehicle Occupancy Pers./Veh	No. of People
Plymouth Plantation	700	Parking	2.5	1750
Mayflower II	300	Parking	2.5	750
Myles Standish State Park	1358	Facility Manager	3.5	4753
Plymouth Rock	600	Avg. daily visitors	2.5	1500
Mayflower Society House	6	Avg. daily visitors	2.5	15
Pilgrim Hall Museum	26	Avg. daily visitors	2.5	65
Wm. Harlow House	2	Avg. daily visitors	2.5	5
Sparrow House	6	Avg. daily visitors	2.5	15
Howland House	6	Avg. daily visitors	2.5	15
Spooner House	2	Avg. daily visitors	2.5	5
Antiquarian House	8	Avg. daily visitors	2.5	20
Cranberry World	200	Avg. daily visitors	2.5	500
Jenny Grist Mill	40	Avg. daily visitors	2.5	100
Town Courthouse	10	Avg. daily visitors	2.5	25
Super Sports	300	Avg. daily visitors	2.5	750
	3564	Totals		10268

Table 2-4. Estimated Population
Parks, Historic Sites (conc.)

Location	Est. No. of Vehs.	Source of Data	Vehicle Occupancy Pers./Veh	No. of People
Plymouth Colony Winery	6	Avg. daily visitors	2.5	15
Plymouth Wax Museum	160	HMM est.	2.5	400
Mayflower Experience	20	HMM est.	2.5	50
John Bradford House	8	HMM est.	2.5	20
King Richard's Faire[1]	1480	Office Management	2.5	3700
Myles Standish Monument	150	Avg. monthly visitors	2.5	375
John Alden House	4	Avg. daily visitors	2.5	10
Duxbury Art Complex	5	Avg. daily visitors	2.5	13
King Caesar House	3	Avg. daily visitors	2.5	8
	1836	Totals (This Page)		4591
	5400	Grand Totals		14859

[1] King Richard's Faire is open for about two months on weekends after Labor Day. Although King Richard's Faire is outside of the EPZ, the access road to the facility discharges traffic onto Route 58 in Carver, a major evacuation route. Consequently, it is prudent to include this attraction. The fair draws approximately 200,000 people over 19 days, or about 11,000 people per day. If the average length of stay is 3 hours, then about 3,700 people are present at any one time. These people use 1,480 vehicles.

Table 2-5. Estimated Population
Hotels and Motels

Town	No. of Vehicles (1)	Estimated No. of People (2)
Plymouth	471	1130
Kingston	82	197
Carver	-	-
Duxbury	16	15
Marshfield	-	-
Totals	569	1342

Notes: (1) To account for bus tours and for passenger vehicle occupants who use more than one unit at hotels, a factor of 0.85 vehicles per occupied room is used to estimate numbers of vehicles.

(2) Person estimates are computed as follows:
Persons = (No. of Rooms) x (Peak Occupancy Rate, %)
x (0.85 vehicles/room)
x (2.4 persons/vehicle)

Public and private campgrounds identified were contacted to ascertain the number of available sites and the peak period occupancy rate. One vehicle was assigned to each occupied site. A value of 2.4 persons per vehicle was assigned to estimate campsite population. The results of these procedures are shown in Table 2-6.

Estimation of Day-Trippers and Elimination of Double-Counting

As stated earlier, summing the number of people at attractions (beaches, tourist attractions) and the number of people at lodgings (hotels, campsites) is incorrect due to potential double counting. Furthermore, it is recognized that one additional population group exists for which estimates are required, the day-trippers. Day-trippers enter the EPZ for recreational purposes. At the completion of their trip, day-trippers will exit the EPZ.

The procedure developed to estimate day trippers is as follows:

1.A. For each community, estimate the number of day-trippers at the beach based on the Beach Utilization Survey results.

B. For Kingston, estimate the number of day-trippers at the Independence Mall.

2. For each community, estimate the number of day-trippers at tourist attractions other than beaches and the Independence Mall as follows:

A. Identify those groups of transients who are not likely to travel to these tourist attractions on a typical weekend. This group of transients include:

Businessmen - Discussions with hotel managers indicate 29 percent of their peak period guests are businessmen.

All Children at Camps

95 percent of summer home residents - Given some 20 weekend days in a season implies that, on average, 5 percent of summer home residents will visit the attractions on a particular weekend day. Thus, 95 percent will not.

One half of all persons at campsites.

B. Therefore, transients who do travel to these

attractions are hotel tourists (71 percent of occupied rooms), 5 percent of summer home residents and 50 percent of all people at occupied campsites.

C. Estimate the number of people at these attractions.

D. Estimate the number of day-trippers at tourist attractions excluding beaches and the Independence Mall.

Day-trippers at tourist attractions other than beaches and the Independence Mall = (People at these tourist sites) - (EPZ residents at these tourist sites)

Table 2-7 present day-tripper computations for each town. The average occupancy of day-tripper vehicles is approximately 2.8 persons per vehicle.

Table 2-6. Estimated Population
Camps and Campsites

Camps

Town	No. of Children (1)	No. of Buses (2)	No. of Vehicle Equivalents (3)
Plymouth	1765-**3440**	46-**81**	162
Kingston	**210**-300	**5**-8(1 van)	10
Carver	45-**125**	2-**4**	8
Duxbury	426-**631**	10(2 vans)-**16**	32
Marshfield	0	0	0

Campsites

Town	No. of People	Vehicle Occupancy (Persons/Veh)	No. of Vehicles
Plymouth	3658	2.4	1525
Kingston	0	-	0
Carver	1000	2.4	416
Duxbury	0	-	0
Marshfield	0	-	0
Total	4658		1941

Notes: (1) A range of values is given representing the year to year variations in numbers of children and buses. The bold entry is the value used for the ETE analysis.
(2) Bus occupancy of 44 and 65 children per bus is assumed.
(3) One bus is equivalent to 2 passenger cars.

Table 2-7A. Estimation of Day-Trippers and Total Number of Transients in Plymouth

			Source
1.	Day-trippers at the beach	581	Table 2-3 Exhibit 2-2
2.	Day-trippers at tourist attractions, excluding beaches		
	A. People within the EPZ who do not travel to these attractions		
	Businessmen (29% of hotel, motel occupancy)	327	Table 2-5
	Children's Camps	3,440	Table 2-6
	Summer Residents (95% of summer home residents)	2,880	Table 2-2
	Campsites (50% of occupied campsites)	1,829	Table 2-6
	Total	8,476	
	B. People within the EPZ who do travel to these attractions		
	Overnight tourists (71% of hotel, motel occupancy)	803	Table 2-5
	Summer Residents (5% of summer home residents)	152	Table 2-2
	Campsites (50% of occupied campsites)	1,829	Table 2-6
	Total	2,784	
	C. People at these attractions		
	Parks, recreation and historic attractions	10,733	Table 2-4
	Ponds	600	Table 2-3
	Total	11,333	
	D. Day-trippers at tourist attractions, excluding beaches [(2C) - (2B)]; 11,333 - 2,784 =	8,549	
3.	Day-trippers at all attractions [(1) + (2D)]; 581 + 8,549 =	9,130	
4.	Total number of non-boating transients [(2A) + (2B) + (3)]; 8,476 + 2,784 + 9,130 =	20,390	

Table 2-7B. Estimation of Day-Trippers and Total Number of Transients in Kingston

		Source
1.A. Day-trippers at the beach	0	Table 2-3/ Exhibit 2-2
B. Day-trippers at the Independence Mall	1,219	Appendix E
Total	1,219	
2. Day-trippers at tourist attractions, excluding beaches		
A. People within the EPZ who do not travel to these attractions		
Businessmen (29% of hotel, motel occupancy)	56	Table 2-5
Children's Camps	210	Table 2-6
Summer Residents (95% of summer home residents)	380	Table 2-2
Campsites (50% of occupied campsites)	0	Table 2-6
Total	646	
B. People within the EPZ who do travel to these attractions		
Overnight tourists (71% of hotel, motel occupancy)	136	Table 2-5
Summer Residents (5% of summer home residents)	20	Table 2-2
Campsites (50% of occupied campsites)	0	Table 2-6
Total	156	
C. People at these attractions		
Parks, recreation and historic attractions	20	Table 2-4
Ponds	0	Table 2-3
Total	20	
D. Day-trippers at tourist attractions, excluding beaches and Independence Mall [(2C) - (2B)];	150*	
3. Day-trippers at all attractions [(1) + (2D)]; 1,219 + 150 =	1,369	
4. Total number of non-boating transients [(2A) + (2B) + (3)]; 646 + 156 + 1,369 =	2,171	

* A nominal estimate of 150 people for day-trippers at attractions other than the beach or the Independence Mall is used because the estimated number of people drawn to attractions in Kingston is satisfied by the transients already in Kingston.

Table 2-7C. Estimation of Day-Trippers and Total Number of Transients in Carver

			Source
1.	Day-trippers at the beach		Table 2-3
		0	Exhibit 2-2
2.	Day-trippers at tourist attractions, excluding beaches		
	A. People within the EPZ who do not travel to these attractions		
	Businessmen		
	(29% of hotel, motel occupancy)	0	Table 2-5
	Children's Camps	125	Table 2-6
	Summer Residents		
	(95% of summer home residents)	565	Table 2-2
	Campsites		
	(50% of occupied campsites)	500	Table 2-6
	Total	1,190	
	B. People within the EPZ who do travel to these attractions		
	Overnight tourists		
	(71% of hotel, motel occupancy)	0	Table 2-5
	Summer Residents		
	(5% of summer home residents)	30	Table 2-2
	Campsites		
	(50% of occupied campsites)	500	Table 2-6
	Total	530	
	C. People at these attractions		
	Parks, recreation and historic attractions	3,700	Table 2-4
	Ponds	600	Table 2-3
	Total	4,300	
	D. Day-trippers at tourist attractions, excluding beaches [(2C) - (2B)]; 4,300 - 530 =	3,770	
3.	Day-trippers at all attractions [(1) + (2D)]; 0 + 3,770 =	3,770	
4.	Total number of non-boating transients [(2A) + (2B) + (3)]; 1,190 + 530 + 3,770 =	5,490	

Table 2-7D. Estimation of Day-Trippers and Total Number of Transients in Duxbury

			Source
1.	Day-trippers at the beach		Table 2-3
		1,316	Exhibit 2-2
2.	Day-trippers at tourist attractions, excluding beaches		
	A. People within the EPZ who do not travel to these attractions		
	Businessmen		
	(29% of hotel, motel occupancy)	21	Table 2-5
	Children's Camps	631	Table 2-6
	Summer Residents		
	(95% of summer home residents)	1,173	Table 2-2
	Campsites		
	(50% of occupied campsites)	0	Table 2-6
	Total	1,825	
	B. People within the EPZ who do travel to these attractions		
	Overnight tourists		
	(71% of hotel, motel occupancy)	52	Table 2-5
	Summer Residents		
	(5% of summer home residents)	62	Table 2-2
	Campsites		
	(50% of occupied campsites)	0	Table 2-6
	Total	114	
	C. People at these attractions		
	Parks, recreation and historic attractions	406	Table 2-4
	Ponds	0	Table 2-3
	Total	406	
	D. Day-trippers at tourist attractions, excluding beaches [(2C) - (2B)]; 406 - 114	= 292	
3.	Day-trippers at all attractions [(1) + (2D)]; 1,316 + 292	= 1,608	
4.	Total number of non-boating transients [(2A) + (2B) + (3)]; 1,825 + 114 + 1,608	= 3,547	

Table 2-7E. Estimation of Day-Trippers and Total Number of Transients in Marshfield

			Source
1.	Day-trippers at the beach	804	Table 2-3 Exhibit 2-2
2.	Day-trippers at tourist attractions, excluding beaches		
	A. People within the EPZ who do not travel to these attractions		
	Businessmen (29% of hotel, motel occupancy)	0	Table 2-5
	Children's Camps	0	Table 2-6
	Summer Residents (95% of summer home residents)	3,048	Table 2-2
	Campsites (50% of occupied campsites)	0	Table 2-6
	Total	3,048	
	B. People within the EPZ who do travel to these attractions		
	Overnight tourists (71% of hotel, motel occupancy)	0	Table 2-5
	Summer Residents (5% of summer home residents)	160	Table 2-2
	Campsites (50% of occupied campsites)	0	Table 2-6
	Total	160	
	C. People at these attractions		
	Parks, recreation and historic attractions	0	Table 2-4
	Ponds	0	Table 2-3
	Total	0	
	D. Day-trippers at tourist attractions, excluding beaches [(2C) - (2B)];	150*	
3.	Day-trippers at all attractions [(1) + (2D)]; 804 + 150 =	954	
4.	Total number of non-boating transients [(2A) + (2B) + (3)]; 3,048 + 160 + 954 =	4,162	

* A nominal estimate of 150 people for day-trippers at attractions other than the beach is used because the estimated number of people drawn to attractions in Marshfield is satisfied by the transients already in Marshfield.

Boaters

The EPZ for Pilgrim Station encompasses an area which is popular with recreational and commercial boaters. The Towns of Plymouth, Kingston, Duxbury and Marshfield have many facilities to service the boating public. These facilities include marinas, yacht clubs, town wharfs and public access ramps. Since it may be expected that, for summer scenarios, people will be boating within the off-shore region of the EPZ, it is prudent to estimate this population.

Contacts were established with town harbor masters, marina operators, and yacht club stewards to estimate the number of boats which may be expected. In addition, aerial photographs of the coastal region were used to count the number of boat trailers at some public launch ramps. Specifics of this data collection process are presented in Appendix E.

It is likely that many of the boats in use belong to people who have been counted as part of the permanent population and summer home residents. It will be assumed that 75 percent of boats in use belong to these population segments. Further, it is assumed that each boat in use implies a single vehicle on shore. The average occupancy of these vehicles is assumed to be 2.5 persons. Table 2-8 summarizes the boating estimates.

A town-by-town summary of the transient population is presented in Table 2-9. Estimates of transient population and of evacuating vehicles are presented in the format of "roses" in Figures 2-6 and 2-7.

Employees

The procedure utilized to estimate the number of employees who enter the EPZ each day involves a number of steps:

1. Estimate current total employment for each town

2. Estimate the number of employees who live within the EPZ and commute to work in the EPZ

3. Estimate the number of people in each community who walk to work, or work at home

4. Determine the number of employees who arrive in each town who live beyond the EPZ boundary.

Each of these steps will be discussed.

Table 2-8. Estimated Boating Population

Town	Total No. of Boats in Use	Transient Boats in Use (1)	No. of Vehs. (2)	No. of People (3)
Plymouth	463	116	116	290
Kingston	200	50	50	125
Duxbury	825	206	206	515
Marshfield	270	68	68	170
TOTALS	1758	440	440	1100

Notes: (1) Assumed 25 percent of boats in use by non-EPZ residents and previously identified transients.

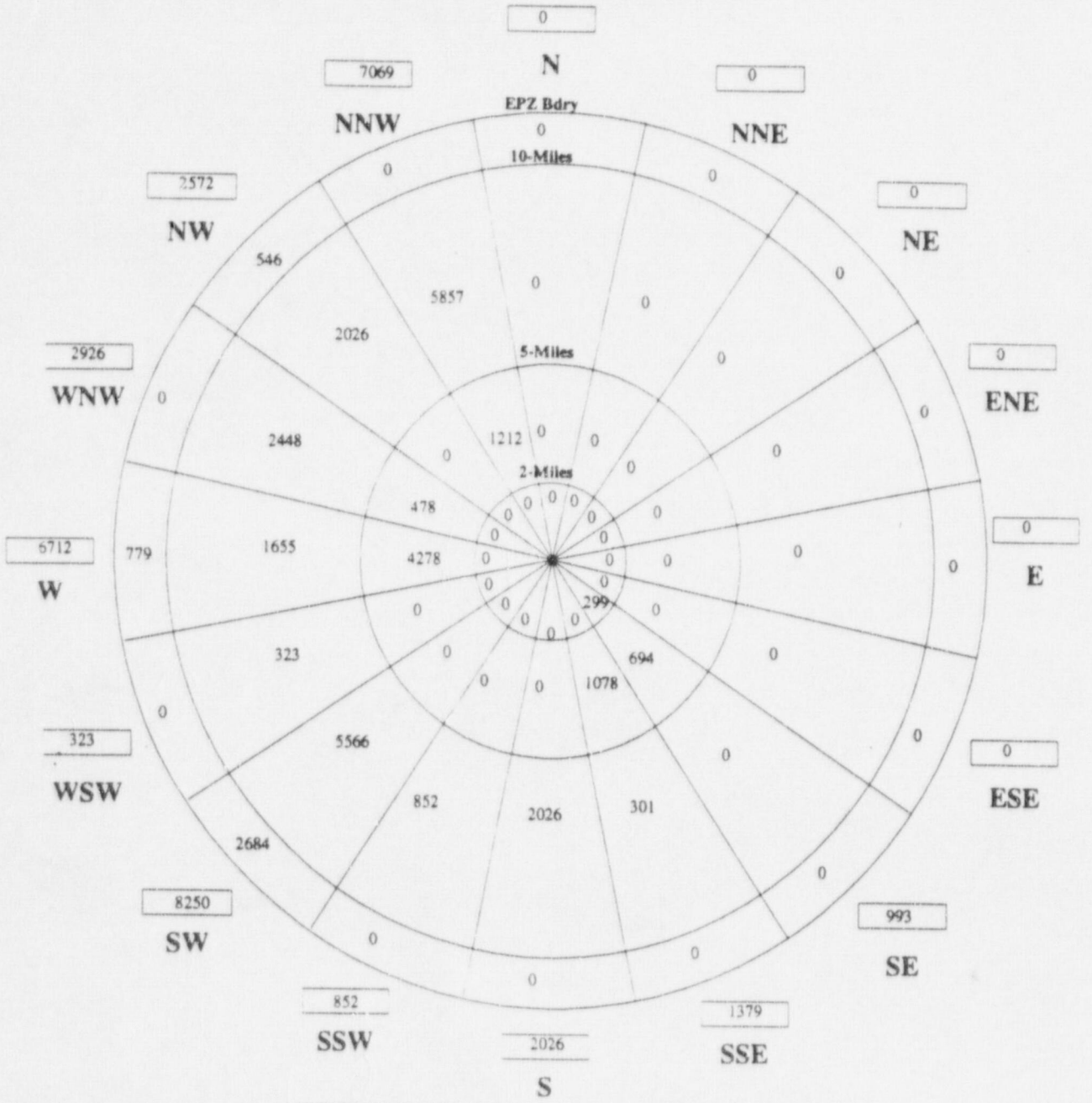
(2) 1 vehicle on-shore per boat.

(3) Vehicular occupancy is 2.5 persons per vehicle.

Table 2-9. Summary of Transient Population

	Plymouth	Kingston	Carver	Duxbury	Marshfield
Summer Homes	3032	400	595	1235	3208
Hotel, Motel	1130	197	0	15	0
Campers	3440	210	125	631	0
Campsites	3658	0	1000	0	0
Day-trippers	9130	1369	3770	1608	954
Boaters	290	125	0	515	170
Total	20680	2301	5490	4004	4332

Note: The values presented in this table are the peak transient population for each town. The peak transient population within the Pilgrim EPZ occurs during the summer tourist season (Scenarios 1 and 2). The values presented here therefore represent Scenarios 1 and 2 plus the number of people at King Richard's Faire. It should be noted that peak attendance at King Richard's Faire occurs after Labor Day. This fact is reflected in the transient population roses on a scenario by scenario basis.

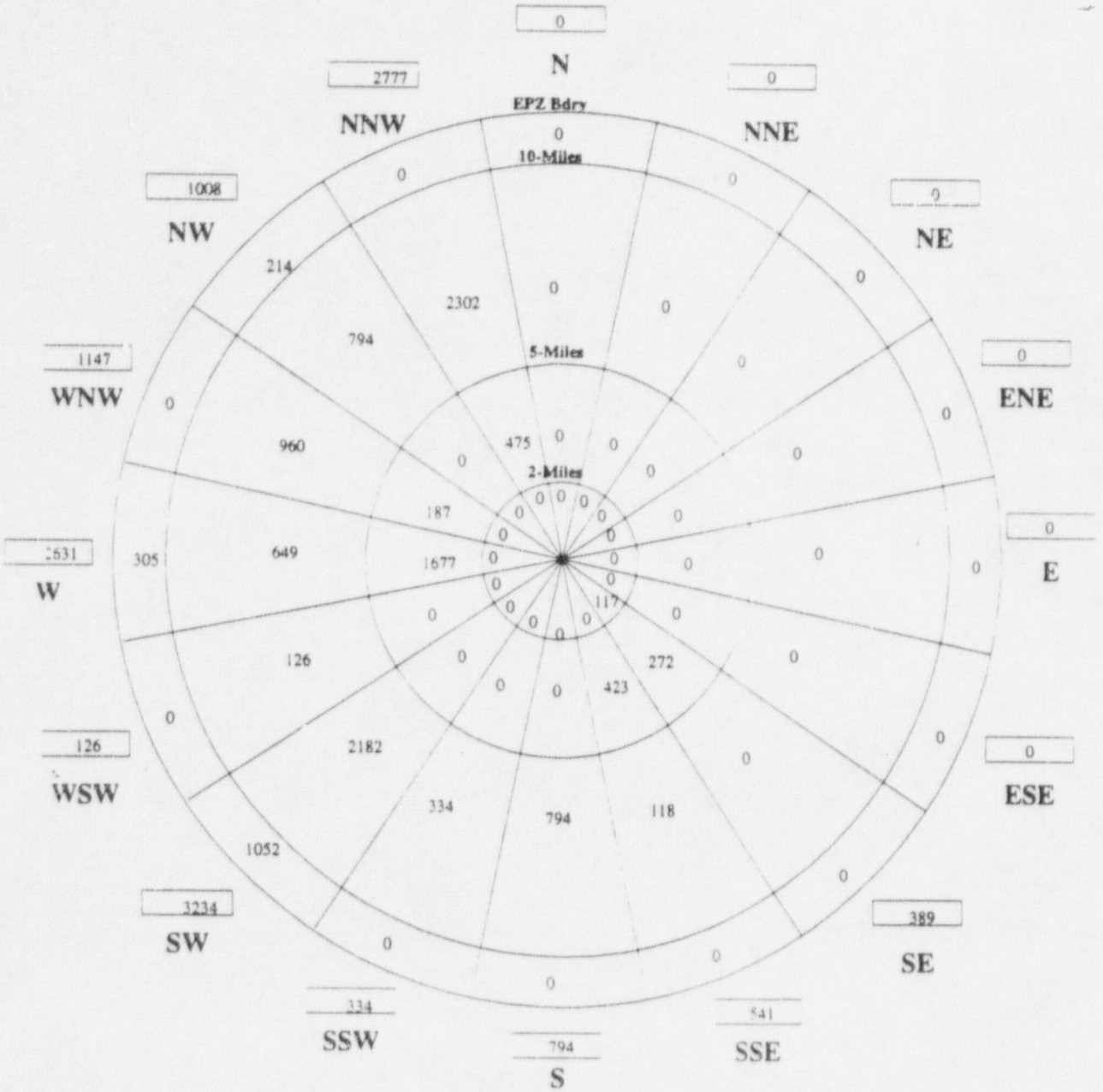


33102

Total Segment Population 0 to EPZ Boundary

Population Totals			
Ring	Ring Population	Total	Cumulative Population
0-2 Mi.	299	0-2 Mi.	299
2-5 Mi.	7740	0-5 Mi.	8039
5-10 Mi.	21054	0-10 Mi.	29093
10-EPZ	4009	0-EPZ	33102

Figure 2-6. Transient Population Scenarios 1, 2



12981

Total Segment Population 0 to EPZ Boundary

Vehicle Totals

Ring	Ring Population	Total	Cumulative Population
0-2 Mi	117	0-2 Mi	117
2-5 Mi	3034	0-5 Mi	3151
5-10 Mi	8259	0-10 Mi	11410
10-EPZ	1571	0-EPZ	12981

Figure 2-7. Transient Population Vehicles Scenarios 1, 2

1. Estimate current total employment.

   Growth in employment between 1990 and 1999 was estimated by computing an annual rate of growth based upon Massachusetts Department of Employment and Training statistics. Table 2-10 presents the 1999 estimated employment for each town.

2. Estimate the number of employees who live within the EPZ and commute to work in the EPZ.

   Table 2-11 summarizes the employment estimates by town.

   The balance of this discussion will focus on Plymouth, Kingston, Carver and Duxbury (with a total 1999 estimated number of workers of 31,580; see Table 2-11). At the conclusion of the analysis, results will be applied to Marshfield. The reason for this approach is the need to use the telephone survey results. Survey results were not available for Marshfield.

   Table 2-13 presents an origin-destination matrix for home to work trips within the Pilgrim EPZ. Table 2-13 is based upon the telephone survey. Data from this table is used to develop the number of jobs in the EPZ filled by EPZ residents:

Plymouth	(215/754)	x (31,580)	= 9,005
Kingston	(41/754)	x (31,580)	= 2,047
Carver	(7/754)	x (31,580)	= 293
Duxbury	(48/754)	x (31,580)	= 2,010

Table 2-10. 1999 Estimated Employment within the Pilgrim EPZ

Town	Correction Factors(1)	1990 Employ-ment	1996 Employ-ment	Annual Growth (2)	1999 Employ-ment(3)
Plymouth	1.12	16,064	17,438	1.38%	20,349
Kingston	1.20	4,657	5,118	1.59%	6,438
Carver (4)	1.82	1,298	1,579	3.32%	3,170 (1,839)
Duxbury	1.31	2,255	2,255	0.00%	2,954
Marshfield (5)	1.07	4,200	4,224	0.10%	4,533 (363)

Notes: (1) The data obtained from the State of Massachusetts shows lower employment than actual town employment because State data does not include some categories of employment e.g. workers with no state disability insurance or workmen's compensation. Correction factors are used to adjust the MDET data.

(2) Compound annual growth rate based upon Mass. Dept. of Employment and Training data (MDET).

(3) The 1999 estimate is based upon the 1996 MDET data to which the annual growth rate is applied for 3 years and then adjusted using the correction factors.

(4) 58 percent of Carver lies within the EPZ. 1999 EPZ employment estimate is shown in parentheses.

(5) 8 percent of Marshfield lies within the EPZ. 1999 EPZ employment estimate is shown in parentheses.

Table 2-11. 1999 Estimated Number of Workers within the Pilgrim EPZ

Town	1999 Worker Estimate
Plymouth	20,349
Kingston	6,438
Carver (1)	1,839
Duxbury	2,954
Marshfield (2)	363

Notes:

(1) 58 percent of Carver lies within the EPZ. The figures shown include this factor.

(2) 8 percent of Marshfield lies within the EPZ. The figures shown include this factor.

Table 2-12. Comparison of 1999 Worker Estimates Based upon Employment and Telephone Survey Results

Town	Survey Sample	1999 Pop Est.	Survey Scale	Survey Workers	1999 Survey Est.	Est. Employ-ment
Plymouth	1,163	50,262	43.22	453	19,578	20,349
Kingston	244	11,235	46.05	107	4,927	6,438
Carver	121	6,411	52.98	52	2,755	1,839
Duxbury	396	14,768	37.29	142	5,296	2,954
					34,555	31,580

Table 2-13. Employee Origin-Destination Trip Table

Trip Origins	Total Total Trips	Trip Destinations Plymouth	Kingston	Carver	Duxbury	Total EPZ	Non-EPZ
Plymouth	453	172	15	3	7	197	256
Kingston	107	19	15	1	7	42	65
Carver	52	8	4	3	3	18	34
Duxbury	142	16	7	0	31	54	88
Total	754	215	41	7	48	311	443

Source: Telephone Survey

3. Estimate the number of people who walk to work, or work at home.

The 1990 Census data yields information on the number of non-commuters in each town. This figure can be updated to provide a 1999 estimate by applying annual employee growth estimates (see Table 2-10). Consequently,

Town	No. of Jobs Filled by Non-Commuters
Plymouth	1,451
Kingston	297
Carver	207
Duxbury	593

4. Determine the number of employees who arrive in each town who live beyond the EPZ boundary.

Table 2-14 presents the development of these figures for the four towns addressed in the telephone survey. The ratio:

Jobs held by non-EPZ commuters: No. of jobs within EPZ

is used to estimate the figure for Marshfield:

No. of jobs in Marshfield	363	(Table 2-10)
Ratio 16,061/31,580 = 0.509 of jobs held by non-EPZ residents		(Table 2-14)
No. of Marshfield jobs held by non-EPZ residents (0.509 x 363)	185	
Employee vehicle occupancy	1.18	(1990 Census)
No. of Marshfield vehicles	157	

Table 2-15 presents a summary of the numbers of employees who enter the EPZ daily. Figures 2-8 and 2-9 present the data of employee population from outside the EPZ and their estimates of evacuating vehicles in the "rose" format.

Other Vehicles

There will be vehicles traveling 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 travelers will also be evacuating since they are already in their cars. Many vehicles traveling through the EPZ do so on Route 3. Table 2-16 presents estimates of peak hour volumes on Route 3 based upon MDPW traffic counts. These volumes are applied until access control becomes effective in diverting traffic

Table 2-14. Estimated Number Employees Who Enter the EPZ to Work and the Associated Number of Vehicles

Town	No. of Jobs Within EPZ	Jobs Held by EPZ Res.	Jobs Held by Non-Comm.	Jobs Held by Non-EPZ Res.	Employees per Vehicle	Employee Vehicles
Plymouth	20,349	9,005	1,451	9,893	1.17	8,456
Kingston	6,438	1,717	297	4.424	1.19	3,718
Carver	1,839	293	207	1,393	1.13	1,233
Duxbury	2,954	2,010	593	351	1.14	308
Total	31,580	13,025	2,548	16,061		13,715

Column:
(1) From Table 2-11
(2) Table 2-13 [Trips to town/Total Trips]*EPZ Employment (Table 2-12). Example: Plymouth, [215/754]*31,580 = 9,005
(3) Data on Page 2-43
(4) (1)-(2)-(3)
(5) 1990 Census Data

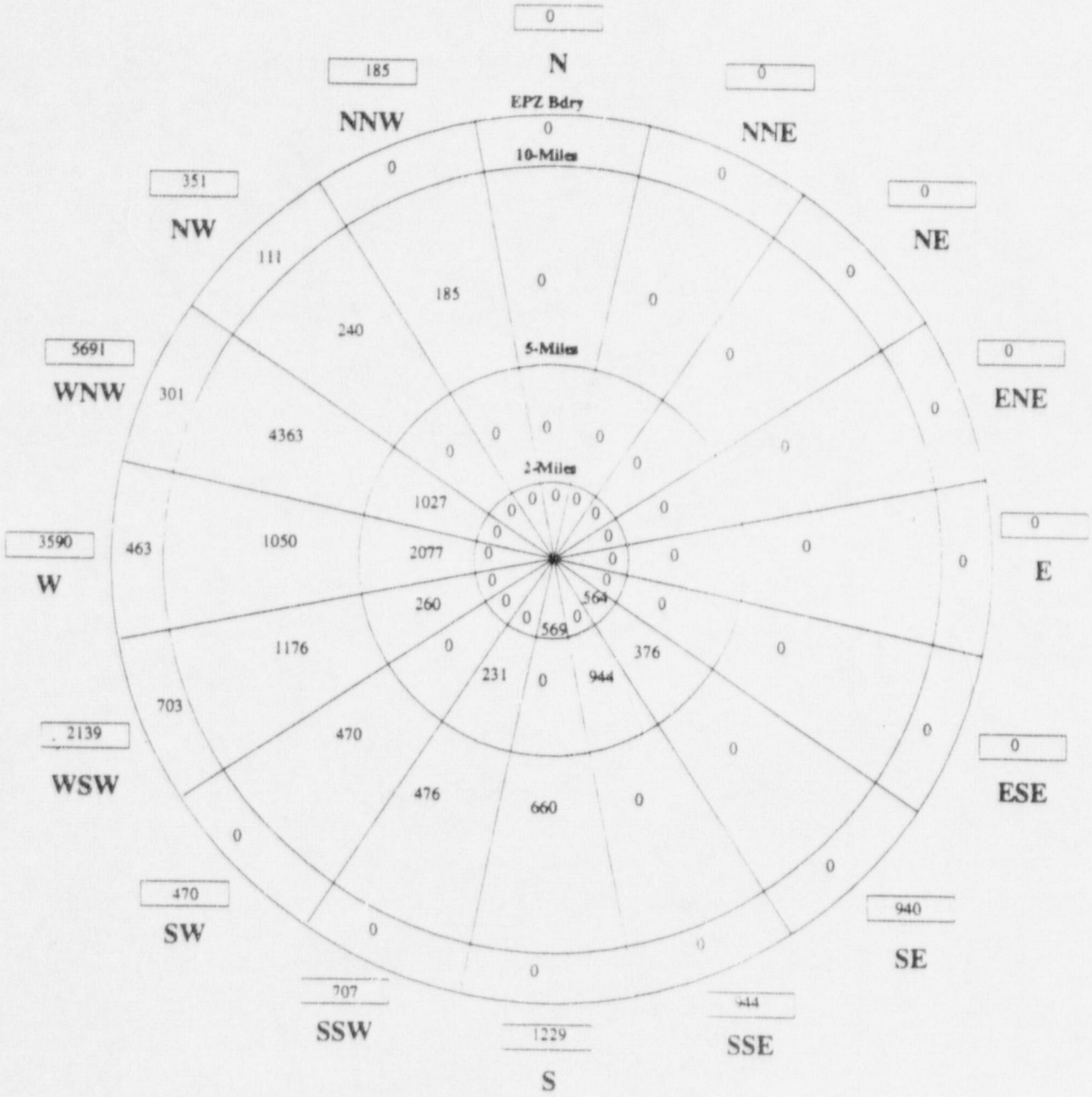
Table 2-15. Estimated Number Employees Who Enter the EPZ and the Number of Their Vehicles That Will Evacuate

Town	No. of Employees	No. of Vehicles
Plymouth	9,893	8,456
Kingston	4,424	3,718
Carver	1,393	1,233
Duxbury	351	308
Marshfield	185	157
Totals	16,246	13,872

Table 2-16. Route 3 Traffic Estimates

Season	Average Daily Traffic ADT (1)	Peak Hour Factor	Directional Peak Hour Volume (Veh/Hr)
Peak	42,315	0.10	2,116
Off-Peak (Midweek)	31,843	0.15	2,388

Notes: 1. Source: MDPW, 1997 Counts. Peak season uses the highest monthly ADT, August.



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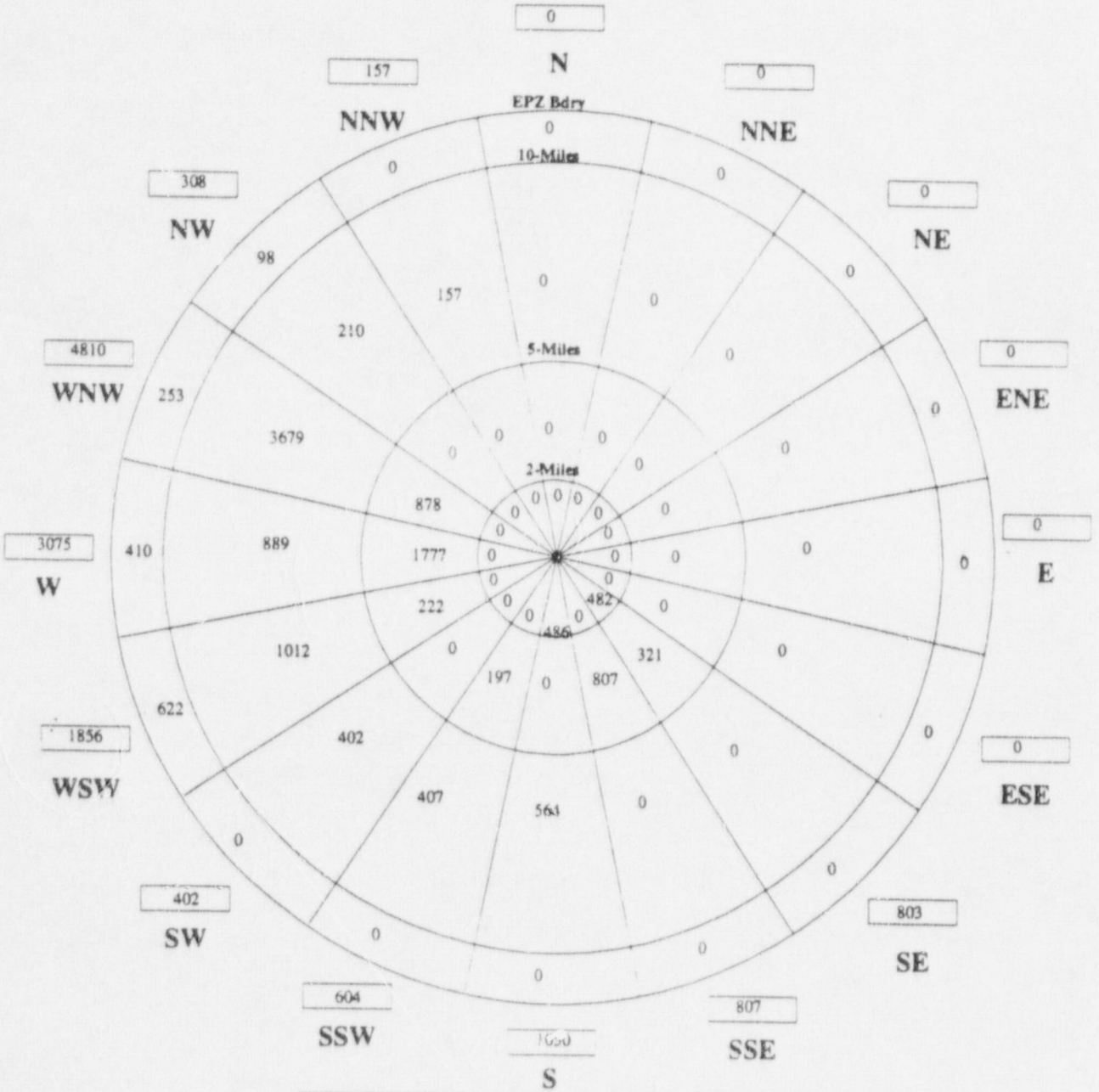
Total Segment Population 0 to EPZ Boundary

Population Totals

Ring	Ring Population	Total	Cumulative Population
0-2 Mi.	1133	0-2 Mi.	1133
2-5 Mi.	4915	0-5 Mi.	6048
5-10 Mi.	8620	0-10 Mi.	14668
10-EPZ	1578	0-EPZ	16246

Figure 2-8. Employees within the EPZ Who Live Outside the EPZ



Vehicle Totals			
Ring	Ring Population	Total	Cumulative Population
0-2 Mi.	968	0-2 Mi.	968
2-5 Mi.	4201	0-5 Mi.	5169
5-10 Mi.	7320	0-10 Mi.	12489
10-EPZ	1383	0-EPZ	13872

Figure 2-9. Employee Vehicles which Join in the Evacuation

from Route 3 at the EPZ boundaries. It is estimated that the total number of through vehicles within the EPZ at the time evacuation is directed is between 2500 and 3000 vehicles.

Table 2-17 presents a summary of all population estimates aggregated by evacuation subareas.

Table 2-17. Pilgrim Station EPZ Population
By Subarea

1999 Estimate

Evacuation Subareas	Population Category		
	Permanent Residents	Transients	Employees
1	5,002	1,568	1,695
2	6,521	1,296	1,652
3	12,118	5,160	4,346
4	25	1,466	0
5	6,411	8,600	660
6	12,267	2,153	706
7	7,904	435	835
8	11,235	2,301	4,423
9	14,768	4,001	351
10	1,857	4,332	185
11	6,425	1,790	1,393
Totals	**84,533**	**33,102**	**16,246**
	All Scenarios	**Scenarios 1, 2**	**Scenarios 3, 4, 5, 6, 7**

3. ESTIMATION OF HIGHWAY CAPACITY

The ability of the road network to service vehicle demand is a major factor in determining how rapidly an evacuation can be completed. It is, therefore, necessary to know the capacities 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 1994 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" (LOS). For example, LOS A connotes free-flow and high-speed operating conditions; LOS F represents a forced flow condition. LOS E describes traffic operating at or near capacity.

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 snowy 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:

- On the approach to intersections
  - Saturation queue discharge headways
  - Turning movements
  - Competing traffic streams
  - Control policy, if any
  - Traffic Composition
  - Approach geometrics and channelization

- Along sections of roadway
  - Roadway geometrics
  - Traffic composition
- 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:

$$Q_{cap,m} = \frac{3600}{h_m}\left(\frac{G-L}{C}\right)_m = \frac{3600}{h_m} P_m \qquad (1)$$

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 which 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_m

$f_m (\cdot)$ = Complex function relating h_m to the known (or estimated) values of h_{sat}, F_1, F_2

The estimation of h_m for specified values of h_{sat}, F_1, F_2, ... is undertaken by a mathematical model[1]* which has been programmed into the Traffic Assignment and Traffic Simulation software of the IDYNEV System. The resulting values for h_m always satisfy the condition:

$$h_m \geq h_{sat}$$

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

It is seen that, given the ability to determine h_m 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

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[1] 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.

evacuation plan represent conservative estimates[2] based on this empirical data. Specifically, observed values for h_{sat} ranged from 2.1 to 2.4 sec/veh; higher (more conservative) figures were adopted based on capacities which were estimated using the procedures of the 1985 Highway Capacity Manual. These estimates are described later.

To summarize the foregoing discussion:

- The saturation queue discharge headways, h_{sat}, for through vehicles can be quantified by empirical observation
- The turn-movement-specific headways, h_m, are then calculated, taking into account the effects of turn movement percentages, link geometry and other factors
- With the control treatment prescribed as part of the evacuation plan, the value of P_m may be defined
- 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

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[2] 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.

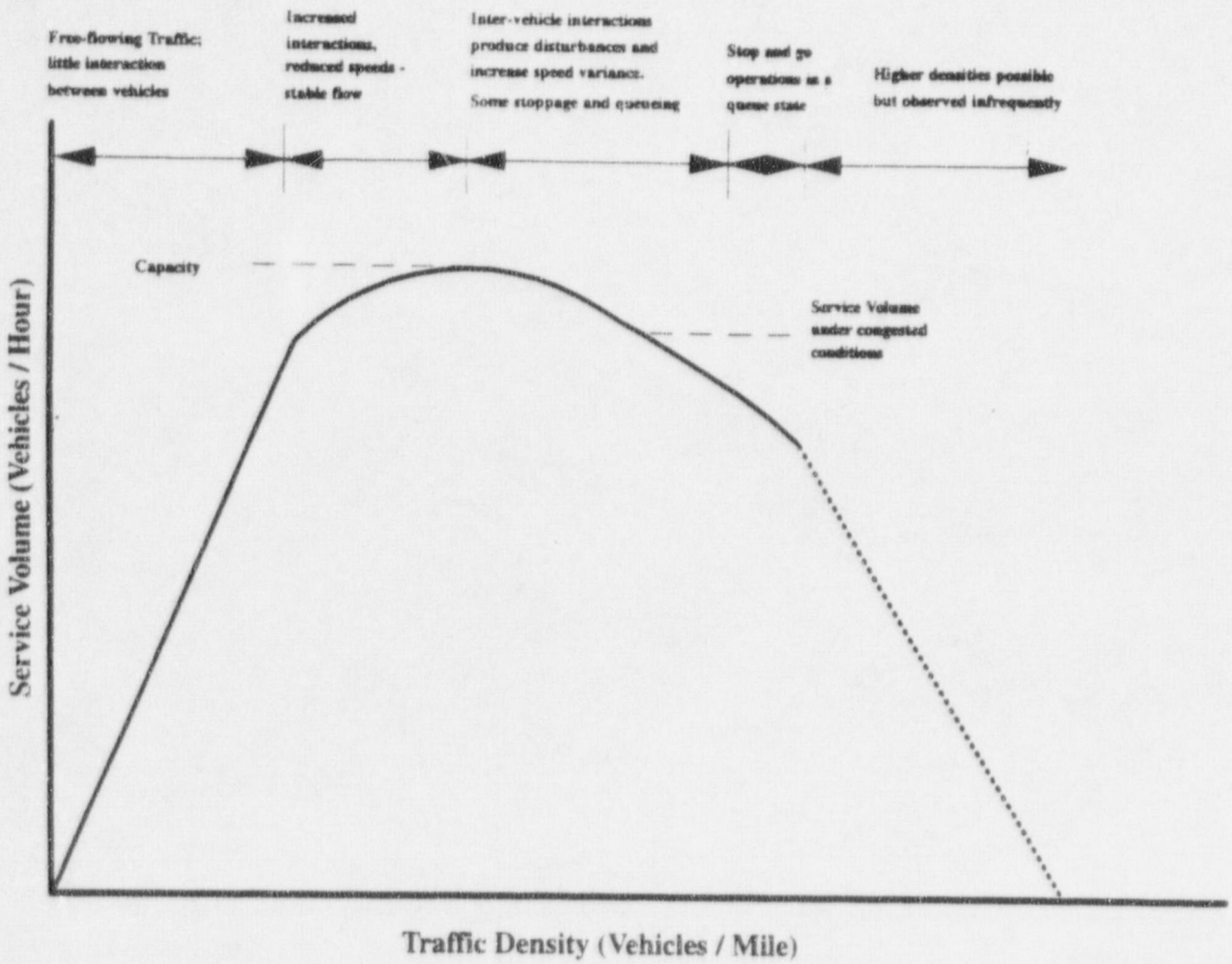


Figure 3-1. Fundamental Relationship between Volume and Density

"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 estimating evacuation times, and 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.

Based on empirical data collected on freeways, we have employed a value of R = 0.85. 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, V_F, during LOS F conditions.

The estimated value of capacity, V_E, is based primarily upon the type of facility (e.g. controlled access highway such as State Route 3, uncontrolled access highway such as Route 3A) and on roadway geometrics. Clearly, a winding narrow road has significantly lower service volume than does Route 3. 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 first factor increases travel time when conditions are undersaturated. The latter factor produces lower service volumes, thereby reducing capacity.

The procedure used here was to estimate "section" capacity, V_E, based on our observations traveling over each section of the evacuation network and by reference to the Highway Capacity Manual. We then determined for each highway section, represented as a network link, whether its capacity would be limited by the "section-specific" service volume, V_E or by the intersection-specific capacity. For each link, we selected the lower value of capacity. Note that the reduction of capacity, from V_E to V_F, is automatically implemented by the IDYNEV simulation model.

General Considerations

Inclement weather conditions (rain, fog, snow) and poor or wet pavement conditions reduce capacity by virtue of:

- o Lower free-flow speeds reflecting greater caution on the part of motorists.

- Longer vehicle headways reflecting lower traction and/or more cautious driver behavior.

The decrease in service volume due to these factors can be estimated based on either direct observation or by referencing other studies in the literature.

Application to Pilgrim EPZ

As part of the development of the Pilgrim EPZ traffic network, an estimate of roadway capacity is required. The source material for the capacity estimates presented herein is contained in:

1985 Highway Capacity Manual (HCM), Special Report 209

Transportation Research Board
National Research Council
Washington, D.C. 1985

The highway system in the Pilgrim EPZ consists primarily of three categories of roads:

- Two-lane roads: local, State
- Multi-lane Expressways
- Freeway ramps

Each of these classifications will be discussed.

Two-Lane Roads

Ref: HCM Chapter 8

As a further aid to the estimate of roadway capacity, we have adopted the following three general types of rural roads:

1. "Low" design roads - 10 ft. lanes, 1 ft. shoulders (e.g. Rocky Hill Road)

2. "Medium" design roads - 11 ft. lanes, 2 ft. shoulders (e.g. Route 139)

3. "High" design roads - 12 ft. lanes, 4 ft. shoulders (e.g. Route 58)

The relationship describing traffic operations on general terrain segments is as follows:

$$SF_i = 2,800 \times (v/c)_i \times f_d \times f_w \times f_{HV}$$

where:

SF_I = total service flow rate in both directions for prevailing roadway and traffic conditions, for level of service I, in vph

$(v/c)_I$ = ratio of flow rate to ideal capacity for level of service I, obtained from HCM Table 8-1

f_d = adjustment factor for directional distribution of traffic, obtained from HCM Table 8-4

f_w = adjustment factor for narrow lanes and restricted shoulder width, obtained from HCM Table 8-5

f_{HV} = adjustment factor for the presence of heavy vehicles in the traffic stream, which can be computed as outlined in the HCM

We have applied these procedures of the 1985 HCM to obtain estimates of the "section" capacities of two-lane roads within the EPZ. An outline of these procedures is presented below. Note that capacity is defined as the service flow at the upper bound of Level of Service, LOS E.

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

- The two-lane roads within the EPZ are classified as "rolling terrain".
- Percent no passing zones is approximately 60.
- Directionality of traffic moving over two-lane roads during evacuation will approximate a "split" of 90 percent moving outbound; 10 percent moving inbound, averaged over the duration of the evacuation. (For a mid-day mid-week scenario, this split way increase to 80/20 reflecting commuter traffic returning home. Highway capacity for outbound traffic, for this split, is essentially the same as for the postulated 90/10 directional split).
- Traffic mix is: 1% trucks, 1% buses, 4% recreational vehicles during the summer.

On this basis, the value of v/c of LOS E is 0.91 taken from Table 8-1 of the HCM. The directional split factor, f_d is 0.75 from Table 8-4 of the HCM. These factors apply to all three rural road types.

The road width factors, f_w, are obtained from Table 8-5 of the HCM:

- "Low" design roads - 0.78 (by interpolation)
- "Medium" design roads - 0.88
- "High" design roads - 0.97

The vehicle mix factor is based both on the percentages of heavy vehicles and on the Passenger Car Equivalent (PCE) value of each vehicle type. Since PCE is related to vehicle performance, the PCE is lower on higher speed roads. For example, due to sluggish acceleration, a truck moving in local street traffic exhibits a higher PCE than the same truck does when it is on a freeway.

On this basis, the following values were obtained:

f_{HV} = 0.87 for roads of high, medium and low designs;

The following table represents the two-way and one-way (directional) capacity estimates for the three road types identified:

Road Type	(V/C)	f_s	f_w	f_{HV}	2-way V_E (vph)	1-way V_E (vph)	Equivalent Headway (sec)
Low design	0.91	0.75	0.78	0.87	1297	1167	3.1
Medium design	0.91	0.75	0.88	0.87	1463	1317	2.7
High design	0.91	0.75	0.97	0.87	1613	1452	2.5

Notes: 1. The one-way capacities of roads for evacuating vehicles are calculated by multiplying the two-way values obtained from the HCM procedures, by the directional split, 0.9.
2. These directional (i.e. one-way) estimates will be multiplied by the factor, R = 0.85, when the traffic is moving under congested conditions.

Freeway Capacity

There is one freeway in the Pilgrim EPZ; State Route 3. A general relationship is used to compute the one-way freeway service flow at different Levels of Service.

$$SF_i = c_j \times (v/c)_i \times N \times f_w \times f_{HV} \times f_p$$

where:

SF_i = service flow rate for LOS I under prevailing roadway and traffic conditions for N lanes in one direction, in vph

$(v/c)_I$ = maximum volume-to-capacity ratio for LOS I

c_j = capacity under ideal conditions for freeway element of design speed j; 2,000 pcphpl for 60 mph and 70 mph freeway elements, 1,900 pcphpl for 50 mph freeway elements; the value of c_j is synonymous with the maximum service flow rate for LOS E

N = number of lanes in one direction of the freeway

f_w = factor to adjust for the effects of restricted lane widths and/or lateral clearances

f_{HV} = factor to adjust for the effect of heavy vehicles (trucks, buses and recreational vehicles) in the traffic stream

f_p = factor to adjust for the effect of driver population

Based on the field survey, Route 3 exhibits:

- Essentially level terrain
- Two lanes
- A traffic mix approximating: 1% trucks, 1% buses, 4% recreational vehicles during the summer

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 3-2 = 1, for a facility with 12 ft. lanes, 6 ft. shoulder, and a 4 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 this major

road in the Pilgrim 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.* This estimate translates into a mean vehicle headway of 2.1 seconds.

Freeway Ramps

Capacity of freeway ramps was assumed to be 1333 vphl. This is a conservative estimate [see HCM, Table 5-5], and corresponds to a queue discharge headway of 2.7 seconds per vehicle. Note that the simulation model will limit this service volume on the ramp to lower values when traffic volumes on Route 3 are heavy.

Fog

The issue of ocean 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.

Link Capacities

Appendix N presents the link capacities, V_E, for the evacuation network shown in Figure 1-2. All links are identified by name and location (community).

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

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. If we limit this discussion to the evacuation decision action, then the first off-site public notification and response can occur at the time of the Site Area Emergency.

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 accident escalates almost immediately to a Site Area Emergency following activation of the local Emergency Operation Centers (EOC).
- That further escalation to a General Emergency occurs 15 minutes later.
- That the directive 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 not a representation that these events can occur at the Pilgrim Station within the indicated time frame. Rather, these assumptions are only 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 Pilgrim. For example, suppose two hours elapse from the declaration of a General Emergency to the Directive 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 Directive to Evacuate is announced, than at the time of the General Emergency. Thus, the time needed to evacuate the EPZ, after the Directive to Evacuate may 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 Directive 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.

The notification process consists of two events:

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

- Receiving and correctly interpreting the information that is transmitted.

The resident population within the EPZ exceeds 80,000 persons who are deployed over an area of approximately 150 square miles, and engaged in a wide variety of activities. During the summer, more than 30,000 additional persons could 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 Appendix 4 of NUREG 0654, the estimated elapsed times for the receipt of notification can be expressed as a distribution reflecting the different notification times for different people within, and outside, the EPZ. By using time

distributions, it is also possible to distinguish between different population groups and different day-of-week and time-of-day scenarios, so that more accurate assessments may be obtained.

For example, persons located inland within the EPZ will be notified by siren and radio. Those well outside the EPZ will be notified by telephone, radio, TV and word-of-mouth, with potentially longer time lags.

Furthermore, the spatial distribution of the EPZ population will differ with time of day -- families will be united in the evenings 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 (other than the first) occurs at an instant in time and is the outcome of an activity.

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

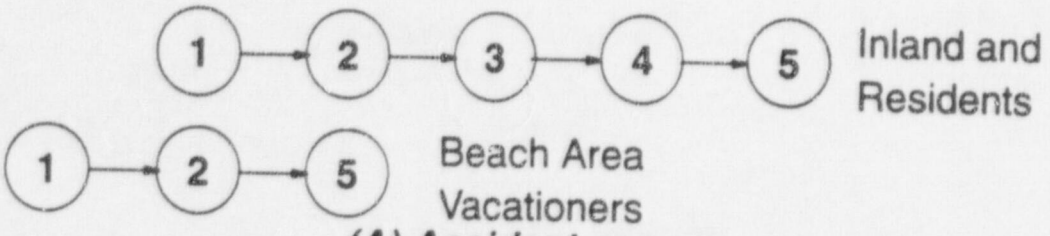
Activities conducted in series are functionally dependent on the completion of prior activities; activities conducted in parallel are functionally independent of one-another. The relevant events associated with the public's preparation for evacuation are:

Event Number	Event Description
1	No-accident condition
2	Awareness of accident situation
3	Depart place of work
4	Arrive home
5	Leave to evacuate the area

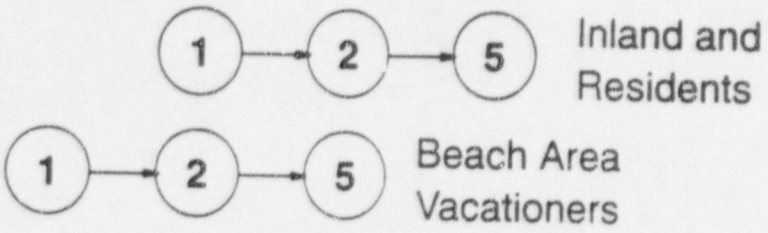
Associated with each sequence of events are one or more activities, as outlined below:

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

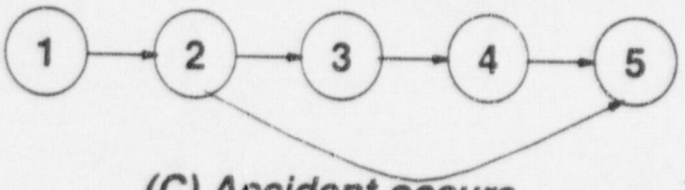
These relationships may be depicted graphically as shown in Figure 4-1.



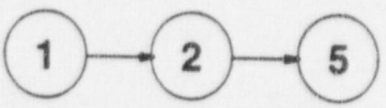
(A) Accident occurs during midweek, at midday; summer season



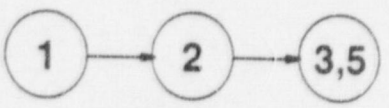
(B) Accident occurs during weekend, at midday; summer season



(C) Accident occurs during midweek at midday; non-summer season



(D) Accident occurs in the evening; non-summer season



(E) Employees within the EPZ who live outside the area

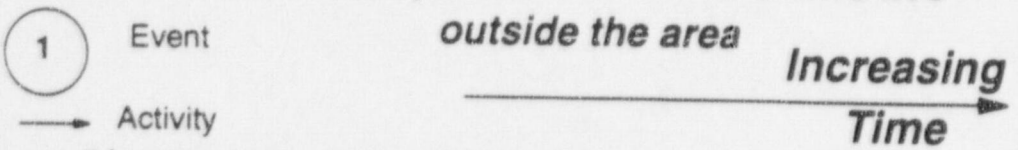


Figure 4-1. Events and Activities Preceding the Evacuation
(See Text for definitions)

Note that event 5, "Leave to evacuate the area" is conditional either on event 2 or event 4. That is, activities 2 --> 5 can be undertaken in parallel with activities 2 --> 3, 3 --> 4 and 4 --> 5, 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 traveling 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. 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. (See Appendices F and G).

The following information is relevant:

Average Household (HH) Size: 3.21
Avg. Number of Commuters per HH: 754/599 = 1.26
Percentage of Residents who will be within the EPZ if accident occurs at mid-week, mid-day:

$$\frac{0.41\ (1.26) + (3.21-1.26)}{3.21} \times 100 = 76.8$$

since 41 percent of all commuters work within the EPZ, according to the survey results.

The population within the EPZ includes 76.8 percent of all residents, as computed above, and 100 percent of all tourists and employees, by definition.

It is reasonable to expect that 90 percent of those within the EPZ will be aware of the accident within 15 minutes with the remainder notified within the following 15 minutes. The commuters outside the EPZ will be notified somewhat later, say uniformly between 10 and 40 minutes, while the entire beach area population will be notified within 15 minutes. The primary means of notifying boaters off shore is through EBS and Coast Guard broadcasts. However, mariners who do not have radios, or whose radios are not tuned to EBS or emergency frequencies will take longer to notify. It is assumed that 50 percent of boaters are notified by 40 minutes, with the balance notified by 1 hour after the Site Area Emergency has been declared. The resulting distributions for this notification activity are given below:

Distribution No. 1, Notification Time: Activity 1 --> 2

Persons off the Beach: Distribution 1A

Elapsed Time (min.)	Cum. Pct. Notified
5	15
10	46
15	79
20	85
25	90
30	95
35	98
40	100

Persons on the Beach: Distribution 1B

Elapsed Time (min.)	Cum. Pct. Notified
5	20
10	60
15	100

Persons on Boats: Distribution 1C

Elapsed Time (min.)	Cum. Pct. Notified
5	5
10	10
15	15
20	20

Elapsed Time (min.)	Cum. Pct. Notified
25	25
30	30
35	40
40	50
45	60
50	75
55	90
60	100

It is reasonable to expect that the vast majority of business enterprises within the EPZ will elect to shut down following notification. Most employees would take action to leave work quickly. Commuters who work outside the EPZ could, in all probability, also leave quickly since facilities outside the EPZ would remain open and other personnel would remain. Personnel responsible for equipment would require additional time to secure the facility. The distribution of Activity 2 --> 3 reflects data obtained by the telephone survey. This distribution is plotted in Figure 2-1 and listed below as Distribution 2.

Distribution No. 2, Time to Prepare to Leave Work: Activity 2 --> 3

Elapsed Time (min.)	Cum. Pct. Leaving Work
5	56
10	72
15	81
20	84
25	85
30	92
35	93
40	94
45	95
50	96
55	96
60	98
65	98
70	98
75	98
80	98
85	99
90	99
95	99
100	99
105	99
110	100

NOTE: The survey data was normalized to distribute the "Don't know" response

Distribution No. 3, Time to Travel Home: Activity 3 --> 4

This data is provided directly by the telephone survey. This distribution is plotted in Figure 2-1 and listed below:

Elapsed Time (min.)	Cum. Pct. Returning Home
5	12
10	26
15	37
20	47
25	52
30	60
35	64
40	68
45	77
50	80
55	81
60	89
65	91
70	92
75	94
80	96
85	97
90	98
95	98
100	98
105	99
110	99
115	100

NOTE: The survey data was normalized to distribute the "Don't know" response

Distribution No. 4, Time to Prepare to Leave Home: Activity 2,4 --> 5

This data is provided directly by the telephone survey. This distribution is plotted in Figure 2-1 and listed below:

Distribution 4A: Residents & Tourists off the Beach

Elapsed Time (min)	Cum. Pct. Ready to Evacuate
5	9
10	19
15	30
20	43

Elapsed Time (min)	Cum. Pct. Ready to Evacuate
25	53
30	60
35	63
40	66
45	68
50	73
55	76
60	80
65	83
70	85
75	88
80	89
85	89
90	90
95	90
100	90
105	90
110	91
115	92
120	92
125	93
130	94
135	96
140	96
145	96
150	96
155	96
160	96
165	96
170	96
175	96
180	97
185	97
190	98
195	99
200	99
205	99
210	100

NOTE: The original data was obtained in 15-minute increments. The above figures were calculated by interpolation and normalized as before.

Distribution 4B: Tourists on the Beach

Distribution 4B describes the estimated preparation time to leave the beach area. While we have no empirical data to support this distribution, we do know the physical domain of the beach area and the activities involved.

People on the beach or out walking would merely gather their belongings and walk to their respective cars. Others who are lodged in overnight accommodations and in tourist facilities would return to pack their belongings and leave. Business people and permanent residents must secure their property and then pack, before leaving.

On a weekend, almost half of all visitors are day-trippers. These people should be able to access their respective cars within 30 minutes of the receipt of the notification information and be ready to depart.

About 80 percent of the remaining visitors (i.e. 40 percent of the total) should be able to access their respective cars within 1.5 hours. The remaining people are those who must take longer, say, up to two hours.

The resulting distribution follows:

Elapsed Time (min)	Cum. Pct. Ready to Evacuate
5	12
10	23
15	35
20	46
25	57
30	68
35	70
40	72
45	74
50	76
55	79
60	81
65	84
70	86
75	89
80	91
85	94
90	97
95	97
100	98
105	98
110	99
115	99
120	100

Distribution 4C: Boaters Return to Launch Sites

Distribution 4C describing the estimated time required for boaters to motor, or sail, back to the marina, yacht club, or launching ramp from where their trip originated after notification. The data for this distribution was obtained from

interviews with boaters returning to public launch ramps in Plymouth and Duxbury.

Elapsed Time (min)	Cum. Pct. Arriving at Dock
5	0
10	7
15	17
20	51
25	54
30	70
35	73
40	80
45	93
50	93
55	93
60	100

Distribution 4D: Boaters Prepare to Evacuate

Distribution 4D describes the time required to load a boat trailer once the boat is at the launch ramp. The data for this distribution was obtained from interviews with boaters.

Elapsed Time (min)	Cum. Pct. Boats Loaded
5	39
10	81
15	97
20	97
25	97
30	97
35	97
40	97
45	97
50	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:

- The time distribution of event, k, is known, and
- 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,

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

$$T_m(k+1) = T_i(k)+t_j \text{ where } I+j-1=m$$

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

Example: Dependent Events--Application of Algorithm No. 1

Time Distribution of event, k			Time Distribution of activity, k->k+1		
I	$P_i(k)$	$T_i(k)$	j	P_j	t_j
1	30	10	1	50	20
2	50	20	2	30	30
3	10	30	3	20	40
4	10	40			

Let m = 1. Then I = j = 1

$P_1(k+1) = (30)\ (50)/100 = 15$; $T_1(k+1) = 10+20=30$

Let m = 2. Then I=1, j=2 ; I=2, j=1

$P_2(k+1) = [(30)(30) + (50)(50)]/100=34$

$T_2(k+1) = 10 + 30 = 40$

Let m = 3. Then I = 1, j = 3 ; I = 2, j = 2 ; I = 3, j = 1

$P_3(k+1) = [(30)(20) + (50)(30) + (10)(50)]/100 = 26$

$T_3(k+1) = 10 + 40 = 50$

Let m = 4. Then I = 2, j = 3 ; I = 3, j = 2 ; I = 4, j = 1

$P_4(k+1) = 18$, $T_4(k+1) = 60$

Let m = 5. Then I = 3, j = 3 ; I = 4, j = 2

$P_5(k+1) = 5$, $T_5(k+1) = 70$

Let m = 6. Then I = 4, j = 3 ; $P_1(k+1) = 2$, $T_1(k+1) = 80$

Computed Time Distribution of Event k+1

m	$P_m(k+1)$	$T_m(k+1)$
1	15	30
2	34	40
3	26	50
4	18	60

m	$P_m(k+1)$	$T_m(k+1)$
5	5	70
6	2	80

Definitionally, the distribution for Event No 2 is identical to Distribution 1A (or 1B), since Event No. 1 (the normal condition) is a continuum. To obtain the needed distributions we apply algorithm No. 1 repeatedly, as indicated below:

Apply Algorithm No. 1 to	in order to Obtain Dist. for	which is named Distribution
Distributions 1A and 2	Event No. 3	A
Distributions A and 3	Event No. 4	B
Distributions B and 4A	Event No. 5	C
Distributions 1A and 4A	Event No. 5	D
Distributions 1B and 4B	Event No. 5	E
Distributions 1C and 4C and 4D	Event No. 5	E_B

Table 4-1 lists the calculated distributions, which are explained below:

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

Table 4-1. Computed Trip Generation Cumulative Distributions (Percent) from Start of Notification

Elapsed Time (Hr:Min)	A	B	C	D	E	E_B
0:05	0	0	0	0	0	0
0:10	8	0	0	1	2	0
0:15	28	1	0	6	11	0
0:20	53	5	0	13	25	0
0:25	65	11	1	23	36	1
0:30	73	19	2	33	44	2
0:35	79	27	4	43	55	4
0:40	85	34	6	51	64	7
0:45	90	41	10	57	70	11
0:50	92	48	14	61	72	14
0:55	93	54	19	65	74	19
1:00	95	60	23	69	76	25
1:05	96	65	28	73	78	32
1:10	97	70	32	77	81	40
1:15	97	75	37	80	83	49
1:20	98	79	42	83	86	59
1:25	98	83	46	85	88	69
1:30	98	85	51	87	91	76
1:35	98	88	55	88	93	82
1:40	99	90	60	89	96	87
1:45	99	92	63	90	97	91
1:50	99	93	67	90	98	94
1:55	99	94	70	90	98	96
2:00	99	95	73	91	99	97
2:05	100	96	76	91	99	99
2:10		97	78	92	100	99
2:15		97	80	92		99
2:20		98	82	93		99
2:25		98	83	95		99
2:30		99	85	95		100
2:35		99	86	96		
2:40		100	87	96		
2:45			89	96		
2:50			90	96		
2:55			91	96		
3:00			91	96		
3:05			92	96		
3:10			93	97		
3:15			93	97		
3:20			94	98		
3:25			94	98		
3:30			95	99		
3:35			95	99		
3:40			96	100		
3:45			96			
3:50			96			
3:55			97			

Table 4-1. Computed Trip Generation Cumulative Distributions (Percent) from Start of Notification (conc.)

Elapsed Time (Hr:Min)	A	B	C	D	E	E_B
4:00			97			
4:05			98			
4:10			99			
4:15			100			

The Trip Generation time distributions for non-beachgoing population groups within the EPZ has its origin point at the time notification of the public begins at the Declaration of a General Emergency. Ten minutes later, at the time of the Evacuation Directive, about 8 percent of employees within the area are ready to begin the evacuation trip; less than 1 percent of residents are ready to evacuate.

The scenario is different for people at the beach. Current planning calls for beach areas to be closed beginning at an Alert, or 25 minutes prior to the Evacuation Directive. Consequently, when the Directive to Evacuate is issued, about 36 percent of the people at the beach are ready to comply, or have already begun leaving the beaches. Figure 4-2 presents these distributions (A, D and E) on the same time scale, showing their relative temporal displacement.

Trip Generation Distributions for Week-end Scenarios

The IDYNEV model is designed to accept varying rates of trip generation for each origin centroid, expressed in the form of histograms. These centroids are partitioned into several sets -- those for beach area traffic, for residents and employees. These histograms, which represent Distributions A, D and E, properly displaced with respect to one another, are tabulated in Tables 4-2 and 4-2a. Note that the point of reference (i.e. "zero time") of these histograms is the time at which the Directive to Evacuate is given.

These tabulations present the trips generated and 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:

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

Trip Generation Distribution for Permanent Residents, for Weekday Scenarios

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 22 percent of the households within the EPZ have no commuters, according to the telephone survey (see Appendix G). Distribution F is listed in Tables 4-3 and in Table 4-4 in a format suitable for input to IDYNEV.

Figure 4-2. Comparison of Trip Generation Distributions

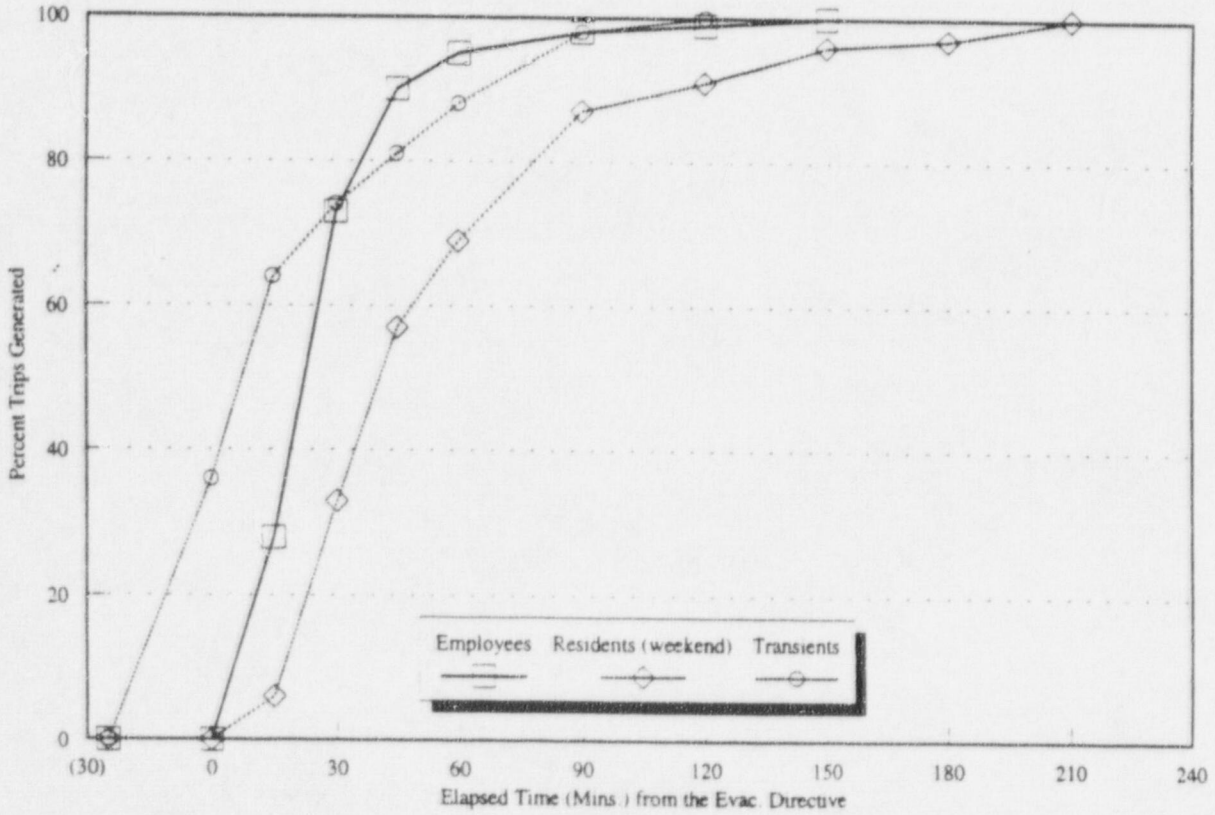


Table 4-2. Trip Generation Time Histograms for the Week-end Scenarios

Time Period Relative to Time of Directive To Evacuate (Hrs.:Min.)	Percent of Total Trips and Rates which are Generated During the Indicated Time Periods					
	Beach Areas (from Dist. E)		Residents (from Dist. D)		Employees (from Dist. A)	
	Trips	Rate	Trips	Rate	Trips	Rate
-0:25 to 0:00	36	86	0	0	0	0
0:00 to 0:15	28	112	6	24	28	112
0:15 to 0:30	10	40	27	108	45	180
0:30 to 0:45	7	28	24	96	17	68
0:45 to 1:00	7	28	12	48	5	20
1:00 to 1:30	10	20	18	36	3	6
1:30 to 2:00	2	4	4	8	1	2
2:00 to 2:30	0	0	5	10	1	2
2:30 to 3:00	0	0	1	2	0	0
3:00 to 3:30	0	0	3	6	0	0
3:30 onward	0	0	0	0	0	0

Units: Trips, percent of total trips which are generated at the origin centroids during indicated Time Period
Rate, percent of total trips per hour during indicated Time Period

Table 4-2a. Trip Generation Time Histograms for the Boating Population (Distribution E_B)

Time Period Relative to Time of Directive to Evacuate (Hrs:Min)	Percent of Total Trips and Rates which are Generated During the Indicated Time Periods	
	Trips	Rate
-0:25 to 0:00	0	0
0:00 to 0:15	0	0
0:15 to 0:30	2	8
0:30 to 0:45	9	36
0:45 to 1:00	14	56
1:00 to 1:30	51	102
1:30 to 2:00	21	42
2:00 to 2:30	3	6
2:30 to 3:00	0	0

Units: Trips, percent of total trips which are generated at the origin centroids during indicated Time Period
Rate, percent of total trips per hour during indicated Time Period

Table 4-3. Computed Trip Generation Time Distribution for the Mid-week, Mid-day Scenario (Distribution F)

Elapsed Time (Hrs:Min)	Cum. Pct. of Trips Generated	Elapsed Time (Hrs:Min)	Cum. Pct of Trips Generated
0:05	0	2:05	79
0:10	0	2:10	81
0:15	1	2:15	83
0:20	3	2:20	84
0:25	6	2:25	86
0:30	9	2:30	87
0:35	13	2:35	88
0:40	16	2:40	89
0:45	20	2:45	91
0:50	24	2:50	91
0:55	29	2:55	92
1:00	33	3:00	92
1:05	38	3:05	93
1:10	42	3:10	94
1:15	46	3:15	94
1:20	51	3:20	95
1:25	55	3:25	95
1:30	59	3:30	96
1:35	62	3:35	96
1:40	66	3:40	96
1:45	69	3:45	97
1:50	72	3:50	97
1:55	74	3:55	98
2:00	77	4:00	98
		4:05	99
		4:10	100

Table 4-4. Trip Generation Time Histograms for the Week-day Scenarios (Dist. F)

Time Period Relative to Time of Directive to Evacuate (Hrs.:Min)	Percent of Total Trips and Rates which are Generated During the Indicated Time Periods	
	Trips	Rate
-0:25 to 0:00	0	0
0:00 to 0:15	1	4
0:15 to 0:30	8	32
0:30 to 0:45	11	44
0:45 to 1:00	13	52
1:00 to 1:30	26	52
1:30 to 2:00	18	36
2:00 to 2:30	10	20
2:30 to 3:00	5	10
3:00 to 3:30	4	8
3:30 to 4:00	2	4
4:00 to 4:10	2	12
4:10 onward	0	

Units: Trips, percent of total trips at centroid
Rate, percent of total trips, per hour

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 snow clearance distribution shown in Table 4-5 was obtained from the telephone survey.

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

The following additional operations are needed to compute the trip generation distributions for the inclement weather, snow scenarios:

Table 4-5: Distribution of Snow Clearance Time: Distribution 5

Elapsed Time (min.)	Cum. Percent of Driveways Cleared
5	8
10	17
15	28
20	37
25	45
30	50
35	53
40	56
45	59
50	63
55	66
60	70
65	73
70	76
75	79
80	81
85	83
90	84
95	85
100	86
105	86
110	87
115	88
120	88
125	89
130	90
135	91
140	91
145	91
150	92
155	92
160	92
165	92
170	92
175	93
180	94
185	95
190	97
195	100

Note: The survey data was normalized to distribute the "Don't Know" response

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:

- Distribution G applies to employees
- Distribution H applies to residents during mid-day
- Distribution I applies to residents during the evening/weekend and for transients.

Appendix M presents the loading rates at each origin centroid shown in Figure 1-2. Note that these are the estimated rates at which vehicles leave their respective points of origin (i.e. home, beach area, motel, place of business) to begin the evacuation trip. The rates at which these vehicles enter the evacuation network, as shown on Figure 1-2, via their respective Access Links, depend on traffic conditions, and may be lower than the rates shown in Appendix M. The IDYNEV simulation submodel computes these "access" loading rates internally, in order to realistically represent the evacuation environment.

Table 4-6. Trip Generation Time Histograms for the Inclement Weather, Snow, Scenarios (Distributions G, H, I)

Time Period Relative to Time of Directive to Evacuate (Hrs.:Min.)	Percent of Trips and Rates which are Generated During the Indicated Time Periods					
	Dist. G Trips	Rate	Dist. H Trips	Rate	Dist. I Trips	Rate
0:00 to 0:15	1	4	0	0	0	0
0:15 to 0:30	8	32	0	0	4	16
0:30 to 0:45	11	44	3	12	11	44
0:45 to 1:00	13	52	5	20	13	52
1:00 to 1:30	26	52	16	32	23	46
1:30 to 2:00	18	36	19	38	17	34
2:00 to 2:30	10	20	17	34	10	20
2:30 to 3:00	5	10	13	26	6	12
3:00 to 3:30	4	8	8	16	5	10
3:30 to 4:00	4	8	7	14	6	12
4:00 to 4:10	0	0	2	12	1	6
4:10 to 4:30	0	0	4	12	2	6
4:30 to 5:00	0	0	3	6	1	2
5:00 to 5:30	0	0	3	6	1	2
5:30 onward	0	0	0	0	0	0

Units: Trips, percent of total trips at centroid
Rate, percent of total trips per hour

5. ESTIMATED TRAFFIC DEMAND FOR EVACUATION SCENARIOS

An evacuation case may be defined in terms of the region to be evacuated and the scenario under consideration. The definition of region and scenario is as follows:

Region - A grouping of emergency response planning areas (Subareas) within the EPZ. Depending on such factors as wind direction, and accident severity, a protective action decision may identify the need to evacuate one or more such subareas. Each region takes the approximate form of a circular area, or of a "keyhole" configuration consisting of a quadrant appended to a central circular area.

Scenario - A combination of time of day, season and weather conditions. Scenarios define the sizes of, and trip generation distributions for, the various population groups. In addition, the specified weather conditions influence the estimates used for highway capacity.

A total of 12 Subareas were defined which encompass all of the potential groupings to be considered. Subarea boundaries are described in Table 5-1 and shown in Figure 5-1. Regional groupings are presented in Table 5-2.

A total of 10 scenarios were evaluated for all regions, yielding 220 case studies. Table 5-3 presents a description of all scenarios.

Each accident scenario implies a specific population to be evacuated. Table 5-4 summarizes the percentage of each population group assumed to evacuate with each scenario. The following figure numbers present population "roses" for each scenario.

Figure Numbers

Scenario	Permanent Resident Pop.	Veh.	Transients Pop.	Veh.	Employees Pop.	Veh.
1,2	2-4,	2-5	2-6,	2-7	5-2,	5-3
3,4	2-4,	2-5	5-4,	5-5	2-8,	2-9
5,6,7	2-4,	2-5	5-6,	5-7	2-8,	2-9
8,9,10	2-4,	2-5	5-10,	5-11	5-8,	5-9

Table 5-1. Description of Pilgrim Emergency Response Planning Areas

Subarea 1

Clifford Road north to coast and south to Howland Pond's southern shore; from Howland Pond southeast to Strand Avenue/Route 3 intersection; and east on Strand Avenue to coast.

Subarea 2

South along Russell Mills Road to Jordan Road, south to Long Pond Road and south to Long Pond Road and Ship Pond Road intersection. East on Ship Pond Road to the coast; north along the coast to Strand Avenue. Strand Avenue west to Strand Avenue/Route 3A intersection and northwest to the southern shore of Howland Pond.

Subarea 3

South Park Avenue west to North Park Avenue, west to Route 44 west to Route 3. South on Route 3 to eastern shores of Deep Water Pond and Billington Sea, south along Watercourse Road to eastern shores of Little South Pond, Great South Pond, Boot Pond and Gunners Exchange Pond. Southeastern shore of Gunners Exchange Pond southeast to intersection of Long Pond and Alden Roads. North on Long Pond Road to Jordan Road, northeast on Jordan Road to Russell Mills Road. East on Russell Mills Road to Clifford Road. North on Clifford Road to the coast.

Clifford Road north to the coast, north to northern point of Plymouth Beach, south on western shore of Plymouth Beach, north along coast to South Park Avenue.

Subarea 4

Powder Point Bridge south on Duxbury Beach to Gurnet Point; west along Saquish Neck to Saquish Head; and Clarks Island.

Table 5-1. Description of Pilgrim Emergency Response Planning Areas (cont.)

Subarea 5

From intersection of Long Pond and Alden Roads southwest to Upper College Pond Road. Southwest along Upper College Pond Road to Plymouth/Carver Town Line. Southwest on Plymouth/Carver Town Line, east on Plymouth/Wareham Town Line and east along Plymouth/Bourne Town Line. From Plymouth/Bourne Town Line, north along coast to Ship Pond Road, west on Ship Pond Road to Long Pond Road; north on Long Pond Road to intersection at Alden Road.

Subarea 6

From intersection of Routes 3 and 44, west on Route 44 to Plymouth/Carver Town Line. South along Plymouth/Carver Town Line to Upper College Pond Road. Northeast along Upper College Pond Road to Alden Road, east along Alden Road to intersection at Long Pond Road. West to southeastern shore of Gunners Exchange Pond. North along eastern shores of Gunners Exchange Pond, Boot Pond, Great South Pond, and Little South Pond. North along Watercourse Road to eastern shores of Billington Sea and Deep Water Pond to Route 3. North on Route 3 to intersection at Route 44.

Subarea 7

Plymouth/Kingston Town Line from the coast southwest to Plymouth/Carver Town Line and south to Route 44; east along Route 44 to North Park Avenue, east to South Park Avenue, east to the coast.

Subarea 8

Kingston Town Lines (entire Town of Kingston).

Table 5-1. Description of Pilgrim Emergency Response Planning Areas (conc.)

Subarea 9

Duxbury/Marshfield, Duxbury/Pembroke, and Duxbury/Kingston Town Lines; east then northeast along Duxbury coast to Powder Point Bridge; from western edge of bridge east to Duxbury Beach, north to Duxbury/Marshfield Town Line.

Subarea 10

Marshfield/Duxbury Town Line at coast, west and northwest to Route 139. Route 139 east on Careswell Street to coast, south along coast to Marshfield/Duxbury Town Line.

Subarea 11

Plympton/Carver Town Line at Kingston Town Line, west to Route 58; south on Route 58 to Carver/Wareham town Line, southeast to Carver/Plymouth Town Line; north to Carver/Plympton Town Line at Kingston.

Subarea 12

That portion of Cape Cod Bay and Atlantic Ocean extending 10 miles out from the Pilgrim Station.

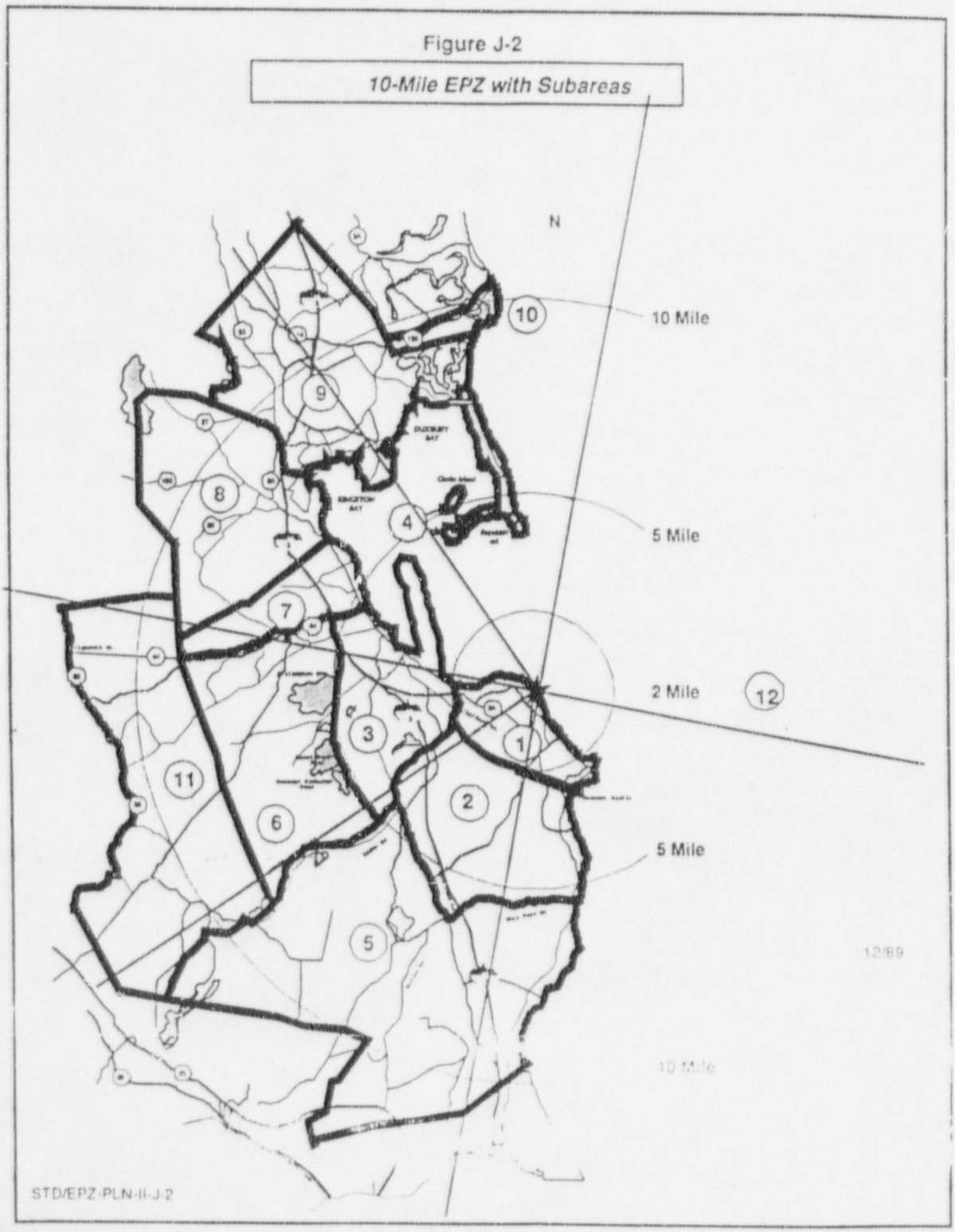


Figure 5-1. Pilgrim Station Emergency Response Planning Areas

Table 5-2. Regional Evacuation Groupings

Wind Direction From	2 - Miles		5 - Miles		EPZ Boundary	
	Reg.	Subareas	Reg.	Subareas	Reg.	Subareas
006°-019°	1	1	2	1,2	7	1,2,5
020°-021°	1	1	3	1,2,3	8	1,2,3,5,6
022°-056°	1	1	3	1,2,3	9	1,2,3,5,6,11
057°-063°	1	1	3	1,2,3	10	1,2,3,6,11
064°-066°	1	1,12	3	1,2,3,12	10	1,2,3,6,11,12
067°-069°	1	1,12	3	1,2,3,12	11	1,2,3,6,7,11,12
070°-103°	1	1,12	4	1,3,12	12	1,3,6,7,8,11,12
104°-109°	1	1,12	4	1,3,12	13	1,3,6,7,8,9,11,12
110°-115°	1	1,12	4	1,3,12	14	1,3,6,7,8,9,12
116°-122°	1	1,12	4	1,3,12	15	1,3,7,8,9,12
123°-129°	1	1,12	5	1,3,4,12	16	1,3,4,7,8,9,12
130°-132°	1	1,12	5	1,3,4,12	17	1,3,4,7,8,9,10,12
133°-140°	1	1,12	5	1,3,4,12	18	1,3,4,8,9,10,12
141°-175°	1	1,12	6	1,4,12	19	1,4,9,10,12
176°-179°	1	1,12	6	1,4,12	20	1,4,10,12
180°-183°	1	1,12	6	1,4,12	6	1,4,12
184°-305°	1	1,12	1	1,12	1	1,12
306°-318°	1	1,12	2	1,2,12	2	1,2,12
319°-005°	1	1,12	2	1,2,12	7	1,2,5,12
Any			21	1,2,3,4,12	22	1 - 12

Table 5-3. Descriptions of Evacuation Scenarios

Scenario 1 - Summer, Weekend, Midday, Good Weather

All of the permanent residents are present. Tourist and beach populations are at capacity. Employees are assumed to be present at 70 percent of midweek levels in the coastal region and at 40 percent of midweek levels throughout the rest of the EPZ. Clear weather.

Scenario 1A - Summer, Weekend, Evening, Good Weather

All of the permanent residents are present. Tourist and beach populations are at capacity. Employees are assumed to be present at 70 percent of midweek levels in the coastal region and at 40 percent of midweek levels throughout the rest of the EPZ. Clear weather. Typical northbound traffic is present on Route 3 at the start of evacuation.

Scenario 2 - Summer, Weekend, Midday, Rain

Same population as for Scenario 1. Rain occurs which reduces highway capacity and free-flow speeds by 20 percent.

Scenario 2A - Summer, Weekend, Evening, Rain

Same population as for Scenario 1A. Rain occurs which reduces highway capacity and free-flow speeds by 20 percent.

Scenario 3 - Summer, Midweek, Midday, Good Weather

All permanent residents are present. Tourists and beach area transients are at 75 percent of peak values. All employees are at work, as are commuters from within the EPZ who work outside the EPZ. Good weather.

Scenario 4 - Summer, Midweek, Midday, Rain

Same population as for Scenario 3. Rain occurs which reduces highway capacity and free-flow speeds by 20 percent.

Table 5-3. Descriptions of Evacuation Scenarios (conc.)

Scenario 5 - Off-season, Midweek, Midday, Good Weather

All permanent residents are present. Tourist population is at 25 percent of peak. There are no beach area transients or boaters. Employment is at 100 percent. Clear weather.

Scenario 6 - Off-season, Midweek, Midday, Rain

Same population as for Scenario 5. Rain occurs which reduces highway capacity and free-flow speeds by 20 percent.

Scenario 7 - Off-season, Midweek, Midday, Snow

Same population as for Scenario 5. Snow reduces highway capacity and free-flow speeds by 25 percent. Driveways must be cleared of snow prior to the start of the evacuation trip.

Scenario 8 - Off-season, Midweek, Evening, Good Weather or
Off-season, Weekend, All day, Good Weather

All permanent residents are present. Tourist population is at 25 percent of peak. There are no beach area transients or boaters. Employment is at 25 percent of the midweek peak. Clear weather.

Scenario 9 - Off-season, Midweek, Evening, Rain or
Off-season, Weekend, All day, Rain

Same population as for Scenario 8. Rain occurs which reduces highway capacity and free-flow speeds by 20 percent.

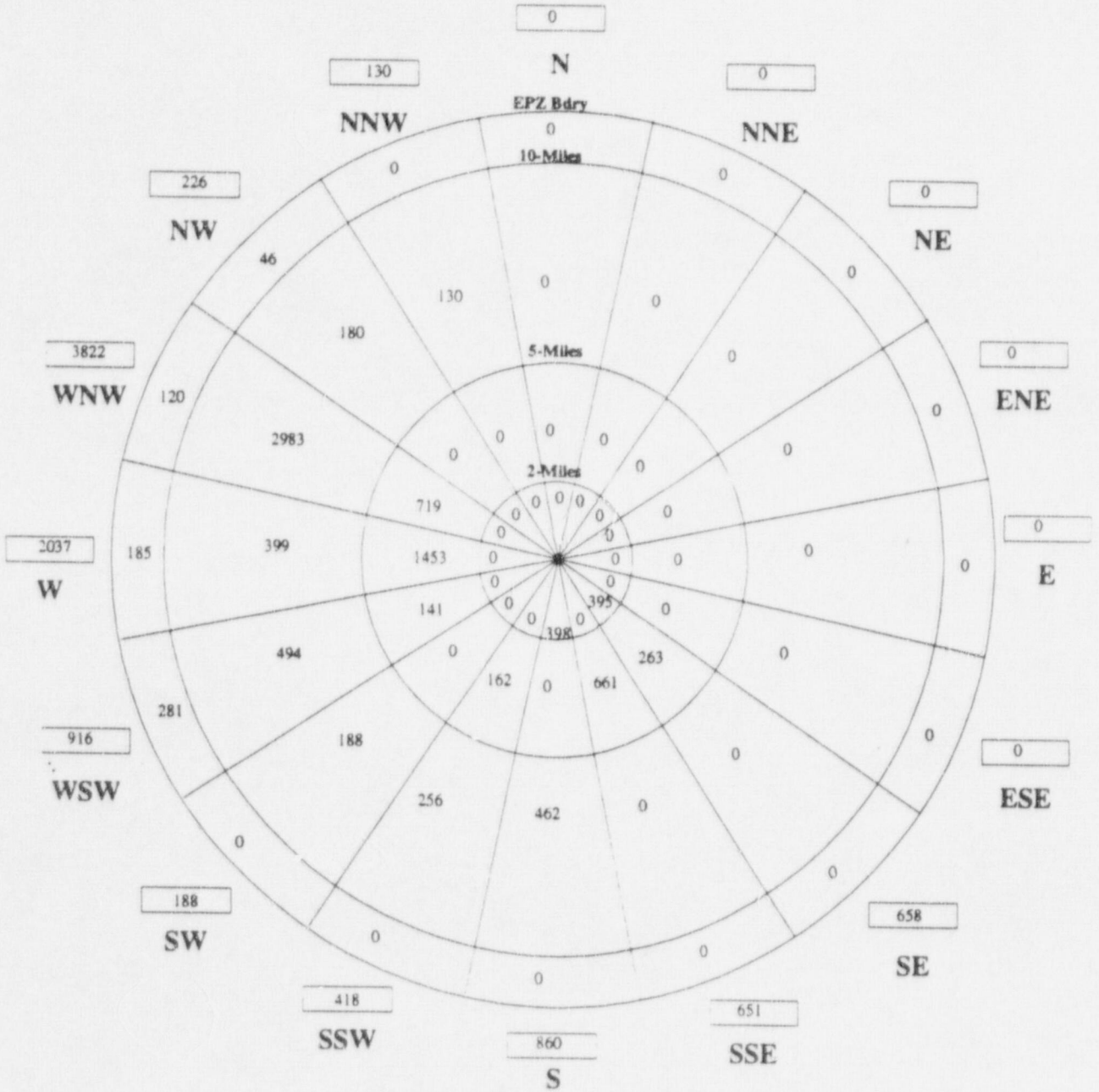
Scenario 10 - Off-season, Midweek, Evening, Snow or
Off-season, Weekend, All day, Snow

Same population as for Scenario 8. Snow reduces highway capacity and free-flow speeds by 25 percent. Driveways must be cleared of snow prior to the start of the evacuation trip.

Table 5-4. Percent of Population Groups for Various Scenarios

Scenario	Population Groups: Permanent	Transient: Tourists	Transient: Beaches	Employees: Coastal	Employees: Inland
Summer					
Weekend, Midday Scenarios 1,2	100	100	100	70	40
Midweek, Midday Scenarios 3,4	100	75	75	100	100
Off-season					
Midweek, Midday Scenarios 5,6,7	100	25	0	100	100
Midweek, Evening Weekend, All day Scenarios 8,9,10	100	25	0	25	25

It must be emphasized that this format is for presentation purposes, only. In conducting the analyses to estimate evacuation times, it was necessary to define the spatial distribution of traffic demand at a higher level of resolution by specifying over 150 centroids. Each centroid represents an area (or "Zone") within a community and a population group. The locations of these centroids are shown in Figure 1-2.

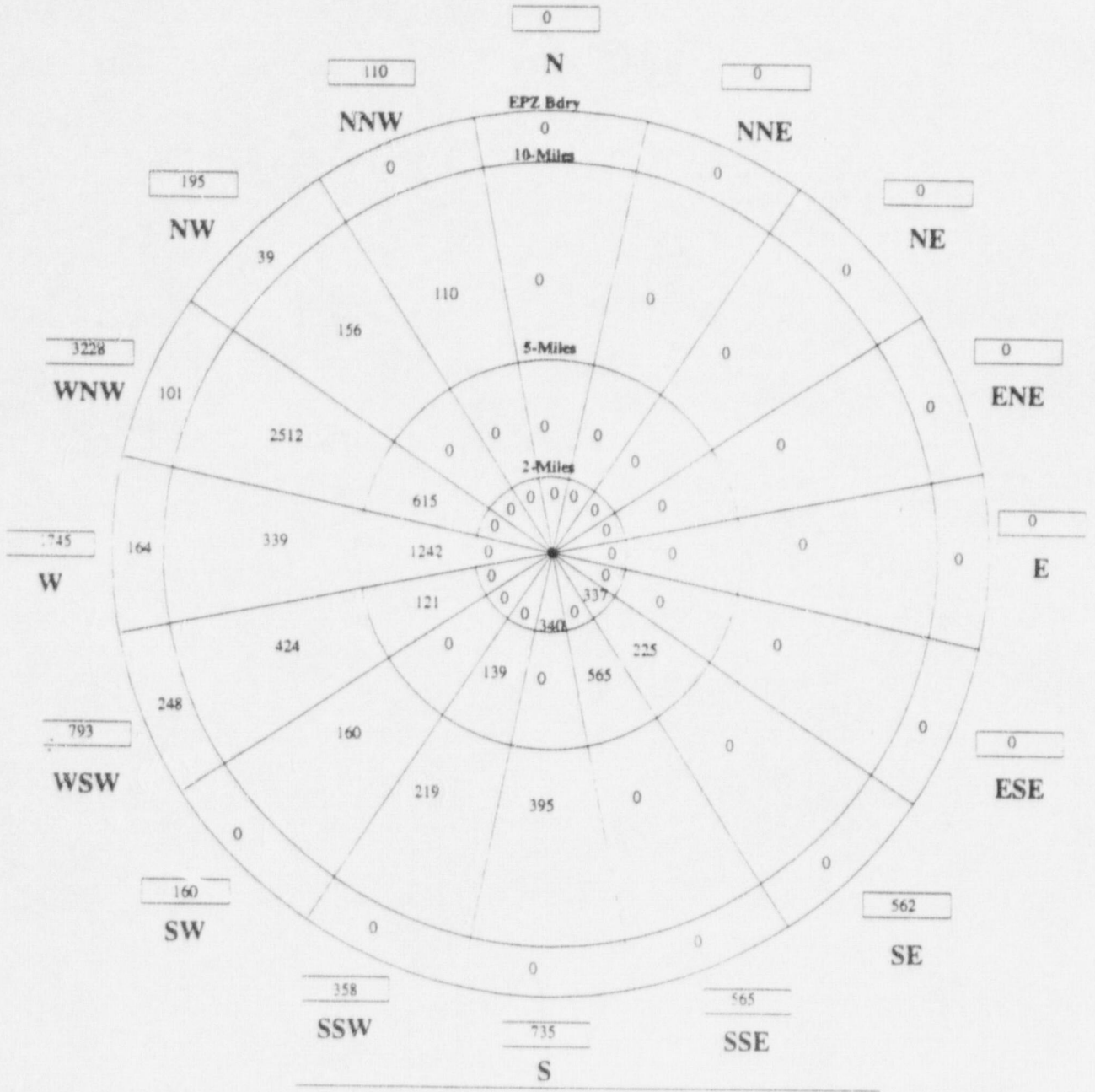


9916

Total Segment Population 0 to EPZ Boundary

Population Totals			
Ring	Ring Population	Total	Cumulative Population
0-2 Mi.	793	0-2 Mi.	793
2-5 Mi.	3399	0-5 Mi.	4192
5-10 Mi.	5092	0-10 Mi.	9284
10-EPZ	632	0-EPZ	9916

Figure 5-2 Employee Population, Scenarios 1, 2.



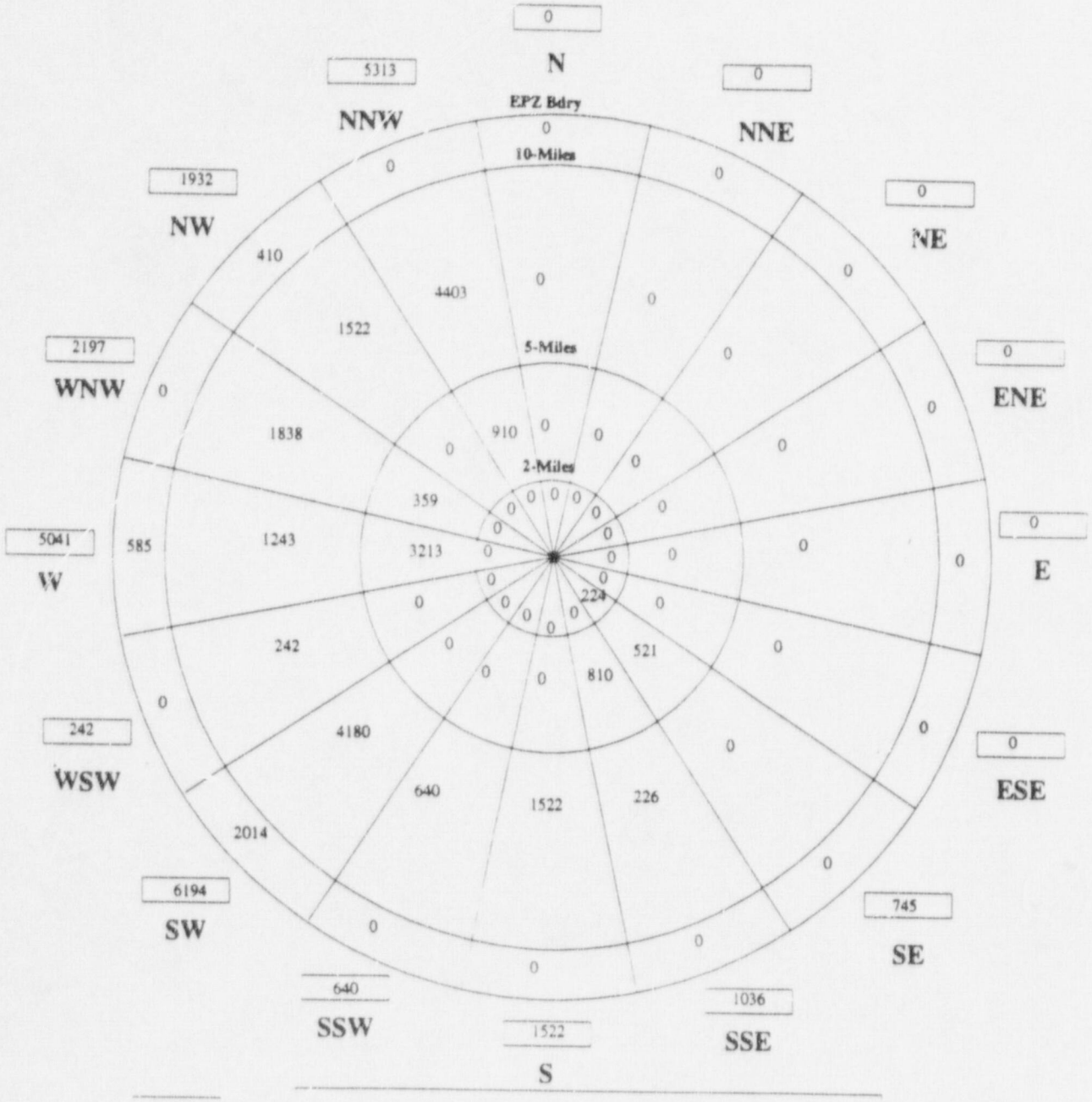
8451

Total Segment Population 0 to EPZ Boundary

Vehicle Totals

Ring	Ring Population	Total	Cumulative Population
0-2 Mi.	677	0-2 Mi.	677
2-5 Mi.	2907	0-5 Mi.	3584
5-10 Mi.	4315	0-10 Mi.	7899
10-EPZ	552	0-EPZ	8451

Figure 5-3 Employee Evacuating Vehicles, Scenarios 1, 2.



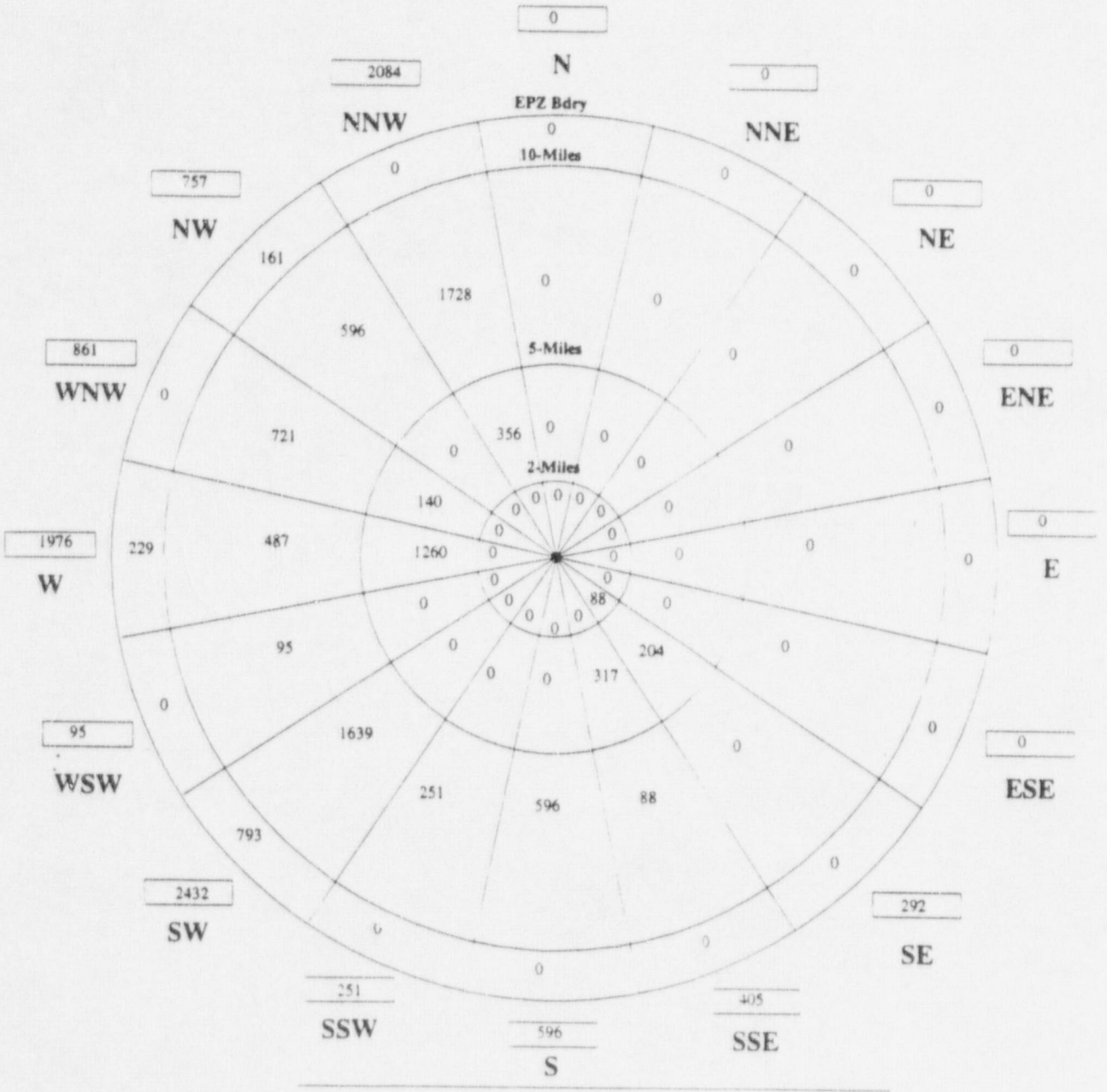
24862

Total Segment Population 0 to EPZ Boundary

Population Totals

Ring	Ring Population	Total	Cumulative Population
0-2 Mi.	224	0-2 Mi.	224
2-5 Mi.	5813	0-5 Mi.	6037
5-10 Mi.	15816	0-10 Mi.	21853
10-EPZ	3009	0-EPZ	24862

Figure 5-4 Transient Population
Scenarios 3, 4.



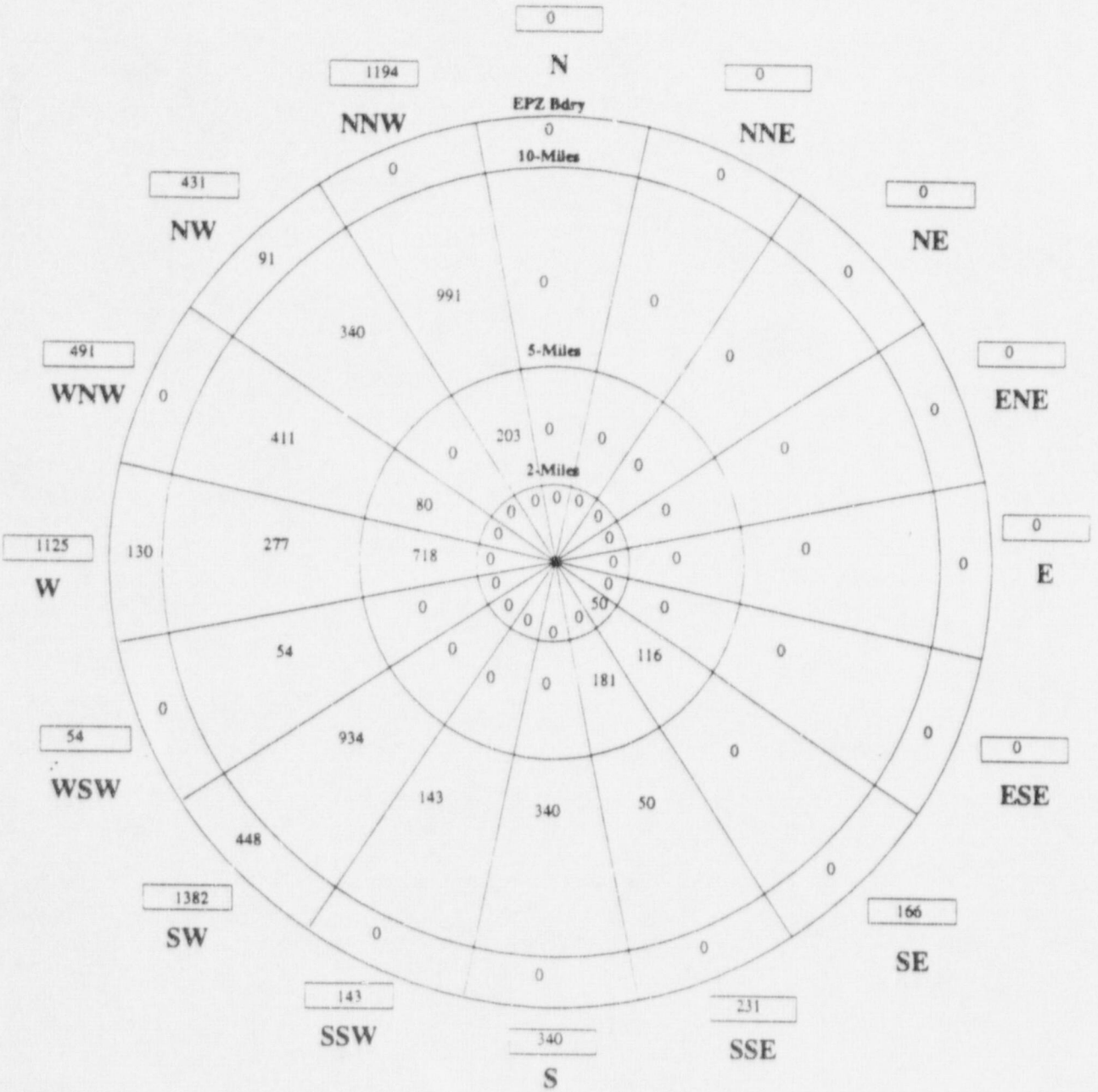
9749

Total Segment Population 0 to EPZ Boundary

Vehicle Totals

Ring	Ring Population	Total	Cumulative Population
0-2 Mi.	88	0-2 Mi.	88
2-5 Mi.	2277	0-5 Mi.	2365
5-10 Mi.	6201	0-10 Mi.	8566
10-EPZ	1183	0-EPZ	9749

Figure 5-5 Transient Population Vehicles Scenarios 3, 4.

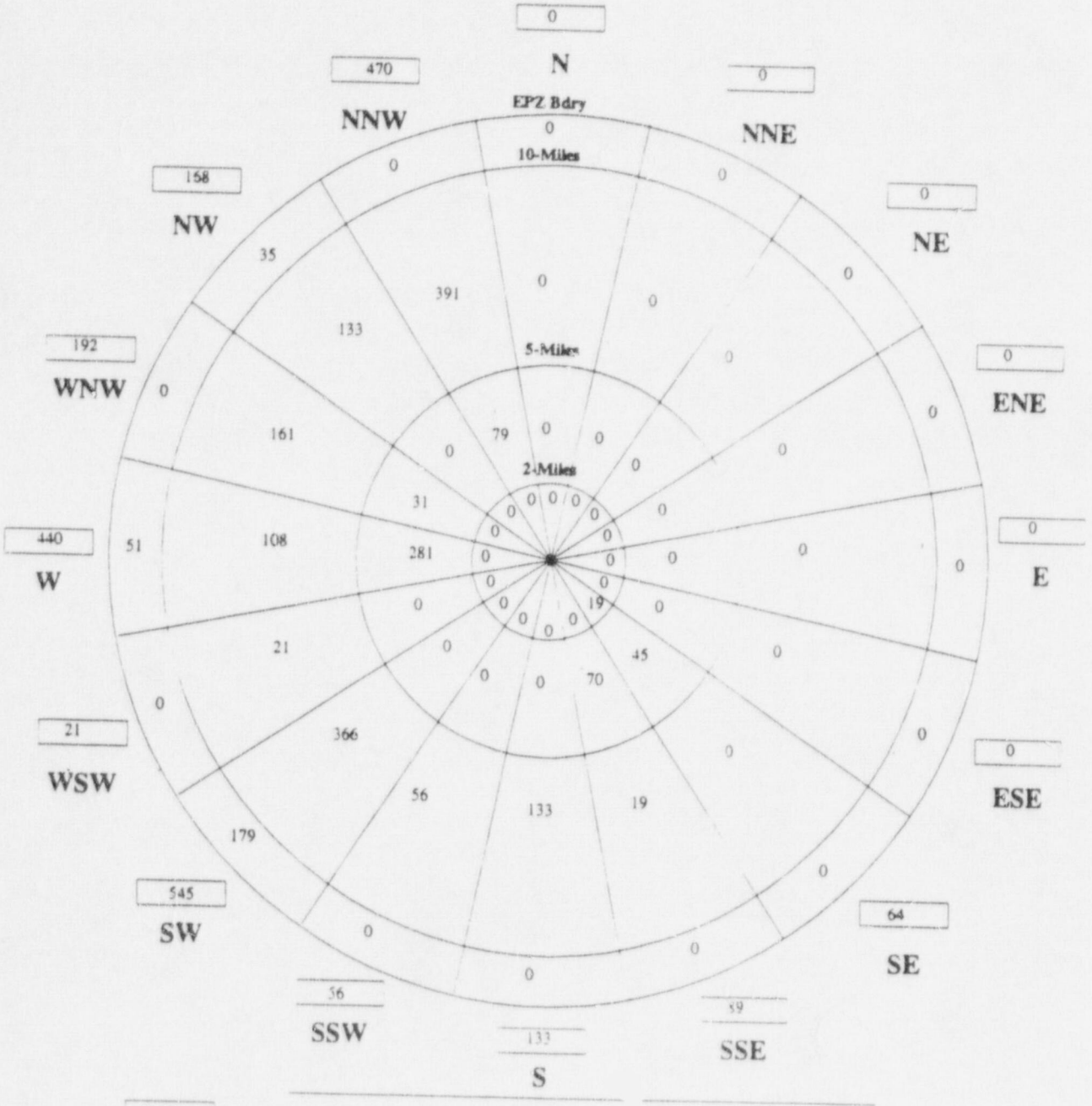


5557

Total Segment Population 0 to EPZ Boundary

Population Totals			
Ring	Ring Population	Total	Cumulative Population
0-2 Mi.	50	0-2 Mi.	50
2-5 Mi.	1298	0-5 Mi.	1348
5-10 Mi.	3540	0-10 Mi.	4888
10-EPZ	669	0-EPZ	5557

Figure 5-6 Transient Population
Scenarios 5, 6, 7.



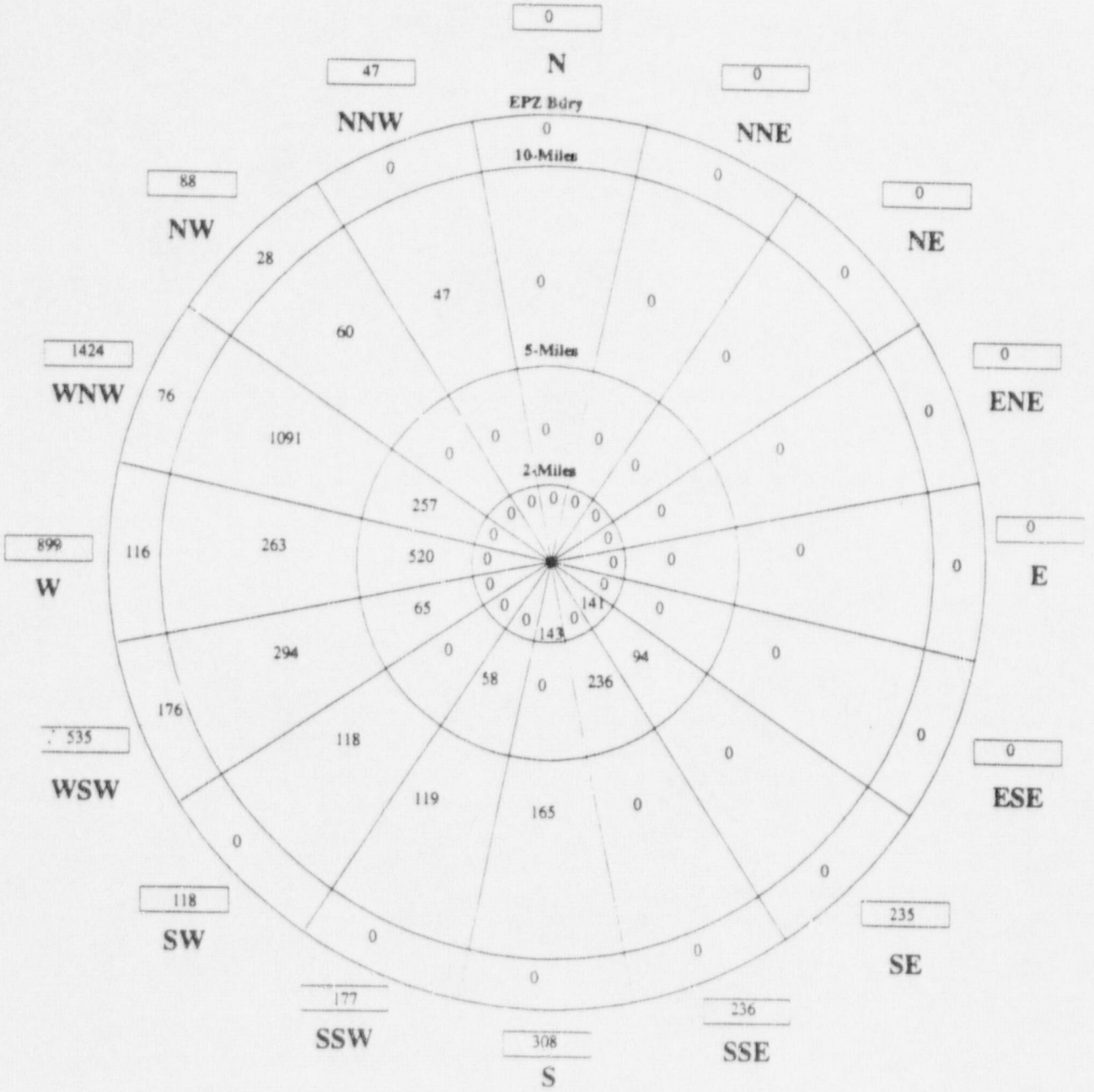
2178

Total Segment Population 0 to EPZ Boundary

Vehicle Totals

Ring	Ring Population	Total	Cumulative Population
0-2 Mi.	19	0-2 Mi.	19
2-5 Mi.	506	0-5 Mi.	525
5-10 Mi.	1388	0-10 Mi.	1913
10-EPZ	265	0-EPZ	2178

Figure 5-7 Transient Population Vehicles
Scenarios 5, 6, 7.

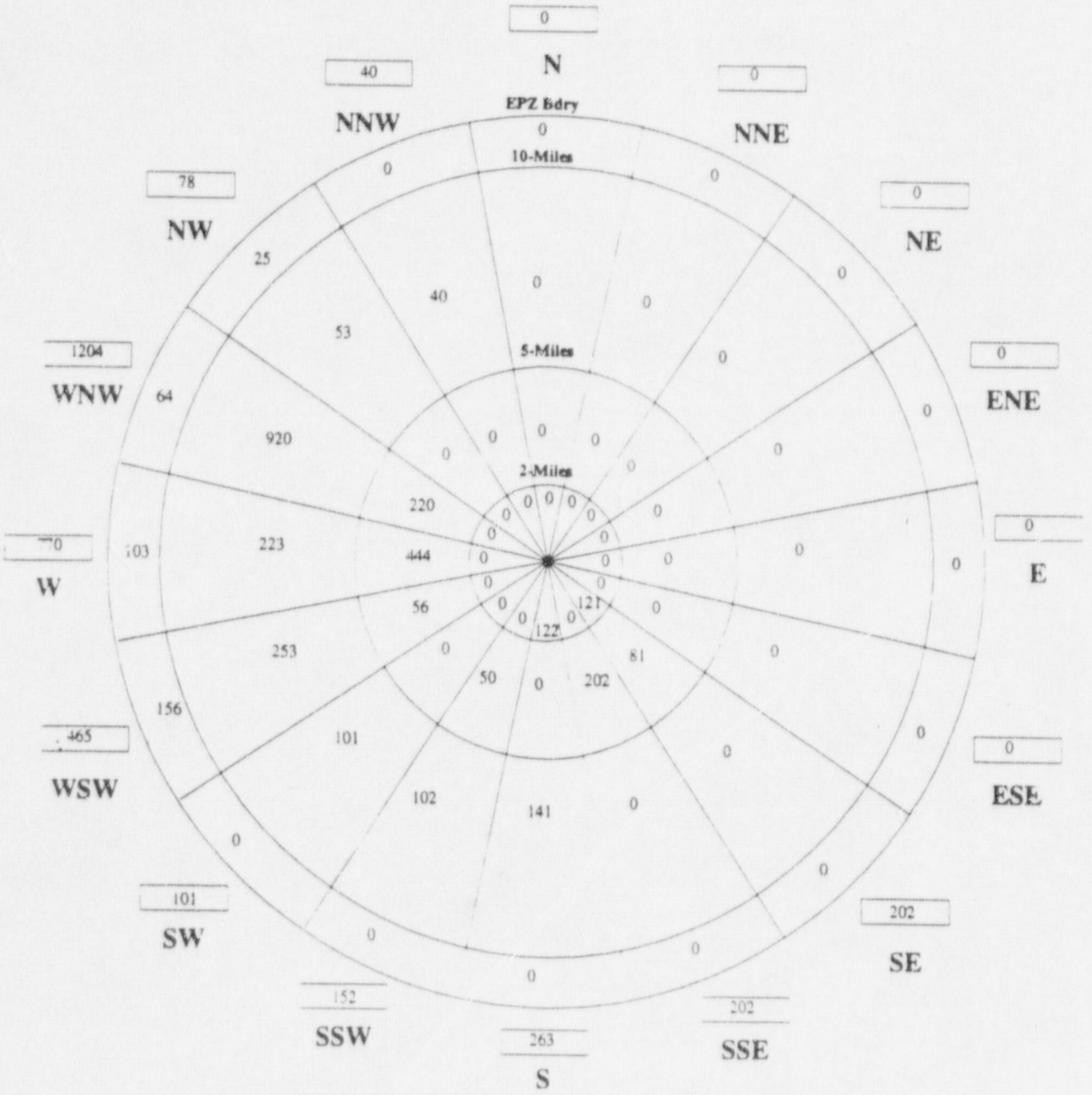


4067

Total Segment Population 0 to EPZ Boundary

Population Totals			
Ring	Ring Population	Total	Cumulative Population
0-2 Mi.	284	0-2 Mi.	284
2-5 Mi.	1230	0-5 Mi.	1514
5-10 Mi.	2157	0-10 Mi.	3671
10-EPZ	396	0-EPZ	4067

Figure 5-8 Employees, Scenarios 8, 9, 10.



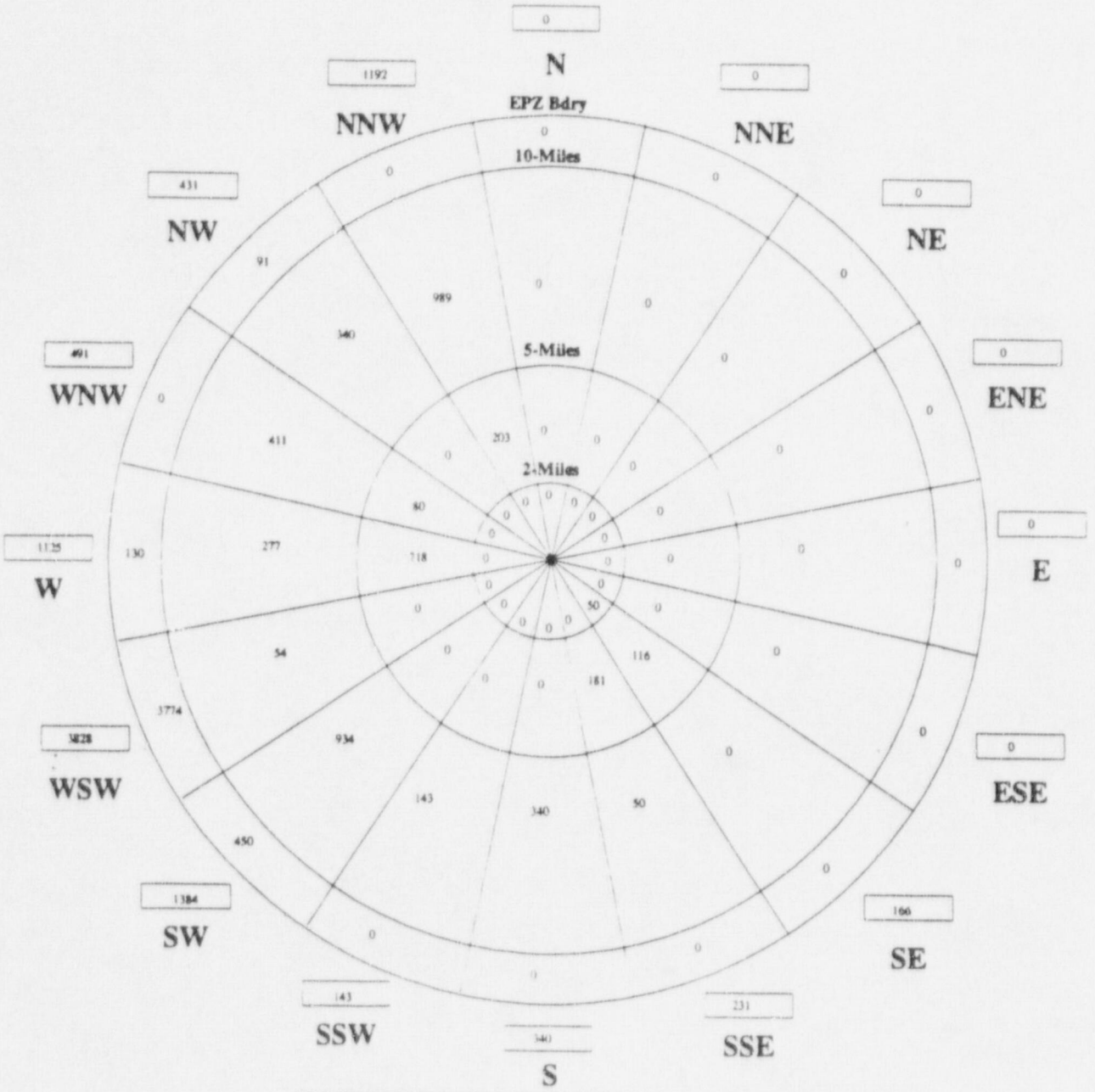
3477

Total Segment Population 0 to EPZ Boundary

Vehicle Totals

Ring	Ring Population	Total	Cumulative Population
0-2 Mi.	243	0-2 Mi.	243
2-5 Mi.	1053	0-5 Mi.	1296
5-10 Mi.	1833	0-10 Mi.	3129
10-EPZ	348	0-EPZ	3477

Figure 5-9 Employee Evacuating Vehicles Scenarios 8, 9, 10.

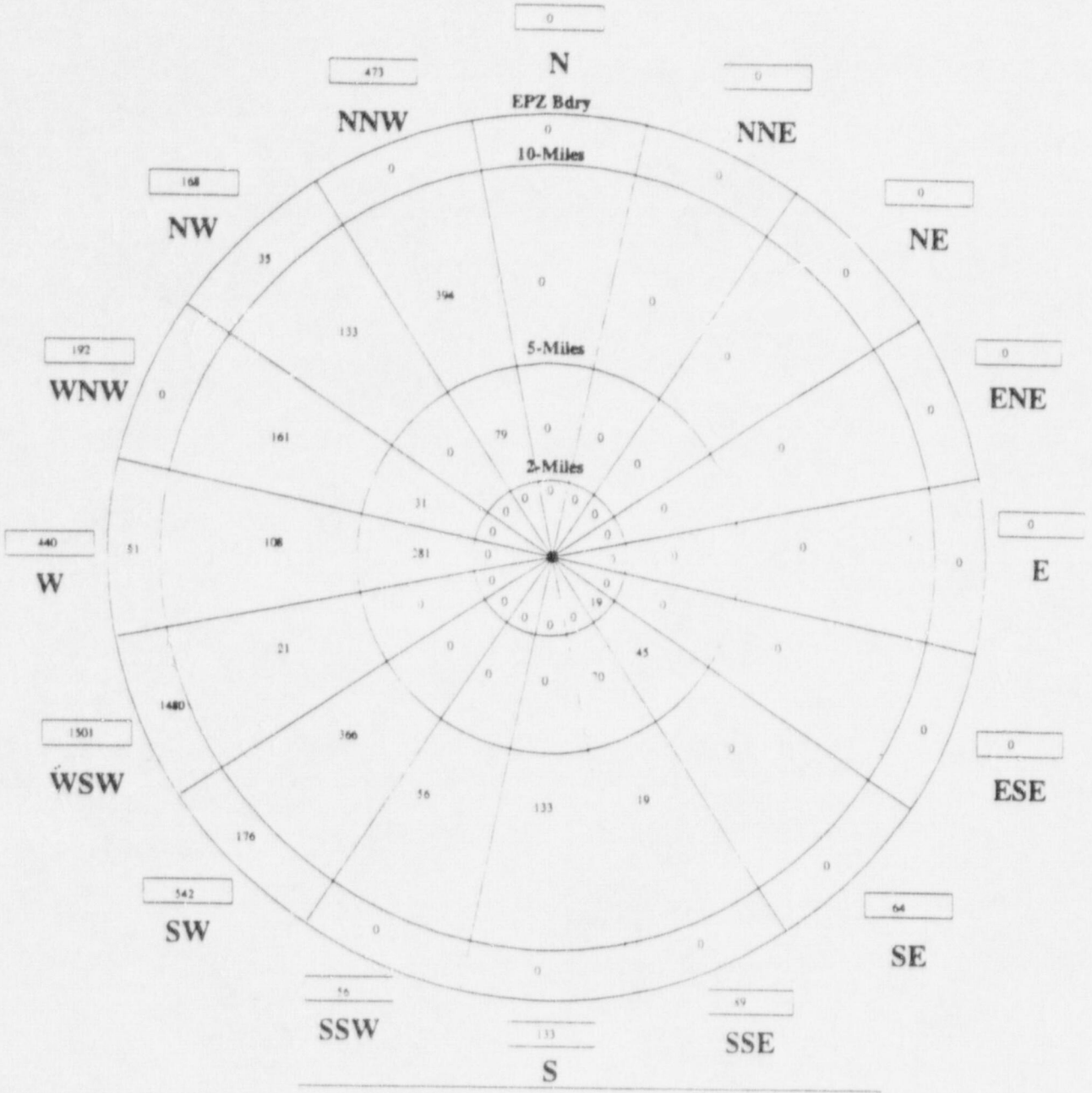


9331

Total Segment Population 0 to EPZ Boundary

Population Totals			
Ring	Ring Population	Total	Cumulative Population
0-2 Mi.	50	0-2 Mi.	50
2-5 Mi.	1298	0-5 Mi.	1348
5-10 Mi.	3538	0-10 Mi.	4886
10-EPZ	4445	0-EPZ	9331

Figure 5-10 Transient Population
Scenarios 8, 9, 10.



Vehicle Totals

Ring	Ring Population	Total	Cumulative Population
0-2 Mi.	19	0-2 Mi.	19
2-5 Mi.	506	0-5 Mi.	525
5-10 Mi.	1391	0-10 Mi.	1916
10-EPZ	1742	0-EPZ	3658

Figure 5-11 Transient Population Vehicles Scenarios 8, 9, 10.

6. 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 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
  - Signs

- 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 serve to expedite travel out of the EPZ along routes which the analysis has found to be most effective.

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 en route 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 sketches of Appendix I, 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 Appendix I 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.

3. Prioritization of these TCP. Application of traffic control at some TCP will have a more pronounced influence on expediting traffic movements, than applying control at other TCP. Thus, during the mobilization of personnel to respond to the emergency situation, those TCP which are assigned a higher priority, will be manned earlier than the others.

   This setting of priorities should be undertaken with the concurrence of town police. These priorities should be compatible with the availability of local manpower resources.

In general the following guidelines were used in assigning Traffic Control Point Priorities:

Priority 1 - Assigned to those locations where two or more evacuation routes interact, or special traffic control tactics are employed to enhance route compliance and expedite traffic movements.

Priority 2 - Assigned to locations which are expected to carry high volumes of traffic.

Priority 3 - Assigned to local collector roads.

Priority 4 - Assigned to local roads which handle low traffic volumes.

In each sketch which appears in Appendix I, the control policy at each TCP is presented in a manner which is self-explanatory. Locations are labeled as:

- Traffic Control Points (P-T-01) where traffic control is applied to assist evacuees. At the conclusion of the evacuation, traffic control points are abandoned.

- Traffic/Access Control Points (P-AT-17) where the traffic control function is applied to assist evacuees until the completion of the evacuation. Following the evacuation, the location is needed to restrict access to an area. The access control at a given location might have several configurations depending on the Regions evacuated.

- Access Control Points (P-A-53) where access to a given area is to be restricted. The access control at a given location might have several configurations depending on the Region evacuated.

Appendix I contains the following information for each town identified as having a direct traffic or access control responsibility:

- A map, indicating the location of traffic and access control points

- A summary table, providing manpower and equipment estimates

- A table indicating which access control points are activated for all evacuation regions

- Sketches of all traffic and access control points.

END

7. TRAFFIC ROUTING PLANS

Evacuation routes are composed of two distinct components:

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

- 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 Pilgrim 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:

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

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

- Assigning the residents of those towns which 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. The current assignment of host communities to communities within the EPZ is shown below:

Reception Center	EPZ Subareas Serviced
Braintree	4, 9, 11
Bridgewater	7, 8, 11
Taunton	1, 2, 3, 5, 6, 7 (Parents with children in Plymouth schools)

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

Traffic control and routing plans evolved from preliminary designs which were reviewed by local law enforcement personnel. Contacts were maintained with town police and Massachusetts State Police officials. These contacts included the submission to the police of materials for review; telephone interviews, and, personal visits. Exhibit 7-1 presents the cover letter sent with the review materials. Table 7-1 presents the list of traffic management plan recipients.

Exhibit 7-1 Letter Interested Parties

Dear _____:

Boston Edison Company is currently undergoing a review of the Evacuation Time Estimate (ETE) and Traffic Management Plan (TMP) for the Pilgrim Nuclear Power Station.

In conjunction with this review, and in order to provide a timely and comprehensive review of this document, we are soliciting information regarding recent town and State population and roadway changes. These may include local planning criteria changes, town growth rate changes, road network and major highway modifications. In some cases, notable construction and development may have occurred which may impact the Traffic Management Plan for your town or community.

Please identify the specific changes that may impact the movement of evacuating traffic in your community. Boston Edison representatives hope to meet with you within the next several months to address and support your concerns.

If you have any questions, please contact Ed Hartnett of my staff at (508) 830-8953.

Table 7-1. Traffic Management Plan Review Agencies

Town of Bridgewater
22 School St.
Bridgewater, MA 02324

Town of Carver
P.O. Box 580
Carver, MA 02330

Town of Marshfield
1639A Ocean Street
Marshfield, MA 02050

Town of Duxbury
Fire Department Hdqtrs.
668 Tremont St.
Duxbury, MA 02331

Massachusetts Emergency Management Agency
400 Worcester Road
PO Box 1496
Framingham, MA 01701

Town of Kingston
Six Maple Ave.
Kingston, MA 02364

Massachusetts Emergency Management Agency
Area II Headquarters
PO Box 54
Bridgewater, MA 02324

Town of Plymouth
83 Court St.
Plymouth, MA 02360

Town of Braintree
1 JFK Memorial Dr.
Braintree, MA 02184

Town of Taunton
15 Summer Street
Taunton, MA 02780

Massachusetts State Police
Troop D
West Grove St.
Middleboro, MA 02346

8. 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.

Figure 8-1 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 (ACP). Appendix I presents maps, summary tables, and sketches detailing the traffic management at each identified location. Appendix L presents a list of access control points to be activated for each evacuation region.

The diversion route was developed to satisfy the following objectives:

1. The route should be sufficiently removed from the EPZ so as to minimize (to the extent possible) the extent that diverted traffic will mingle with, and thereby impede, the evacuating vehicles traveling 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 8-1, with the evacuation routes shown in Appendix K and described in Appendix J, will indicate that the first objective is satisfied.

Specifically, the diversion routes chosen (i.e. I-93/Route 128, I-95, I495/Route 25, US Route 6) offers travelers a path around the Pilgrim EPZ along major, limited-access routes.

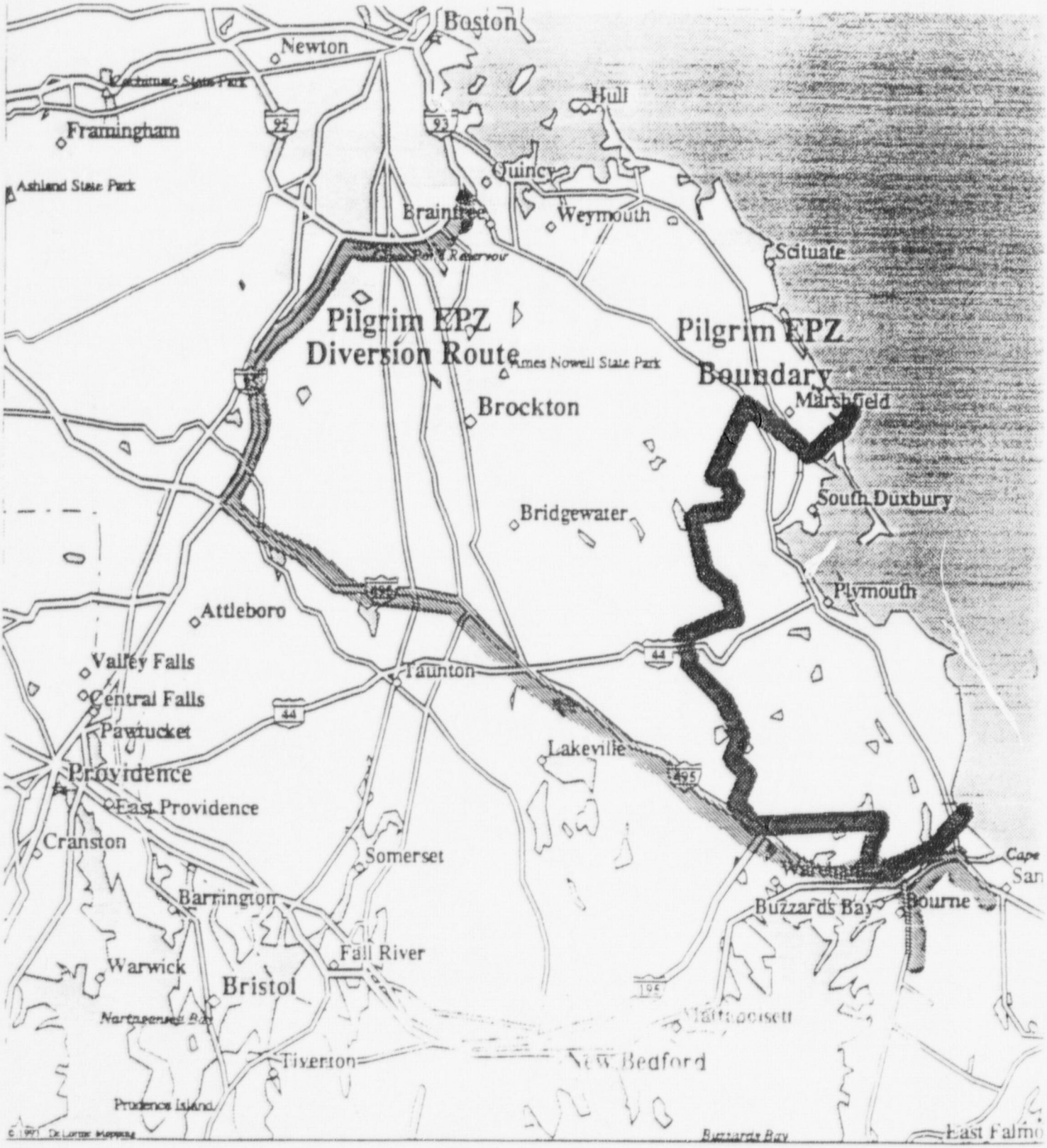


Figure 8-1. Diversion Route and Access Control Cordon For Pilgrim Station Emergency Planning Zone

Discussions with the Massachusetts State Police have indicated the importance of maintaining traffic flow through the I-93, Route 3, Route 128 interchange. Consequently, it is proposed to inform southbound vehicles of the closure of Route 3 southbound at Route 18 and suggest the use of the diversion route. Drivers will be informed of these conditions through the use of temporary road signs, erected along southbound I-93 prior to the Route 3 interchange. Traffic proceeding south on Route 3 will also be informed via road signs of the closure of Route 3 at the Route 18 interchange.

An advisory sign will also be placed along southbound I-93 at Furnace Brook Parkway to recommend that drivers use southbound Route 37 (Willard St.) as an alternative path to Route 128. Drivers who divert using this path will relieve traffic on the I-93 connector to Route 128 when the Braintree Reception Center is active.

In the event of an accident at Pilgrim Station, traffic from Cape Cod will be diverted from the Sagamore Bridge to the Bourne Bridge. Thus, use of the Sagamore Rotary and westbound Route 6 north of the canal will be reserved for evacuating vehicles. At the option of state officials, traffic exiting Cape Cod across the Bourne Bridge will be routed onto Route 25. Evacuating traffic will enter Route 25 farther west, in Wareham. After the completion of evacuation from within the EPZ, the Sagamore Bridge would be reopened to traffic from Cape Cod, at the discretion of state officials.

Sketches of specific traffic control plans are presented in Appendix I.

The second objective has been satisfied by the choice of routes. All diversion routes are multilane highways. Routes I-93, I-95, I-495 and 25 are limited access highways.

The northern end of the diversion route connects with I-93 at the Route 3 interchange, south of Boston, while the southern end of the diversion route connects with Routes 6 and 28, the primary access roads to Cape Cod.

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

1. Control all open roads crossing each Region 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.

3. Prioritize all ACP

- Priority 1 is assigned to all primary "Numbered" routes which service substantive volumes of traffic.
- Priority 2 is assigned to all other numbered routes.
- Priority 3 is assigned to all local "collector" roads.
- Priority 4 is assigned to all local roads which service low volumes of traffic.

Based on a careful study of available, large-scale county maps, the selected ACP locations satisfy objectives 1 and 2. The need for prioritization arises because well-defined criteria are needed to identify:

- o The sequence in which the ACP will be manned.
- o Those ACP where a barrier, with a sign, will suffice for purposes of control, thus obviating the need for police personnel. Depending on circumstances, all Priority 4 ACP may be selected for unmanned (i.e. barrier + sign, only) control and, possibly, Priority 3 ACP as well.
- o Perform a field survey
- o Sketch all ACP
- o Distribute to police for review

The assignment of ACP by region depends on the geographical properties of each region. A total of 22 sets of Access Control Points were developed; one set for each Region. Appendix L presents this information. Note that <u>all</u> TCP within the EPZ should be activated even when the Directive to Evacuate affects a portion of the EPZ. Those TCP which are located outside the Region which is evacuated will be needed to expedite the movement of evacuees outside that Region who elect to evacuate spontaneously. At the completion of the evacuation process only the appropriate ACP will continue to be manned.

<u>Identification and Installation of Control Devices</u>

All Access Control Posts (ACP) are designed to <u>restrict</u> access into the Emergency Planning Zone (EPZ) or into the Region ordered to evacuate, to those vehicles whose 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. These devices include:

- o Regulatory Signs
- o Barricades
- o Cones
- o Trail Blazer Signs
- o Illumination

It is essential that these control devices, installed singly or in combination, satisfy the specifications of the Manual on Uniform Traffic Control Devices (MUTCD). The need for uniform standards is best explained by reference to the MUTCD; see Exhibit 8-1.

In the following discussion, we refer to relevant sections of the MUTCD as they apply to the Pilgrim Evacuation Plan.

Exhibit 8-2 consists of excerpts from Section G, Part II, of the MUTCD which is entitled, "Signing for Civil Defense". These provisions of Exhibit 8-2 apply directly to the Pilgrim Evacuation Plan.

At ACP which are located at interchanges with Interstate Highways, and at some other Priority 1 locations, it will be necessary to install barricades on roads providing access to the EPZ. These barricades should be portable (either "wing" type, which folds, or with detachable footings) so that they may easily be transported to the ACP locations and installed. For Priority 4 ACP, and possibly for [some] Priority 3 ACP, barricade installations which physically block the lanes will replace the cones indicated on the sketches of Appendix I, when the ACP is unmanned.

Exhibit 8-3 presents excerpts from the MUTCD specifications for barricades. Note that signs may be attached to barricades: for example, the AREA CLOSED sign[1] shown on Exhibit 8-2 should be mounted on all such barricades. Barricade Type III is recommended by the MUTCD for road closure. Lighting devices -- flashing and steady yellow lights -- enhance the visual target value of

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[1] It is also permissible to indicate the cause for a restricted movement. For example, the sign AREA CLOSED - RADIATION may be used if it is believed that improved compliance will result. One or more arrows indicating the direction of the diversion routes are also advisable.

barricades and traffic cones. If available, we recommend that lighting devices be attached to all barricades and clamped onto every third cone used at high priority ACP and TCP locations. Arrow Panels and advance warning signs are recommended for use on approaches to all ACP and TCP located on Expressways so as to inform drivers that traffic will be channelized onto an exit ramp. See Section E, Part 6 of the MUTCD for details on lighting devices and Section B, Part 6 of the MUTCD for channelization treatments on expressways.

Exhibit 8-4 consists of excerpts from Section C, Part 6 of the MUTCD, which describe the design and application of cones as channelizing devices. We prefer the use of cones, rather than drums, because:

- They are more portable
- They will be needed only for a relatively short period of time (hours) while drums are generally used at a site over a period of days or weeks
- They are less costly and consume less storage space
- They take up less room on the highway, allowing the vehicles more room to maneuver.

Exhibit 8-1. General Provisions of the MUTCD

1A-1 Purpose of Traffic Control Devices

The purpose of traffic control devices and warrants for their use is to help insure highway safety by providing for the orderly and predictable movement of all traffic, motorized and non-motorized, throughout the national highway transportation system, and to provide such guidance and warnings as are needed to insure the safe and informed operation of individual elements of the traffic stream.

Traffic control devices are used to direct and assist vehicle operators in the guidance and navigation tasks required to traverse safely any facility open to public travel.

Guide and information signs are solely for the purpose of traffic control and are not an advertising medium.

1A-2 Requirements of Traffic Control Devices

This Manual sets forth the basic principles that govern the design and usage of traffic control devices. These principles appear throughout the text in discussions of the devices to which they apply, and it is important that they be given primary consideration in the selection and application of each device.

The Manual presents traffic control device standards for all streets and highways open to public travel regardless of type or class or the governmental agency having jurisdiction. Where a device is intended for limited application only, or for a specific system, the text specifies the restrictions on its use.

To be effective, a traffic control device should meet five basic requirements:

1. Fulfill a need.
2. Command attention.
3. Convey a clear, simple meaning.
4. Command respect of road users.
5. Give adequate time for proper response.

In the case of regulatory devices, the actions required of vehicle operators and pedestrians should be specified by State statute, or by local ordinance or resolution which are consistent with national standards. Uniformity of meaning is vital or effective traffic control devices. Meanings ascribed to devices in this Manual are in general accord with the Uniform Vehicle Code of the National Committee on Uniform Traffic Laws and Ordinances, which is the nationally recognized standard in this area.

Five basic considerations are employed to insure that these requirements are met: design, placement, operation, maintenance, and uniformity.

Design of the device should assure that such features as size, contrast, colors, shape, composition, and lighting or reflectorization are combined to draw attention to the device; that shape, size, colors, and simplicity of message combine to produce a clear meaning; that legibility and size combine with placement to permit adequate time for response; and that uniformity, size, legibility and reasonableness of the regulation combine to command respect. Except for symbols on traffic control devices, minor modifications in the design of specific design elements of a device may be necessary, provided that the essential appearance characteristics are met. All symbols must be adopted using the procedures described in Section 1A-6. All symbols shall be unmistakably similar to or mirror images of those shown herein.

Placement of the device should assure that it is within the cone of vision of the viewer so that it will command attention; that it is positioned with respect to the point, object, or situation to which it applies to aid in conveying the proper meaning; and that its location, combined with suitable legibility, is such that a driver traveling at normal speed has adequate time to make the proper response.

Operation or application should assure that appropriate devices and related equipment are installed to meet the traffic requirements at a given location. Furthermore, the device must be placed and operated in a uniform and consistent manner to assure, to the extent possible, that vehicle operators can be expected to properly respond to the device, based on their previous exposure to similar traffic control situations.

Maintenance of devices should be to high standards to assure that legibility is retained, that the device is visible, and that it is removed if no longer needed. Clean, legible, properly mounted devices in good working condition command the respect of vehicle operators and pedestrians. In addition to physical maintenance, functional maintenance is required to adjust needed traffic control devices to current conditions and to remove unnecessary traffic control devices. The fact that a device is in good physical condition should not be a basis for deferring needed replacement or change. Furthermore, carelessly executed maintenance can destroy the value of a group of devices by throwing them out of balance. For example, replacement of a sign in a group or series by one that is disproportionately large may tend to depreciate others in the vicinity.

Uniformity of traffic control devices simplifies the task of the road user because it aids in recognition and understanding. It aids road users, police officers, and traffic courts by giving everyone the same interpretation. It aids public highway and traffic officials through economy in manufacture, installation, maintenance, and administration.

Exhibit 8-2. Excerpts from MUTCD Section G: Signing for Civil Defense

In the event of a disaster there will be a closing of highways that cannot be used, a controlled operation of certain designated highways, the establishing of regulation posts for the expediting of essential traffic, and the provision of emergency centers for civilian aid.

To guide and control highway traffic in an emergency, special highway signs will be needed. The signs here specified have been approved and are here prescribed as standard for use when and where applicable in the civil defense program.

These emergency signs will not permanently displace any of the standard signs that are normally applicable, and as conditions permit they should be replaced or augmented by standard signs.

2J-2 Design of Civil Defense Signs

For economy in stockpiling and in emergency fabrication, all the special civil defense signs, with the exception of the Evacuation Route Marker, are designed for a single size of plate measuring 24 by 30 inches, and have a black legend and border on a white background. The background should be reflectorized.

In an emergency these signs may be needed in large numbers and are for essentially temporary use. Consideration should accordingly be given to their fabrication from any light and economical material that can serve through the emergency period.

Any of these signs may be accompanied by a standard triangular marker for marking areas contaminated by biological and chemical warfare agents and radioactive fallout.

2J-4 Area Closed Sign (CD-2)

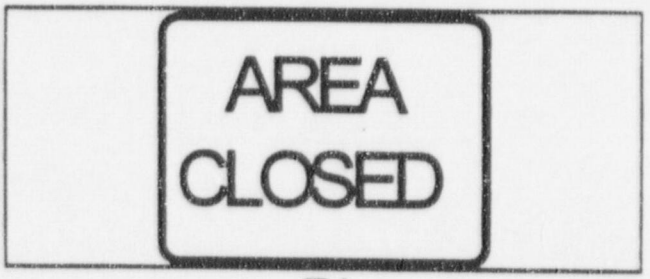
The AREA CLOSED sign shall be used to close a roadway entering an area from which all traffic is excluded because of dangerous radiological or biological contamination. It shall be erected on the shoulder as near as practicable to the right-hand edge of the roadway, or preferably on a portable mounting or barricade partly or wholly in the roadway. For best visibility, particularly at night, its height should not normally exceed 4 feet from the pavement to the bottom of the sign. Unless adequate advance warning signs are used, it should not be so placed as to create a complete and unavoidable blockade. Where feasible, the sign should be located at an intersection that provides a detour route.

2J-8 Emergency Aid Centers Sign (CD-6)

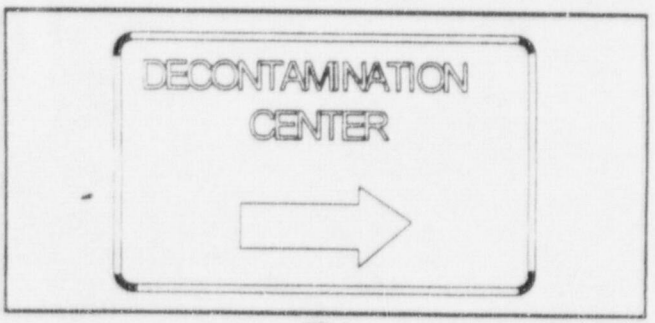
In the event of emergency, State and local authorities will establish various centers for civilian relief, communication, medical service, and similar purposes. To guide the public to such centers a series of directional signs will be needed. These signs shall carry the designation of the center and an arrow indicating the direction to the center. They shall be erected as needed, at intersections and elsewhere, on the right-hand side of the roadway, at a height in urban areas of at least 7 feet, and no less than 1 foot back from the face of the curb, and in rural areas at a height of 5 feet, 6 to 10 feet from the roadway edge.

These signs shall carry one of the following legends, as appropriate, or others designating similar emergency facilities:

DECONTAMINATION CENTER
REGISTRATION CENTER
WELFARE CENTER
MEDICAL CENTER



CD-2
30" x 24"



CD-6
30" x 24"

Exhibit 8-3. Excerpts from the MUTCD on Barricades

Barricades shall be one of three types: Type I, Type II, or Type III. The characteristics of these types are shown in Figure 6-14 and Table VI-1.

Barricades with stripes that begin at the upper right side and slope downward to the lower left side are to be designated as 'right' (R) barricades. Barricades with stripes that begin at the upper left side and slope downward to the lower right side are to be designated as 'left' (L) barricades.

Markings for barricade rails shall be alternate orange and white stripes (sloping downward at an angle of 45 degrees in the direction traffic is to pass).

Where a barricade extends entirely across a roadway, it is desirable that the stripes slope downward in the direction toward which traffic must turn in detouring. Where both right and left turns are provided for, the chevron striping may slope downward in both directions from the center of the barricade.

Barricade rails should be supported in a manner that will allow them to be seen by the motorist and provide a stable support not easily blown over by the wind or traffic. For Type I barricades, the support may include other unstriped horizontal panels necessary to provide stability. To facilitate rapid identification of channelizing devices on a job site, only the name and phone number of an agency, contractor, or supplier may be shown on the nonreflective surface of the face part of a barricade. Such identification shall be in one color and nonreflective with letters not to exceed 1 inch in height.

The entire area of orange and white shall be reflectorized with a material that has a smooth, sealed outer surface that will display the same approximate size, shape and color day and night.

Barricades are located adjacent to traffic and therefore are subject to impact by errant vehicles. Because of their vulnerable position and the possible hazard they could create, they should be constructed of lightweight materials and have no rigid stay bracing for A-frame designs.

Table VI-1 Barricade Characteristics

	Type*		
	I	*II*	*III*
Width of Rail***	8" min-12" max	8" min-12" max	8" min-12" max
Length of Rail***	2 ft. min	2 ft. min	4 ft. min
Width of Stripes**	6 in.	6 in.	6 in.
Height	3 ft. min	3 ft. min	5 ft. min
Number of Reflectorized Rail Faces	2 (one each direction)	4 (two each direction)	3 if facing traffic in one direction 6 if facing traffic in two directions

* For wooden barricades, nominal lumber dimensions will be satisfactory.
** For rails less than 3-feet long, 4-inch-wide stripes shall be used.
*** Barricades intended for use on expressways, freeways and other high speed roadways shall have a minimum of 270 square inches of reflective area facing traffic.

Exhibit 8-4. Excerpts from the MUTCD on Cone Design and Application

Traffic cones and tubular markers of various configurations are available. These shall be a minimum of 18 inches in height with a broadened base and may be made of various materials able to withstand impact without damage to themselves or to vehicles. Twenty-eight inches should be the minimum height of cones used on freeways and other high-speed roadways and on all facilities during hours of darkness or whenever more conspicuous guidance is needed. Orange shall be the predominant color on cones. They should be kept clean and bright for maximum target value. For nighttime use they shall be reflectorized or equipped with lighting devices for maximum visibility. Reflectorized material shall have a smooth, sealed outer surface that will display the same approximate color day and night.

Reflectorization of tubular markers shall be a minimum of two, three-inch-wide white bands placed a maximum of 2 inches from the top with a maximum of 6 inches between the bands. Retroreflection of cones shall be provided by a minimum 6-inch-wide white band placed a minimum of 3 inches but no more than 4 inches from the top. When the 28-inch or larger size cones are used, the standard 6-inch band shall be supplemented with an additional 4-inch white band spaced a minimum of 2 inches below the 6-inch band.

6C-6 Cone Application

Included under this heading are a group of devices whose primary function is the channelization of traffic. They may be conical in shape, but there are also tubular-shaped devices available capable of performing the same function. They may be set on the surface of the roadway or rigidly attached for continued use.

Traffic cones may be easily stacked on a truck and one worker can carry and distribute several cones with ease. This mobility and flexibility (which cannot be equaled by Type I barricades) increases the usefulness of these devices.

When cones are used, precautions are necessary to ensure they will not be blown over or displaced. They may be particularly critical adjacent to lanes of moving traffic where wind may be created by passing vehicles. Some cones are constructed with bases that may be filled with ballast. With others it may be necessary to double the cones or use heavier weight cones, special weighted bases, or weights such as sand bag rings that can be dropped over the cones and onto the base to provide increased stability. These added weights should not be sufficient to present a hazard if the devices are struck inadvertently.

In general, traffic cones have a greater target value than do the tubular-shaped devices. However, the target value of either device may be enhanced during the daytime by the insertion of an orange flag in the top and at night, by reflectorization or the use of lighting devices.

9. EVACUATION TIME ESTIMATES (ETE) FOR GENERAL POPULATION

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

- 12 evacuation scenarios as described in Table 9-1.
- 22 regions within the Pilgrim Station EPZ, as defined in Table 9-2. Each region consists of one or more Emergency Response Planning Areas (Subareas). These Subareas were shown on Figure 5-1; the communities comprising each Subarea are listed in Table 9-3.

These ETE for each Region-Scenario combination, are presented in Tables 9-4 through 9-9.

- Table 9-4 presents the ETE for the area within a circle with a radius of two miles centered at Pilgrim Station.
- Table 9-5 presents the ETE for the area within a circle with a radius of five miles centered at Pilgrim Station.
- Table 9-6 presents the ETE for the area within a circle with a radius of ten miles centered at Pilgrim Station.
- Table 9-7 presents the ETE for the entire Emergency Planning Zone (EPZ) of Pilgrim Station.
- Table 9-8 presents the ETE for the regions directed to evacuate. For example, if it is determined that everyone within 5 miles of the Station should evacuate, then all communities within Region 21 (Subareas 1, 2, 3, 4, 12) will be directed 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 9-8 presents the ETE which are of primary importance within the context of emergency planning.
- Table 9-9 presents the ETE for Scenarios 1A and 2A.

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 Evacuation Directive.

Table 9-1. Description of Evacuation Scenarios 1-10

Scenario	Season	Day	Time	Weather	Comments
1	Summer	Weekend	Midday	Good	Tourist and beach area population at capacity. Employees are at 70% of midweek along the coastal area, 40% in remaining areas. Tourists fill all available seasonal and overnight facilities.
1A	Summer	Weekend	Evening	Good	As above. Heavy traffic on Route 3 northbound.
2	Summer	Weekend	Midday	Rain	As above. Sudden rain occurs with tourist and beach population at capacity concurrent with accident at Pilgrim Station.
2A	Summer	Weekend	Midday	Rain	As above. Heavy traffic on Route 3 northbound.
3	Summer	Midweek	Midday	Good	Beach area and tourist population at 75% of capacity. Employees are at 100% of midweek work force.
4	Summer	Midweek	Midday	Rain	As above. Sudden rain occurs.
5	Off-season	Midweek	Midday	Good	Tourist population at 25% of capacity for open facilities. No beach area transients. Employees at 100%.
6	Off-season	Midweek	Midday	Rain	As above, but for inclement (rain) weather.
7	Off-season	Midweek	Midday	Snow	As above, but for inclement (snow) weather. Evacuees must clear driveways.
8	Off-season	Midweek Weekend	Evening All day	Good	Tourist population at 25% of capacity. No beach area transients. Employees at 25% of midweek, midday work force.
9	Off-season	Midweek Weekend	Evening All day	Rain	As above, but for inclement (rain) weather.
10	Off-season	Midweek Weekend	Evening All day	Snow	As above, but for inclement (snow) weather. Evacuees must clear driveways.

Table 9-2. Regional Evacuation Groupings

Wind Direction From	2 - Miles		5 - Miles		EPZ Boundary	
	Reg.	Subareas	Reg.	Subareas	Reg.	Subareas
006°-019°	1	1	2	1,2	7	1,2,5
020°-021°	1	1	3	1,2,3	8	1,2,3,5,6
022°-056°	1	1	3	1,2,3	9	1,2,3,5,6,11
057°-063°	1	1	3	1,2,3	10	1,2,3,6,11
064°-066°	1	1,12	3	1,2,3,12	10	1,2,3,6,11,12
067°-069°	1	1,12	3	1,2,3,12	11	1,2,3,6,7,11,12
070°-103°	1	1,12	4	1,3,12	12	1,3,6,7,8,11,12
104°-109°	1	1,12	4	1,3,12	13	1,3,6,7,8,9,11,12
110°-115°	1	1,12	4	1,3,12	14	1,3,6,7,8,9,12
116°-122°	1	1,12	4	1,3,12	15	1,3,7,8,9,12
123°-129°	1	1,12	5	1,3,4,12	16	1,3,4,7,8,9,12
130°-132°	1	1,12	5	1,3,4,12	17	1,3,4,7,8,9,10,12
133°-140°	1	1,12	5	1,3,4,12	18	1,3,4,8,9,10,12
141°-175°	1	1,12	6	1,4,12	19	1,4,9,10,12
176°-179°	1	1,12	6	1,4,12	20	1,4,10,12
180°-183°	1	1,12	6	1,4,12	6	1,4,12
184°-305°	1	1,12	1	1,12	1	1,12
306°-318°	1	1,12	2	1,2,12	2	1,2,12
319°-005°	1	1,12	2	1,2,12	7	1,2,5,12
Any			21	1,2,3,4,12	22	1 - 12

Table 9-3. Description of the Emergency Response Planning Subareas of the Pilgrim Nuclear Power Station (PNPS)

Subarea	Description	Towns
1	Includes the area within two miles of the PNPS.	Plymouth
2	Includes the area within a portion of an annular ring extending from the boundary of Subarea 1 to approximately the 5 miles south of the PNPS.	Plymouth
3	Includes the area within a portion of an annular ring extending from the boundary of Subareas 1 and 2 to approximately the 5 miles west of the PNPS.	Plymouth
4	Includes that portion on Duxbury Beach, Saquish Neck and Clarke Island which lies south of the Powder Point Bridge.	Plymouth Duxbury
5	Includes the area within a portion of an annular ring extending from the boundary of Subarea 2 south to the EPZ boundary.	Plymouth
6	Includes the area within a portion of an annular ring extending from the boundaries of Subareas 3 and 5 west to the Plymouth-Carver town line and north to Route 44.	Plymouth
7	Includes that portion of the Town of Plymouth south of the Plymouth-Kingston town line, north of Route 44 and extending from the coastline west to the Plymouth-Carver town line.	Plymouth
8	Includes the area comprising the Town of Kingston.	Kingston
9	Includes the area comprising the Town of Duxbury.	Duxbury
10	Includes that portion of the Town of Marshfield which is south of Route 139 (Careswell St.).	Marshfield
11	Includes the area comprising the Town of Carver East of Route 58	Carver
12	Includes the area of Plymouth, Kingston, Duxbury, Massachusetts and Cape Cod Bays east to approximately 10 miles from the PNPS.	

Table 9-4

Estimated Times (Hrs., Mins.) to Evacuate From Within 2 - Miles of Pilgrim Station after the Evacuation Directive Is Issued to the Indicated Regions

Scenario	Region										
	1	2	3	4	5	6	7	8	9	10	11
1	03:35	03:35	03:35	03:35	03:35	03:35	03:35	03:35	03:35	03:35	03:35
2	04:35	04:35	04:35	04:35	04:35	04:35	04:35	04:35	04:35	04:35	04:35
3	04:30	04:30	04:30	04:30	04:30	04:30	04:30	04:30	04:30	04:30	04:30
4	04:35	04:35	04:35	04:35	04:35	04:35	05:00	05:05	05:05	04:35	04:35
5	04:25	04:25	04:25	04:25	04:25	04:25	04:25	04:25	04:25	04:25	04:25
6	04:25	04:25	04:25	04:25	04:25	04:25	04:25	04:25	04:25	04:25	04:25
7	05:50	05:50	05:50	05:50	05:50	05:50	05:50	05:50	05:50	05:50	05:50
8	03:50	03:50	03:50	03:50	03:50	03:50	03:50	03:50	03:50	03:50	03:50
9	03:50	03:50	03:50	03:50	03:50	03:50	03:50	03:50	03:50	03:50	03:50
10	05:45	05:45	05:45	05:45	05:45	05:45	05:45	05:45	05:45	05:45	05:45

Scenario	Region										
	12	13	14	15	16	17	18	19	20	21	22
1	03:35	03:35	03:35	03:35	03:35	03:35	03:35	03:35	03:35	03:35	03:35
2	04:35	04:35	04:35	04:35	04:35	04:35	04:35	04:35	04:35	04:35	04:35
3	04:30	04:30	04:30	04:30	04:30	04:30	04:30	04:30	04:30	04:30	04:30
4	04:35	04:35	04:35	04:35	04:35	04:35	04:35	04:35	04:35	04:35	05:05
5	04:25	04:25	04:25	04:25	04:25	04:25	04:25	04:25	04:25	04:25	04:25
6	04:25	04:25	04:25	04:25	04:25	04:25	04:25	04:25	04:25	04:25	04:25
7	05:50	05:50	05:50	05:50	05:50	05:50	05:50	05:50	05:50	05:50	05:50
8	03:50	03:50	03:50	03:50	03:50	03:50	03:50	03:50	03:50	03:50	03:50
9	03:50	03:50	03:50	03:50	03:50	03:50	03:50	03:50	03:50	03:50	03:50
10	05:45	05:45	05:45	05:45	05:45	05:45	05:45	05:45	05:45	05:45	05:45

Table 9.5 Estimated Times (Hrs., Mins.) to Evacuate From Within 5 - Miles of Pilgrim Station after the Evacuation Directive Is Issued to the Indicated Regions

Scenario	Region										
	1	2	3	4	5	6	7	8	9	10	11
1	03:35	03:35	03:35	03:35	03:35	03:35	04:00	04:00	04:00	04:00	04:20
2	04:35	04:35	04:35	04:35	04:35	04:35	04:35	05:00	05:00	05:00	05:25
3	04:30	04:30	04:30	04:30	04:30	04:30	04:30	04:30	04:30	04:30	04:30
4	04:35	04:35	04:35	04:35	04:35	04:35	05:00	05:05	05:20	05:20	05:35
5	04:25	04:25	04:25	04:25	04:25	04:25	04:25	04:25	04:25	04:25	04:25
6	04:25	04:25	04:25	04:25	04:25	04:25	04:25	04:55	04:55	04:55	05:35
7	05:50	05:50	05:50	05:50	05:50	05:50	05:50	05:50	05:50	05:50	05:50
8	03:50	03:50	03:50	03:50	03:50	03:50	03:50	03:50	03:50	03:50	03:50
9	03:50	03:50	03:50	03:50	03:50	03:50	03:50	03:50	04:00	04:15	04:25
10	05:45	05:45	05:45	05:45	05:45	05:45	05:45	05:45	05:45	05:45	05:45

Scenario	Region										
	12	13	14	15	16	17	18	19	20	21	22
1	03:35	03:35	03:35	03:35	03:35	03:35	03:35	03:35	03:35	03:35	03:35
2	06:00	06:00	06:00	05:30	05:30	05:30	05:30	04:35	04:35	04:35	06:10
3	04:30	04:30	04:30	04:30	04:30	04:30	04:30	04:30	04:30	04:30	04:30
4	06:00	06:25	06:05	05:30	05:30	05:35	05:25	04:35	04:35	04:35	06:25
5	04:45	04:45	04:40	04:25	04:25	04:25	04:25	04:25	04:25	04:25	04:45
6	06:00	06:00	05:50	05:25	05:25	05:25	05:20	04:25	04:25	04:25	06:00
7	06:00	06:00	06:00	06:00	06:00	06:00	06:00	06:00	06:00	06:00	06:00
8	03:50	03:50	03:50	03:50	03:50	03:50	03:50	03:50	03:50	03:50	03:50
9	04:45	04:50	04:50	04:20	04:20	04:20	04:10	03:50	03:50	03:50	04:50
10	05:45	05:45	05:45	05:45	05:45	05:45	05:45	05:45	05:45	05:45	05:45

Table 9.6

Estimated Times (Hrs., Mins.) to Evacuate From Within 10 - Miles of Pilgrim Station after the Evacuation Directive Is Issued to the Indicated Regions*

Scenario	Region										
	1	2	3	4	5	6	7	8	9	10	11
1	04:00	04:00	04:00	04:00	04:00	04:00	04:05	04:05	04:05	04:05	04:25
2	04:40	05:00	04:55	04:40	04:40	04:40	05:00	05:05	05:15	05:15	05:30
3	04:35	04:35	04:35	04:35	04:35	04:35	04:35	04:35	04:35	04:35	04:35
4	04:40	05:00	05:00	04:55	04:55	05:00	05:05	05:20	05:25	05:25	05:50
5	04:30	04:30	04:30	04:30	04:30	04:30	04:30	04:30	04:30	04:30	04:35
6	04:35	04:35	04:35	04:35	04:35	04:35	04:30	05:15	05:20	05:20	05:45
7	05:55	05:55	05:55	05:55	05:55	05:55	05:55	05:55	05:55	05:55	06:10
8	03:55	03:55	03:55	03:55	03:55	03:55	03:55	03:55	04:00	04:00	04:00
9	03:55	03:55	03:55	03:55	03:55	03:55	03:55	04:45	04:55	04:55	04:55
10	05:50	05:50	05:50	05:50	05:50	05:50	05:50	05:50	05:50	05:50	05:50

Scenario	Region										
	12	13	14	15	16	17	18	19	20	21	22
1	04:35	05:00	04:55	04:55	04:55	05:00	04:30	04:00	04:00	03:40	05:00
2	06:05	06:25	06:25	06:00	06:00	06:05	05:50	05:20	04:40	04:55	06:30
3	05:00	05:05	05:00	05:00	05:00	05:00	04:50	04:35	04:35	04:35	05:10
4	06:30	06:35	06:30	06:20	06:25	06:30	06:00	04:55	05:00	05:00	06:35
5	05:15	05:15	05:05	04:50	04:50	04:50	04:45	04:30	04:30	04:30	05:15
6	06:20	06:20	06:20	06:10	06:10	06:15	05:50	04:30	04:30	04:35	06:20
7	06:50	06:50	06:50	06:50	06:50	06:50	06:20	06:05	06:05	06:05	06:50
8	04:25	04:25	04:20	04:10	04:10	04:10	03:55	03:55	03:55	03:55	04:25
9	05:20	05:20	05:15	05:00	05:10	05:05	04:45	03:55	03:55	03:55	05:20
10	05:50	05:50	05:50	05:50	05:50	05:50	05:50	05:50	05:50	05:50	05:50

Table 9-7. Estimated Times (Hrs., Mins.) to Evacuate From Within The EPZ Boundary of Pilgrim Station after the Evacuation Directive Is Issued to the Indicated Region

Scenario	Region										
	1	2	3	4	5	6	7	8	9	10	11
1	04:00	04:00	04:00	04:00	04:00	04:00	04:05	04:20	04:30	04:30	04:30
2	04:40	05:00	05:00	04:40	04:40	04:40	05:00	05:25	05:35	05:35	05:40
3	04:35	04:35	04:35	04:35	04:35	04:35	04:35	04:35	04:35	04:35	04:35
4	04:40	05:00	05:00	04:55	04:55	05:05	05:05	05:30	05:45	05:45	05:55
5	04:30	04:30	04:30	04:30	04:30	04:30	04:25	04:30	04:45	04:45	04:45
6	04:40	04:40	04:40	04:45	04:45	04:40	04:35	05:20	05:45	05:45	05:50
7	05:55	05:55	05:55	05:55	05:55	05:55	05:50	06:00	06:20	06:20	06:20
8	03:55	03:55	03:55	03:55	03:55	03:55	03:50	04:15	04:15	04:20	04:20
9	03:55	03:55	03:55	03:55	03:55	03:55	03:55	05:15	05:30	05:30	05:30
10	05:50	05:50	05:50	05:50	05:50	05:50	05:50	05:50	06:15	06:15	06:15

Scenario	Region										
	12	13	14	15	16	17	18	19	20	21	22
1	04:55	05:00	04:55	04:55	04:45	05:00	04:35	04:00	04:00	04:00	05:05
2	06:05	06:25	06:25	06:05	06:05	06:05	05:35	05:20	04:45	05:00	06:30
3	05:00	05:05	05:05	05:00	05:00	05:05	04:35	04:35	04:35	04:35	05:10
4	06:30	06:35	06:30	06:20	06:25	06:30	06:00	04:55	05:00	05:00	06:35
5	05:15	05:15	05:05	04:50	04:50	04:50	04:45	04:30	04:30	04:30	05:15
6	06:20	06:20	06:20	06:10	06:10	06:15	05:50	04:35	04:35	04:40	06:20
7	06:50	06:50	06:50	06:50	06:50	06:50	06:20	06:05	06:05	06:05	06:50
8	04:25	04:25	04:20	04:10	04:10	04:10	03:55	03:55	03:55	03:55	04:25
9	05:30	05:25	05:15	05:00	05:10	05:05	04:45	03:55	03:55	03:55	05:30
10	06:15	06:10	05:50	05:50	05:50	05:50	05:50	05:50	05:50	05:50	06:15

Table 9-8 Estimated Times (Hrs., Mins.) to Evacuate From Within The Associated Area about the Pilgrim Station after the Evacuation Directive Is Issued to the Indicated Regions

Scenario	Region										
	1	2	3	4	5	6	7	8	9	10	11
1	03:35	03:35	03:35	03:35	03:35	03:35	04:05	04:20	04:30	04:30	04:30
2	04:35	04:35	04:35	04:35	04:35	04:35	05:00	05:25	05:35	05:35	05:40
3	04:30	04:30	04:30	04:30	04:30	04:30	04:35	04:35	04:35	04:35	04:35
4	04:35	04:35	04:35	04:35	04:35	04:35	05:05	05:30	05:45	05:45	05:55
5	04:25	04:25	04:25	04:25	04:25	04:25	04:25	04:30	04:45	04:45	04:45
6	04:25	04:25	04:25	04:25	04:25	04:25	04:35	05:20	05:45	05:45	05:50
7	05:50	05:50	05:50	05:50	05:50	05:50	05:50	06:00	06:20	06:20	06:20
8	03:50	03:50	03:50	03:50	03:50	03:50	03:50	04:15	04:15	04:20	04:20
9	03:50	03:50	03:50	03:50	03:50	03:50	03:55	05:15	05:30	05:30	05:30
10	05:45	05:45	05:45	05:45	05:45	05:45	05:50	05:50	06:15	06:15	06:15

Scenario	Region										
	12	13	14	15	16	17	18	19	20	21	22
1	04:55	05:00	04:55	04:55	04:45	05:00	04:35	04:00	04:00	03:35	05:05
2	06:05	06:25	06:25	06:05	06:05	06:05	05:35	05:20	04:45	04:35	06:30
3	05:00	05:05	05:05	05:00	05:00	05:05	04:35	04:35	04:35	04:30	05:10
4	06:30	06:35	06:30	06:20	06:25	06:30	06:00	04:55	05:00	04:35	06:35
5	05:15	05:15	05:05	04:50	04:50	04:50	04:45	04:30	04:30	04:25	05:15
6	06:20	06:20	06:20	06:10	06:10	06:15	05:50	04:35	04:35	04:25	06:20
7	06:50	06:50	06:50	06:50	06:50	06:50	06:20	06:05	06:05	06:00	06:50
8	04:25	04:25	04:20	04:10	04:10	04:10	03:55	03:55	03:55	03:50	04:25
9	05:30	05:25	05:15	05:00	05:10	05:05	04:45	03:55	03:55	03:50	05:30
10	06:15	06:10	05:50	05:50	05:50	05:50	05:50	05:50	05:50	05:45	06:15

Associated with each region is an "Associated Area" about the Pilgrim Station. These are:

Regions	7-20; 22	2-6; 21	1
Radius of Associated Area	EPZ-Boundary	5-Miles	2-Miles

Thus all entries for Regions 7 through 20 and Region 22 are the ETE for all vehicles evacuating from within the EPZ; those for Regions 2 through 6 and Region 21 are the ETE for all vehicles evacuating the area within a 5-mile radius around Pilgrim Station.

The entries for Region 1 are the ETE for vehicles evacuating the area within a radius of 2 miles around Pilgrim Station

Table 9-9. Evacuation Time Estimates for Scenarios 1A and 2A: Summer, Weekend, Evening

Scenario	Elapsed Time (Hrs..Min.) from the Directive to Evacuate needed to clear the indicated areas: 2 Miles	5 Miles	10 Miles	Entire EPZ
1	3:35	4:20	4:35	4:40
1A	3:35	4:40	4:45	5:05
Clear Weather				
2	3:55	6:05	6:10	6:10
2A	3:55	6:15	6:20	6:20
Rain				

Session 1A and 2A were undertaken to test the sensitivity of ETE to changes in traffic volumes along Route 3 at the time the evacuation directive is issued. These scenarios postulate an evacuation of the entire EPZ during a summer, weekend, evening when traffic flow along Route 3 is at peak hour volumes and 80 percent of the peak hour flow is moving northbound.

Comparisons between Scenarios 1A and 2A and their associated Scenarios 1 and 2 are based upon Revision 0 volumes. The comparisons indicate that for the postulated conditions, the ETE would increase by between 10 and 25 minutes.

The issue of voluntary evacuation must be addressed when the evacuation directive is issued to regions which comprise an area less than the entire EPZ. Voluntary evacuees are defined as those people who live within the EPZ in subareas for which an evacuation directive has not been issued who, nevertheless, choose to evacuate spontaneously. People who have been asked to evacuate may be delayed in leaving the area at risk due to the presence of voluntary evacuees on evacuation routes.

The ETE for Pilgrim Station addressed the issue of voluntary evacuees in the manner shown in Figure 9-1. Within the annular ring defined by the furthest extent of the evacuation directive, 50 percent of those people in subareas not advised to evacuate will do so. In the annular ring beginning at the furthest extent of the evacuation directive, 25 percent of the people will evacuate spontaneously.

Discussion of ETE

A total of 220 cases have been analyzed -- each case represents a possible evacuation protective action:

- If an accident escalates beyond the Alert stage, and it is determined that evacuation is advisable, the protective action will specify the region to be evacuated. There are a total of 22 regions. Associated with each region are one or more Subarea (See Table 9-2); the communities within each Subarea are listed in Table 9-3.

- The protective action could occur within the context of any one of 10 evacuation scenarios; these are defined in Table 9-1.

These data are presented in a concise tabular format in Tables 9-4 through 9-9. Each entry in these tables is the value of ETE for the indicated circumstances (i.e. Scenario), protective action (i.e. Region directed to evacuate), and radius of the circular area centered at Pilgrim Station. For example, it is estimated that the entire population within 5 miles of Pilgrim Station can evacuate that circular area [of 5-mile radius centered at the Station] within 3 hours and 35 minutes, under Scenario 1 conditions, when the entire populace within the EPZ (Region 22) is directed to evacuate (see Table 9-5).

The use of these tables is best illustrated through the medium of illustrative examples.

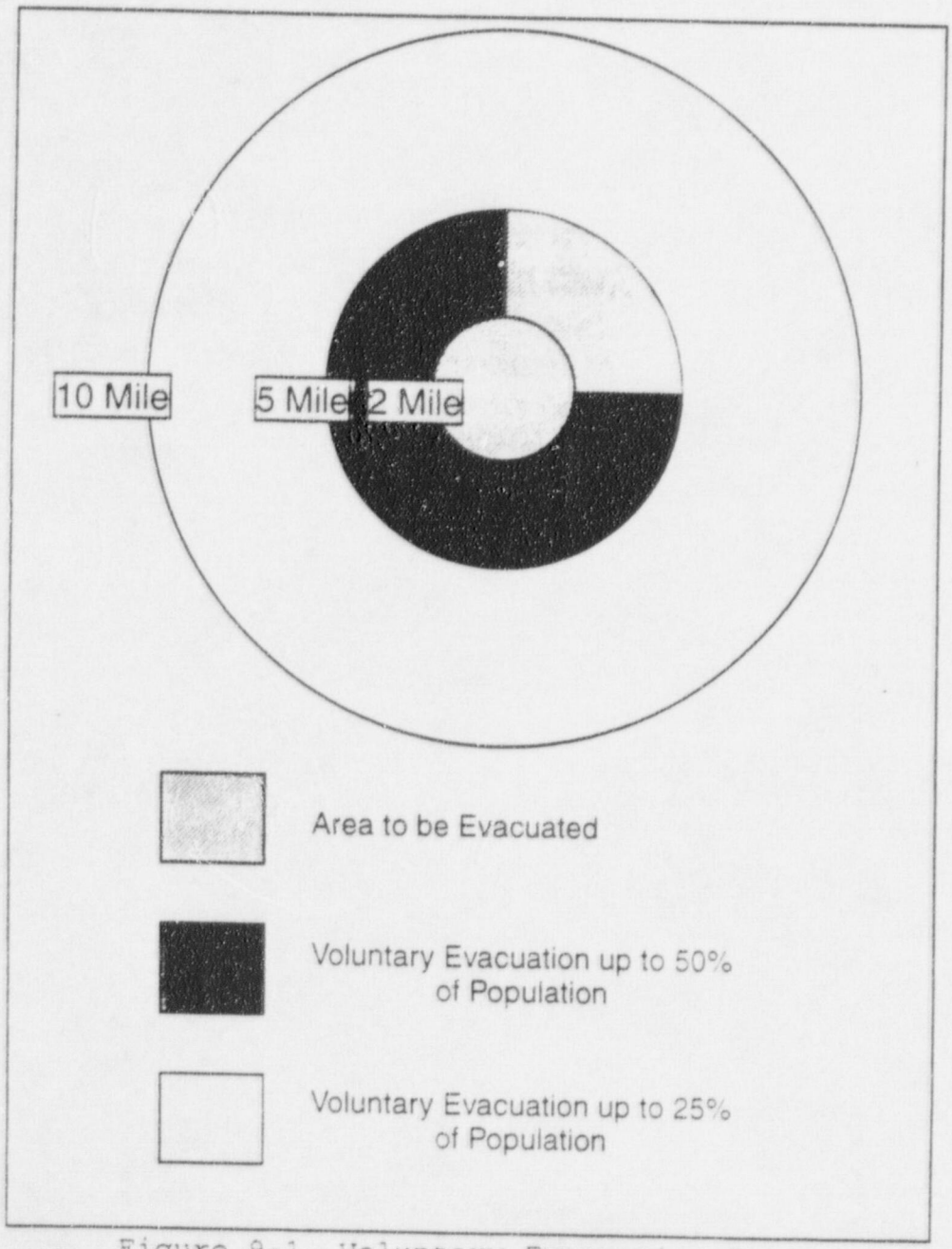


Figure 9-1. Voluntary Evacuation Rates

Example 1

Consider an accident situation on a summer weekend day (Scenario 1). Based on meteorological and on-site data, a release is projected while wind direction is from the west. The protective action is to evacuate Region 1 (see Table 9-2).

In arriving at this decision, the ETE for evacuating the two-mile area, for Region 1 and Scenario 1, is referenced in Table 9-4 and is found to be 3:35. (Table 9-8 yields the same value). This ETE is referenced to the issuance of the directive to evacuate which, in turn, is assumed to follow the initiation of notification by 10 minutes.

For this case, Table 9-6 yields an ETE of 4:00 for evacuating the populace from within Region 1, to points further than 10 miles from Pilgrim Station. Thus, it takes about 25 minutes to travel the distance of about 8 miles.

Since only the area within 2 miles of Pilgrim Station has been judged to be subject to potential exposure to radiation under the conditions of this example (i.e. only Region 1 is evacuated) the additional time to clear the 10-mile area is somewhat of academic interest. That is, travelers who are outside the 2-mile areas are not subject to potential exposure to radiation. Note that the population clearing the 10-mile area is assumed to include 25 percent of the population in the area outside Region 1, but inside the EPZ. This 25 percent represents those who are assumed to spontaneously evacuate contrary to EBS messages.

Example 2

Consider an accident situation on a dry, mid-week day in late Autumn (Scenario 5) in early afternoon. A release is projected which will travel to the southwest. The protective action is to evacuate Region 12 (see Table 9-2).

In arriving at this decision, the ETE for evacuating Region 12 in Scenario 5 is referenced in Table 9-7 (or Table 9-8) and is found to be 5:15. The ETE for areas closer to the Station are (from Tables 9-4 through 9-7):

Distance (miles) from Pilgrim Station	ETE
2	4:25
5	4:45
10	5:15
EPZ Boundary	5:15

It would appear that it takes zero time to travel from 10 miles to the EPZ boundary, a distance of 3 miles. This apparent anomaly reflects the interpolation procedures used to obtain these

ETE, and the subsequent rounding to the nearest 5 minutes. As a result, our tabulation of ETE does not distinguish small differences of a few minutes needed to travel the distance of several miles. Understand that towards the conclusion of the evacuation, the speed of vehicles remaining in the EPZ are not constrained by the presence of other vehicles. Evacuees who begin their trips late in the process may be able to complete their evacuation at free flow speed. Hence, less than five minutes would be required to travel the 3 miles cited.

As discussed earlier, a Planning Basis was adopted for calculating the ETE. It is important to explore the effects, on ETE, of variations about this basis. Appendix Q presents the results of a series of ETE sensitivity studies.

Patterns of Traffic Congestion during Evacuation (Region 22, Scenario 1)

Figures 9-2a) through 9-2c) illustrate the patterns of traffic congestion at 1, 2, and 3 hours of after the evacuation directive is issued. Scenario 1, Region 22, the case when the entire EPZ is directed to evacuate on a summer weekend day at the time when the beach area population is at capacity is used.

Traffic congestion, as the term is used here, is defined as Level of Service F. These terms are defined in the 1994 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 them.



Figure 9-2A: Traffic Congestion Patterns for Region 22 Scenario 1 at 1-Hour After the Evacuation Directive



Figure 9-2B: Traffic Congestion Patterns for Region 22 Scenario 1 at 2-Hours After the Evacuation Directive



Figure 9-2C: Traffic Congestion Patterns for Region 22 Scenario 1 at 3-Hours After the Evacuation Directive

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

Beaches were ordered closed at the Alert Level, or 25 minutes earlier than the issuance of the Evacuation Directive. By 0:35 after the Evacuation Directive congestion is present on roads departing most beaches, tourist sites and parks.

Peak traffic congestion is present between one and two hours after the Evacuation Directive is issued.

By 2:35 levels of congestion at some locations have begun to dissipate, most notably in Carver and Plymouth. Northbound Route 3 shows congestion north of Route 44. Congestion on roads leading from the Whitehorse Beach area have eased, although Route 3A is still heavily utilized.

By 3:35 most of the congestion in western Plymouth, Kingston and Duxbury has cleared. There remains some local congestion in downtown Plymouth. However, by 4:05 this local congestion has effectively cleared. By 4:05 most of the remaining congestion is at the periphery of the EPZ, with some congestion along northbound Route 3. By 5:05 the area has been cleared.

Patterns of Traffic Congestion during Evacuation (Region 22, Scenario 5)

Figures 9-3a) through 9-3c) illustrate the patterns of traffic congestion at 1, 2, and 3 hours of after the evacuation directive is issued. Scenario 5, Region 22, the case when the entire EPZ is directed to evacuate during the off-season, midweek, midday period. As before, highway "links" exhibiting Level of Service F are delineated by a thick, dark line.

The characteristics of Scenario 5 are: peak employment in the EPZ, and 25 percent of peak tourists with no beach area transients. As a consequence, congestion which is apparent at beach areas (Marshfield, Duxbury, Manomet Area) in Scenario 1 (see Figures 9-2a,b) is not present in Scenario 5.

Patterns of congestion associated with the general population and employees are apparent in Scenario 5. By 2 hours after the Evacuation Directive congestion has peaked in Plymouth and Carver. Route 3 is congested northbound through Duxbury. Note that tourists and beach goers are able to respond to an Evacuation Directive faster than the general population (see Section 4). Therefore, the onset of congestion occurs earlier in Scenario 1 than in Scenario 5.



Figure 9-3A: Traffic Congestion Patterns for Region 22 Scenario 5 at 1-Hour After the Evacuation Directive



Figure 9-3B: Traffic Congestion Patterns for Region 22 Scenario 5 at 2-Hours After the Evacuation Directive



Figure 9-3C: Traffic Congestion Patterns for Region 22 Scenario 5 at 3-Hours After the Evacuation Directive

Congestion effectively clears within the EPZ by about 4:00 and the area is cleared of evacuees by 5:15.

It is possible to identify the extent to which congestion affects evacuation time by comparing Scenarios 1 and 5:

	Elapsed Time to Start of Last Vehicle Trip	Evacuation Time Estimate
Region 22, Scenario 1	3:30	5:05
Region 22, Scenario 5	4:10	5:15

Note that about 1.5 hours elapses between the time the last vehicle in Scenario 1 begins its trip and the time the last vehicle leaves the EPZ. If no congestion were present, this vehicle would require about 20 minutes (12 miles at 40 mph) to traverse the EPZ. The last vehicle in Scenario 5 requires just 45 minutes to complete its trip. Consequently, the extent and intensity of congestion present in Scenario 1 causes the ETE to increase by some 90 minutes. In Scenario 5, the start of the last evacuation trip occurs after most of traffic congestion has dissipated.

Evacuation Rates

Traffic flow is a continuous process, as implied by Figures 9-2 and 9-3. Another format for displaying the dynamics of the evacuation procedure is depicted in Figures 9-4a through 9-4j. These plots indicate the rate at which traffic flows out of the indicated areas for each Scenario associated with the evacuation of the entire EPZ (Region 1).

As indicated in these Figures, there is typically a long "tail" to these distributions. Vehicles evacuate an area slowly at the beginning, as people respond to the directive to evacuate at different rates, then builds rapidly (slopes of curves increase). When the system becomes congested, traffic flows at [near] capacity rates until some evacuation routes have cleared. As more routes clear, the rate of egress slows since many vehicles have already left the EPZ. Towards the end of the process, one or two evacuation routes service the remaining demand.

This decline in aggregate flow rate, with time, is characterized by these curves gradually becoming horizontal. Ideally, it would be desirable to fully saturate all evacuation routes so that all will service traffic near capacity levels and all will clear at the same time. For this ideal situation, all curves would remain steep until the end -- thus minimizing evacuation time. In the real world, this ideal is generally unattainable. Proper planning, however, can make an important difference in the utilization of existing highway capacity and in

reducing evacuation time to a practical minimum.

Summary of Evacuation Time Analysis

A summary of evacuation times is presented in Tables 9-10, 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 11 and 12, respectively.

The estimates of Permanent Resident and Vehicle Population are those of Table 2-1. These town estimates were aggregated to form Subarea 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 Section 2.

Evacuation capacity from each area was ascertained by aggregating the highway capacities of all outward-bound roads which pierce the area's outer boundary. 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 (see Appendix I).

Figure 9-4a: Evacuation Time Estimates
Region 22, Scenario 1

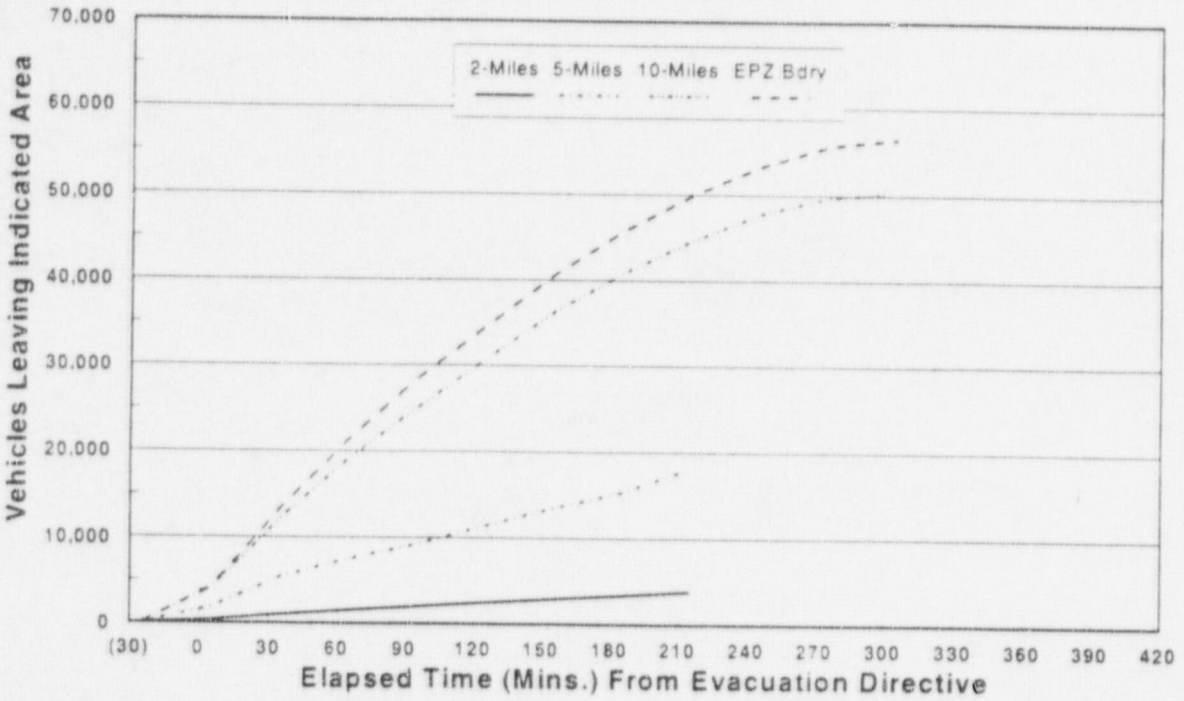


Figure 9-4b: Evacuation Time Estimates
Region 22, Scenario 2

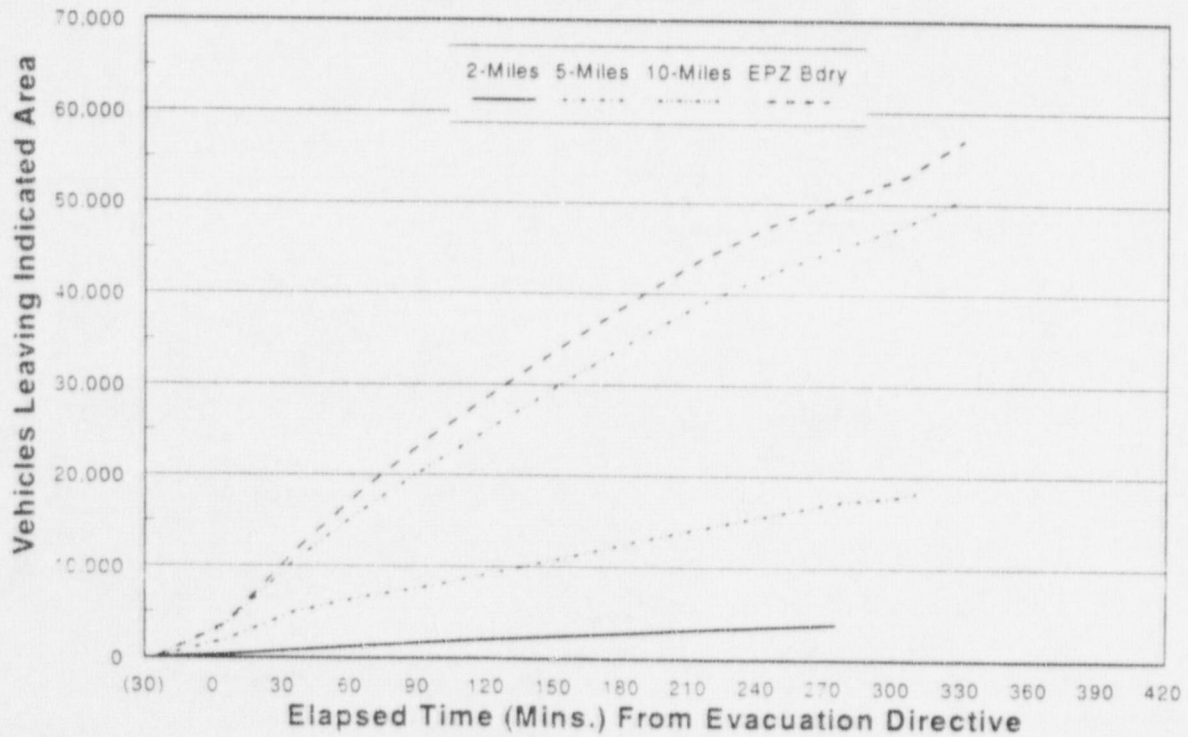


Figure 9-4c: Evacuation Time Estimates Region 22, Scenario 3

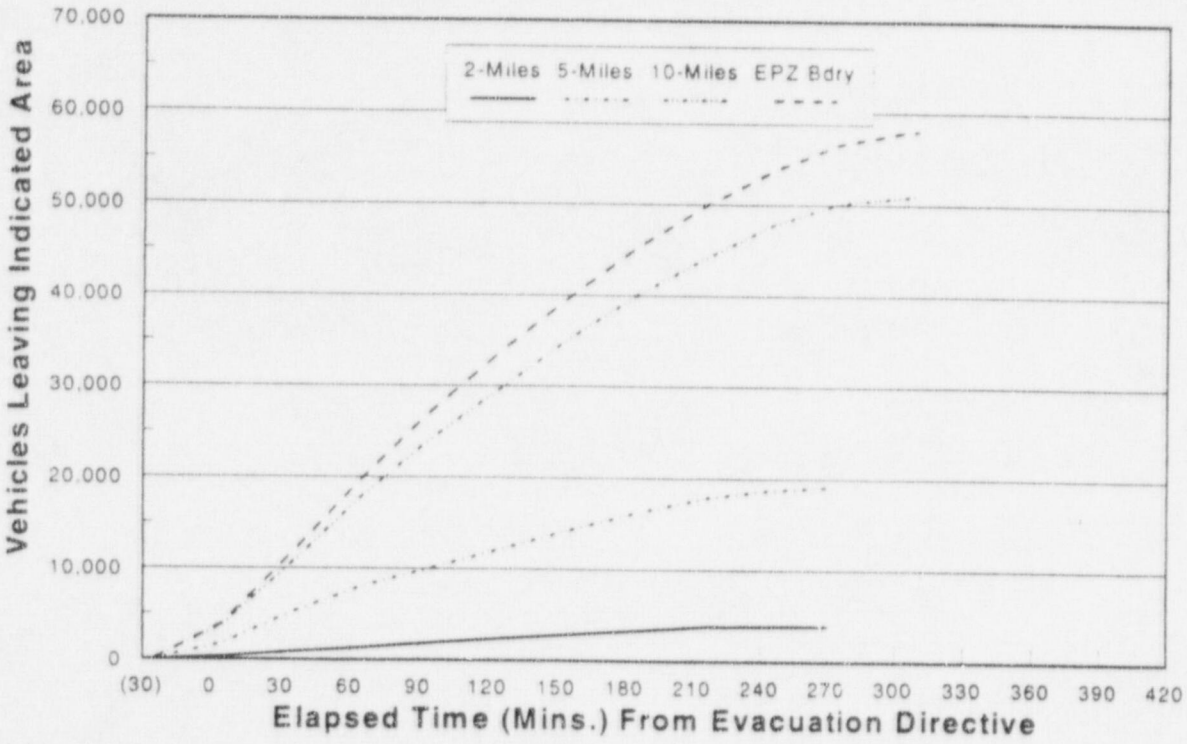


Figure 9-4d: Evacuation Time Estimates Region 22, Scenario 4

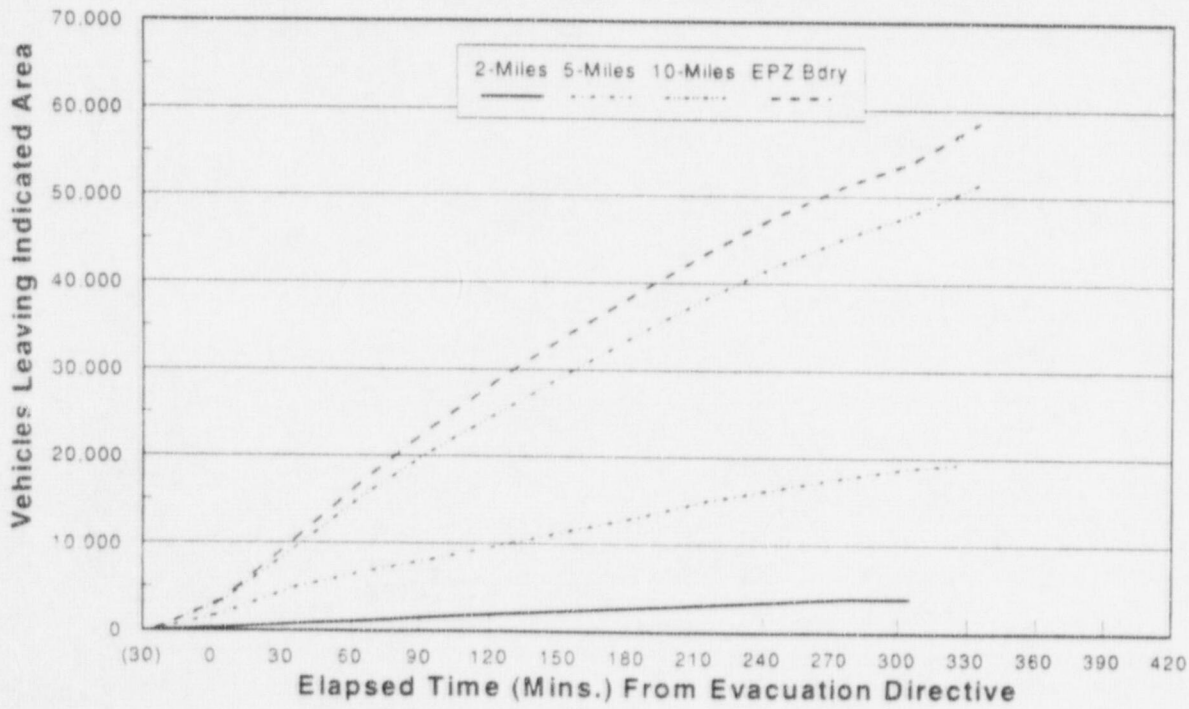


Figure 9-4e: Evacuation Time Estimates
Region 22, Scenario 5

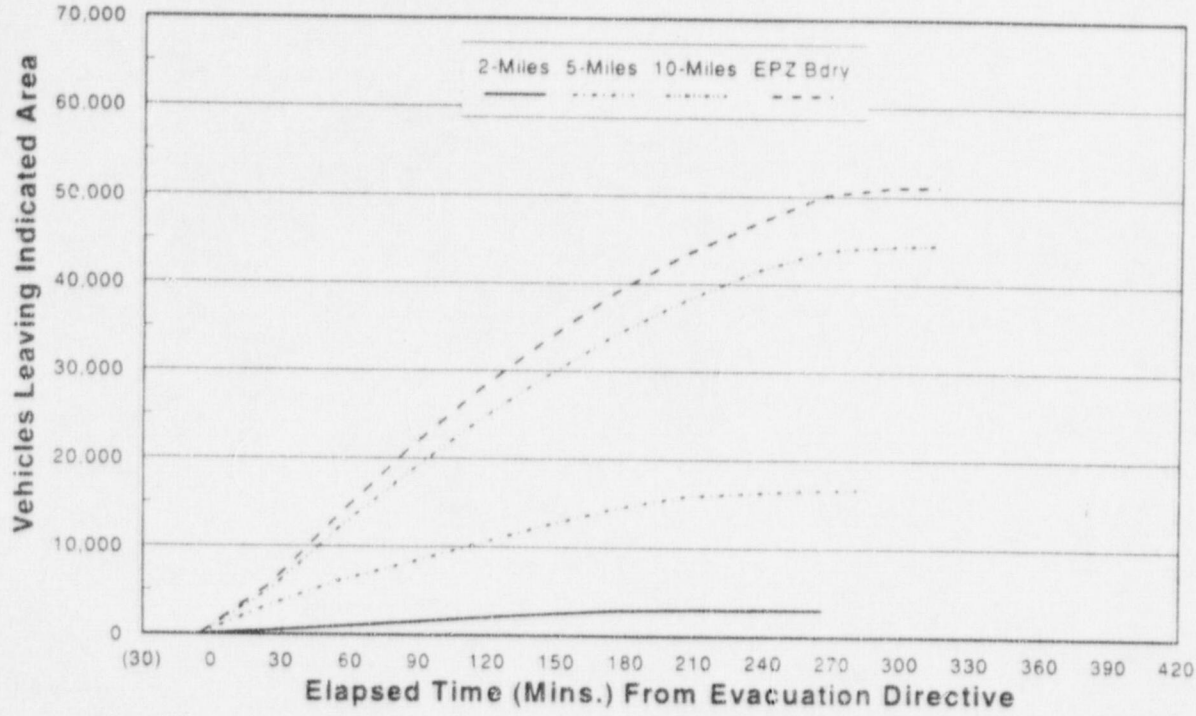


Figure 9-4f: Evacuation Time Estimates
Region 22, Scenario 6

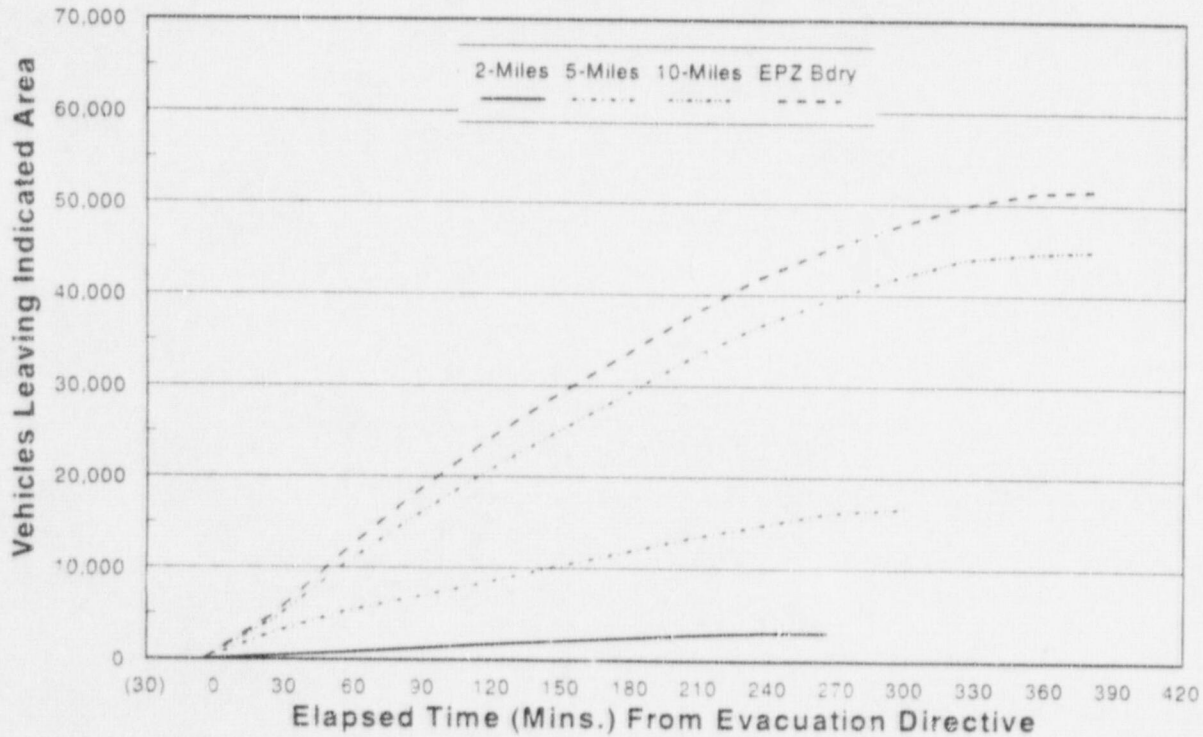


Figure 9-4g: Evacuation Time Estimates
Region 22, Scenario 7

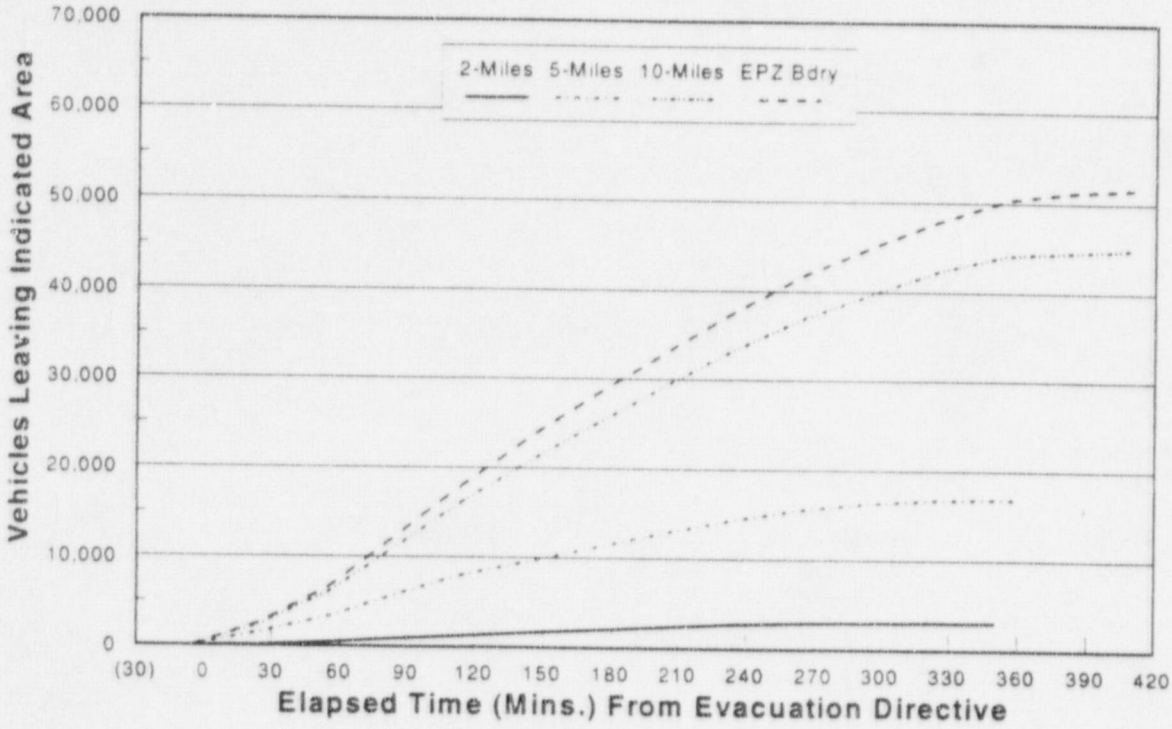


Figure 9-4h: Evacuation Time Estimates
Region 22, Scenario 8

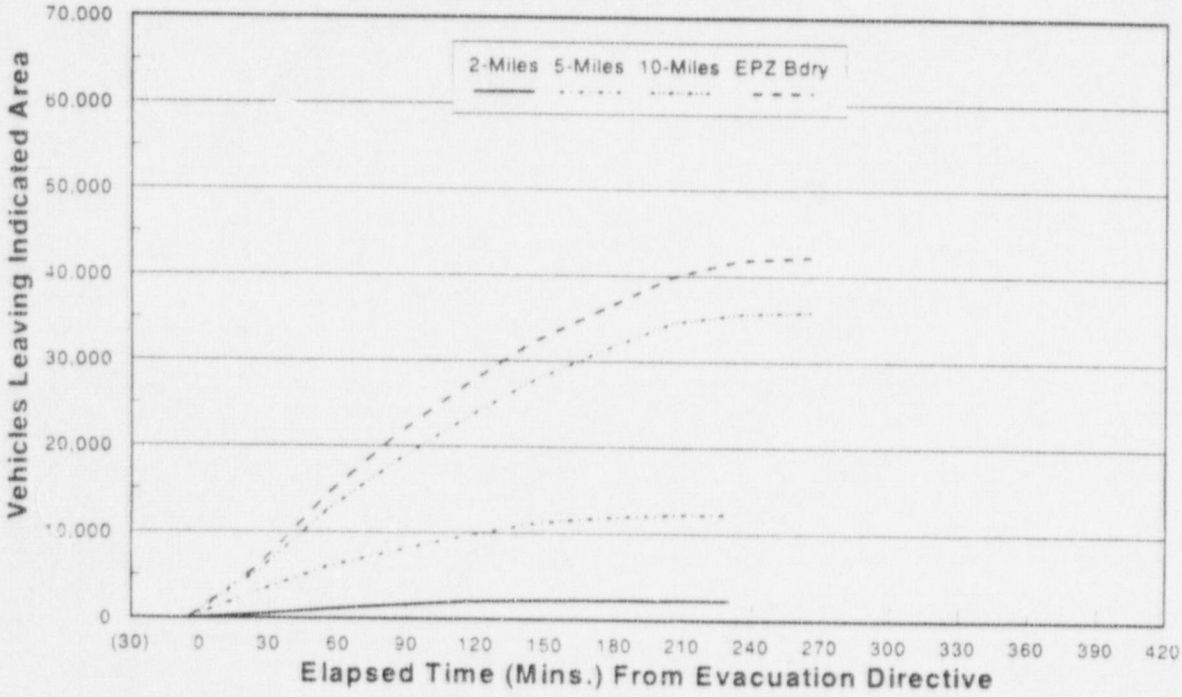


Figure 9-4i: Evacuation Time Estimates Region 22, Scenario 9

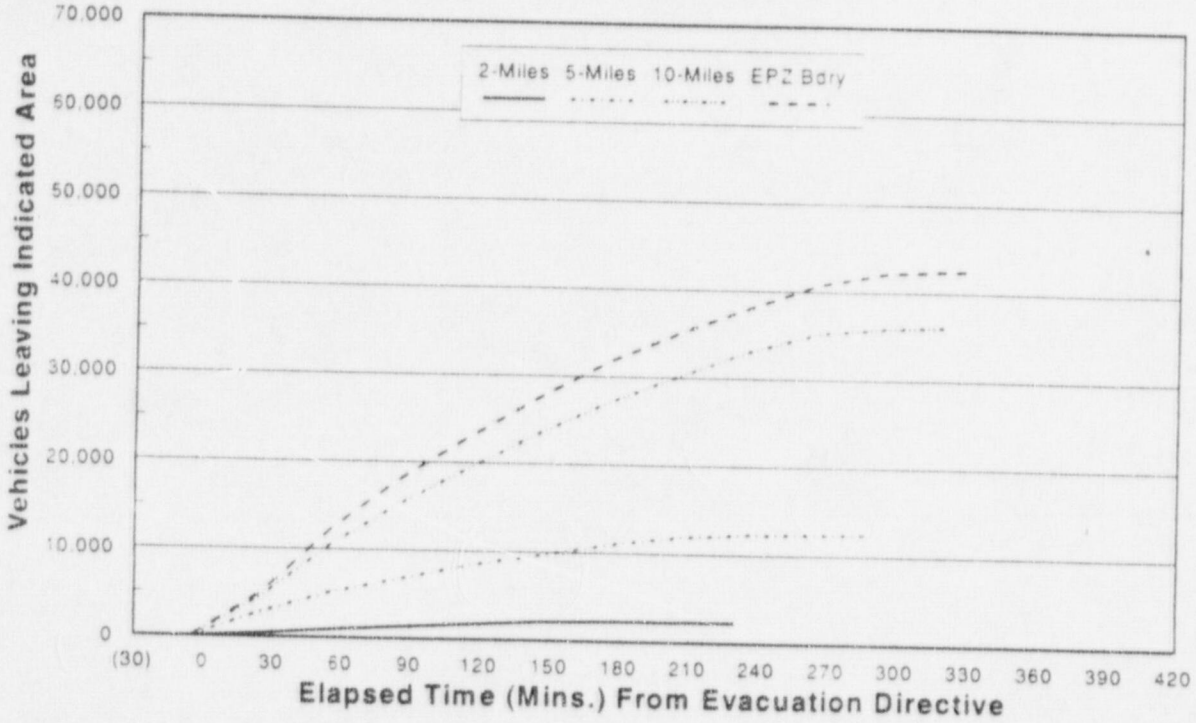
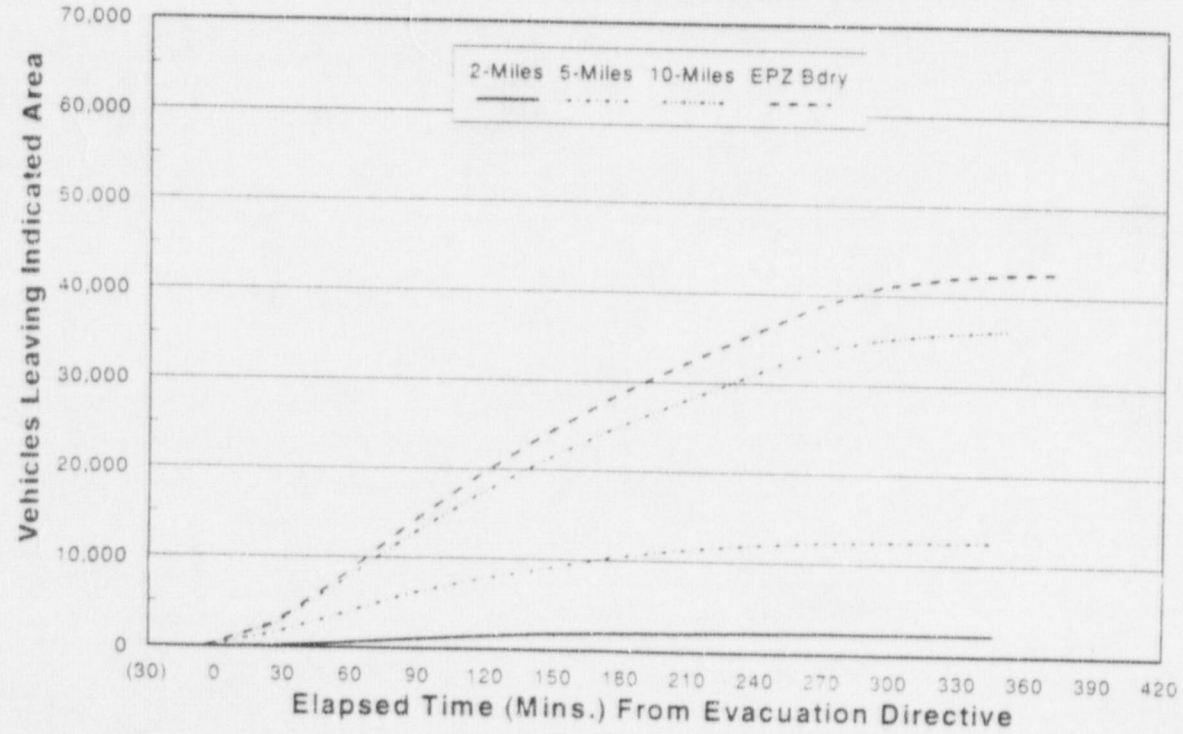


Figure 9-4j: Evacuation Time Estimates Region 22, Scenario 10



It is important to stress that these estimates of available capacity may overstate the actual accessible capacity. Specifically, network topological features may restrict access to all outbound roads. For example, the available capacity of Route 3 southbound is approximately 3,128 vehicles per hour. However, southbound flow rates are controlled by the capacity of the Sagamore Rotary and Cranberry Highway estimated at 2,880 vehicles per hour. Hence the available capacity of Route 3 is not accessible. Although Tables 9-10 present estimates of available capacity, the evacuation time estimates are based upon explicit utilization of accessible capacities.

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 Figure 4-2) which graphically depicts the continuous nature of the process.

The Evacuation Time Estimates (ETE) are those presented in Table 9-8. In Tables 9-10, the population figures (first 4 columns) are those associated with the indicated Regions (see Table 9-2); the capacities and ETE figures are for the indicated distances: 2,5,10 miles from the Pilgrim Station.

Table 9-10A: Summary of Results of Evacuation Time Analysis
Scenarios 1 and 2

Areas	Permanent Pop.	Permanent Vehs.	Transient Pop.	Transient Vehs.	Evacuation Capacity	Relative To Siren Alert: Notify Time	Prep. Time	Permanent Response Time Clear	Permanent Response Time Adv.	Transient Response Time Clear	Transient Response Time Adv.	From Directive To Evacuate: General Pop. Evacuation Time Clear	General Pop. Evacuation Time Adv.	Confirm Time	Special Population Evacuation Time Clear	Special Population Evacuation Time Adv.
Within Two Miles																
Region 1	5002	1924	1568	615	6921	00:40	3:15	3:30	3:30	3:30	3:30	3:35	4:35	1:00	6:30	6:45
Within Five Miles																
Region 2	11523	4433	2864	1123	12843	00:40	3:15	3:30	3:30	3:30	3:30	3:35	4:35	1:15	6:30	6:45
Region 3	23636	9092	8024	3146	21123	00:40	3:15	3:30	3:30	3:30	3:30	3:35	4:35	1:15	6:30	6:45
Region 4	17115	6583	6728	2638	17690	00:40	3:15	3:30	3:30	3:30	3:30	3:35	4:35	1:15	6:30	6:45
Region 5	17140	6593	8194	3213	22895	00:40	3:15	3:30	3:30	3:30	3:30	3:35	4:35	1:15	6:30	6:45
Region 6	5027	1934	3034	1190	9522	00:40	3:15	3:30	3:30	3:30	3:30	3:35	4:35	1:15	6:30	6:45
Region 21	23661	9102	9490	3721	20163	00:40	3:15	3:30	3:30	3:30	3:30	3:35	4:35	1:15	6:30	6:45
Within Ten Miles																
Region 7	17908	6889	11464	4496	16390	00:40	3:15	3:30	3:30	3:30	3:30	4:05	5:00	1:15	6:30	6:45
Region 8	30021	11548	18777	7363	28332	00:40	3:15	3:30	3:30	3:30	3:30	4:20	5:25	1:15	7:05	7:20
Region 9	48714	18738	20567	8065	28332	00:40	3:15	3:30	3:30	3:30	3:30	4:30	5:35	1:15	7:05	7:20
Region 10	42329	16282	11967	4692	28332	00:40	3:15	3:30	3:30	3:30	3:30	4:40	5:35	1:15	7:05	7:20
Region 11	50283	19342	11967	4692	29524	00:40	3:15	3:30	3:30	3:30	3:30	4:30	5:40	1:15	7:05	7:20
Region 12	54997	21155	13407	5257	29524	00:40	3:15	3:30	3:30	3:30	3:30	4:55	6:05	1:15	7:05	7:20
Region 13	69765	26835	17408	6826	37415	00:40	3:15	3:30	3:30	3:30	3:30	5:00	6:25	1:15	7:05	7:20
Region 14	63354	24369	15618	6124	37415	00:40	3:15	3:30	3:30	3:30	3:30	4:55	6:25	1:15	7:05	7:20
Region 15	51072	19645	13465	5280	33202	00:40	3:15	3:30	3:30	3:30	3:30	4:55	6:05	1:15	7:05	7:20
Region 16	51097	19655	14931	5855	33202	00:40	3:15	3:30	3:30	3:30	3:30	4:45	6:05	1:15	7:05	7:20
Region 17	52954	20370	19263	7554	33202	00:40	3:15	3:30	3:30	3:30	3:30	5:00	6:05	1:15	7:05	7:20
Region 18	45000	17310	18828	7383	33202	00:40	3:15	3:30	3:30	3:30	3:30	4:35	5:35	1:15	7:05	7:20
Region 19	21652	8329	11367	4458	21519	00:40	3:15	3:30	3:30	3:30	3:30	4:00	5:20	1:15	5:50	6:05
Region 20	6884	2649	7366	2889	21519	00:40	3:15	3:30	3:30	3:30	3:30	4:00	4:45	1:15	5:50	6:05
Region 22	84553	32525	33102	12981	39042	00:40	3:15	3:30	3:30	3:30	3:30	5:05	6:30	1:15	7:05	7:20

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Table 9-10B: Summary of Results of Evacuation Time Analysis
Scenarios 3 and 4

Areas	Permanent Pop.	Permanent Vehs.	Transient Pop.	Transient Vehs.	Evacuation Capacity	Relative To Siren Alert: Notify Time	Prep. Time	Permanent Response Time Clear	Permanent Response Time Adv.	Transient Response Time Clear	Transient Response Time Adv.	From Directive To Evacuate: General Pop. Evacuation Time Clear	General Pop. Evacuation Time Adv.	Confirm Time	Special Population Evacuation Time Clear	Special Population Evacuation Time Adv.
Within Two Miles																
Region 1	5002	1924	1175	462	6921	00:40	3:15	4:10	4:10	3:30	3:30	4:30	4:35	1:00	6:30	6:45
Within Five Miles																
Region 2	11523	4433	2148	843	12843	00:40	3:15	4:10	4:10	3:30	3:30	4:30	4:35	1:15	6:30	6:45
Region 3	23636	9092	6022	2362	21123	00:40	3:15	4:10	4:10	3:30	3:30	4:30	4:35	1:15	6:30	6:45
Region 4	17115	6583	5049	1981	17690	00:40	3:15	4:10	4:10	3:30	3:30	4:30	4:35	1:15	6:30	6:45
Region 5	17140	6593	6150	2413	22895	00:40	3:15	4:10	4:10	3:30	3:30	4:30	4:35	1:15	6:30	6:45
Region 6	5027	1934	2276	894	9522	00:40	3:15	4:10	4:10	3:30	3:30	4:30	4:35	1:15	6:30	6:45
Region 21	23661	9102	7123	2794	20163	00:40	3:15	4:10	4:10	3:30	3:30	4:30	4:35	1:15	6:30	6:45
Within Ten Miles																
Region 7	17908	6889	8605	3375	16390	00:40	3:15	4:10	4:10	3:30	3:30	4:35	5:05	1:15	6:30	6:45
Region 8	30021	11548	14096	5528	28332	00:40	3:15	4:10	4:10	3:30	3:30	4:35	5:30	1:15	7:05	7:20
Region 9	48714	18738	15443	6056	28332	00:40	3:15	4:10	4:10	3:30	3:30	4:35	5:45	1:15	7:05	7:20
Region 10	42329	16282	8986	3524	28332	00:40	3:15	4:10	4:10	3:30	3:30	4:35	5:45	1:15	7:05	7:20
Region 11	50283	19342	8986	3524	29524	00:40	3:15	4:10	4:10	3:30	3:30	4:35	5:55	1:15	7:05	7:20
Region 12	54997	21155	10071	3950	29524	00:40	3:15	4:10	4:10	3:30	3:30	5:00	6:30	1:15	7:05	7:20
Region 13	69765	26835	13079	5129	37415	00:40	3:15	4:10	4:10	3:30	3:30	5:05	6:35	1:15	7:05	7:20
Region 14	63354	24369	11732	4601	37415	00:40	3:15	4:10	4:10	3:30	3:30	5:05	6:30	1:15	7:05	7:20
Region 15	51072	19645	10115	3967	33202	00:40	3:15	4:10	4:10	3:30	3:30	5:00	6:20	1:15	7:05	7:20
Region 16	51097	19655	11216	4399	33202	00:40	3:15	4:10	4:10	3:30	3:30	5:00	6:25	1:15	7:05	7:20
Region 17	52954	20370	14468	5674	33202	00:40	3:15	4:10	4:10	3:30	3:30	5:05	6:30	1:15	7:05	7:20
Region 18	45000	17310	14141	5546	33202	00:40	3:15	4:10	4:10	3:30	3:30	4:35	6:00	1:15	7:05	7:20
Region 19	21652	8329	8536	3348	21519	00:40	3:15	4:10	4:10	3:30	3:30	4:35	4:55	1:15	5:50	6:05
Region 20	6884	2649	5528	2169	21519	00:40	3:15	4:10	4:10	3:30	3:30	4:35	5:00	1:15	5:50	6:05
Region 22	84553	32525	24862	9749	39042	00:40	3:15	4:10	4:10	3:30	3:30	5:10	6:35	1:15	7:05	7:20

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Table 9-10C: Summary of Results of Evacuation Time Analysis
Scenarios 5 and 6

Areas	Permanent Pop.	Permanent Vehs.	Transient Pop.	Transient Vehs.	Evacuation Capacity	Relative To Siren Alert: Notify Time	Prep. Time	Permanent Response: Time Clear	Permanent Response: Time Adv.	Transient Response: Time Clear	Transient Response: Time Adv.	From Directive To Evacuate: General Pop. Evacuation: Time Clear	General Pop. Evacuation: Time Adv.	Confirm Time	Special Population Evacuation: Time Clear	Special Population Evacuation: Time Adv.
Within Two Miles																
Region 1	5002	1924	291	114	6921	00:40	3:15	4:10	4:10	3:30	3:30	4:25	4:25	1:00	6:30	6:45
Within Five Miles																
Region 2	11523	4433	531	208	12843	00:40	3:15	4:10	4:10	3:30	3:30	4:25	4:25	1:15	6:30	6:45
Region 3	23636	9092	1485	582	21123	00:40	3:15	4:10	4:10	3:30	3:30	4:25	4:25	1:15	6:30	6:45
Region 4	17115	6583	1245	488	17690	00:40	3:15	4:10	4:10	3:30	3:30	4:25	4:25	1:15	6:30	6:45
Region 5	17140	6593	1516	594	22895	00:40	3:15	4:10	4:10	3:30	3:30	4:25	4:25	1:15	6:30	6:45
Region 6	5027	1934	562	220	9522	00:40	3:15	4:10	4:10	3:30	3:30	4:25	4:25	1:15	6:30	6:45
Region 21	23661	9102	1756	688	20163	00:40	3:15	4:10	4:10	3:30	3:30	4:25	4:25	1:15	6:30	6:45
Within Ten Miles																
Region 7	17908	6889	2122	832	16390	00:40	3:15	4:10	4:10	3:30	3:30	4:25	4:35	1:15	6:30	6:45
Region 8	30021	11548	3474	1362	28332	00:40	3:15	4:10	4:10	3:30	3:30	4:30	5:20	1:15	7:05	7:20
Region 9	48714	18738	3803	1491	28332	00:40	3:15	4:10	4:10	3:30	3:30	4:45	5:45	1:15	7:05	7:20
Region 10	42329	16282	2212	867	28332	00:40	3:15	4:10	4:10	3:30	3:30	4:45	5:45	1:15	7:05	7:20
Region 11	50283	19342	2212	867	29524	00:40	3:15	4:10	4:10	3:30	3:30	4:45	5:50	1:15	7:05	7:20
Region 12	54997	21155	2614	1025	29524	00:40	3:15	4:10	4:10	3:30	3:30	5:15	6:20	1:15	7:05	7:20
Region 13	69765	26835	2950	1156	37415	00:40	3:15	4:10	4:10	3:30	3:30	5:15	6:20	1:15	7:05	7:20
Region 14	63354	24369	2621	1027	37415	00:40	3:15	4:10	4:10	3:30	3:30	5:05	6:20	1:15	7:05	7:20
Region 15	51072	19645	2223	871	33202	00:40	3:15	4:10	4:10	3:30	3:30	4:50	6:10	1:15	7:05	7:20
Region 16	51097	19655	2494	977	33202	00:40	3:15	4:10	4:10	3:30	3:30	4:50	6:10	1:15	7:05	7:20
Region 17	52954	20370	2999	1175	33202	00:40	3:15	4:10	4:10	3:30	3:30	4:50	6:15	1:15	7:05	7:20
Region 18	45000	17310	2919	1143	33202	00:40	3:15	4:10	4:10	3:30	3:30	4:45	5:50	1:15	7:05	7:20
Region 19	21652	8329	1403	549	21519	00:40	3:15	4:10	4:10	3:30	3:30	4:30	4:35	1:15	5:50	6:05
Region 20	6884	2649	1067	418	21519	00:40	3:15	4:10	4:10	3:30	3:30	4:30	4:35	1:15	5:50	6:05
Region 22	84553	32525	5557	2178	39042	00:40	3:15	4:10	4:10	3:30	3:30	5:15	6:20	1:15	7:05	7:20

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Table 9-10D: Summary of Results of Evacuation Time Analysis
Scenarios 5 and 7

Areas	Permanent Pop.	Permanent Vehs.	Transient Pop.	Transient Vehs.	Evacuation Capacity	Relative To Siren Alert: Notify Time	Prep. Time	Permanent Response: Time Clear	Permanent Response: Time Adv.	Transient Response: Time Clear	Transient Response: Time Adv.	From Directive To Evacuate: General Pop. Evacuation: Time Clear	General Pop. Evacuation: Time Adv.	Confirm Time	Special Population Evacuation: Time Clear	Special Population Evacuation: Time Adv.
Within Two Miles																
Region 1	5002	1924	291	114	6921	00:40	3:15	4:10	5:30	3:30	5:30	4:25	5:50	1:00	6:30	6:45
Within Five Miles																
Region 2	11523	4433	531	208	12843	00:40	3:15	4:10	5:30	3:30	5:30	4:25	5:50	1:15	6:30	6:45
Region 3	23636	9092	1485	582	21123	00:40	3:15	4:10	5:30	3:30	5:30	4:25	5:50	1:15	6:30	6:45
Region 4	17115	6583	1245	488	17690	00:40	3:15	4:10	5:30	3:30	5:30	4:25	5:50	1:15	6:30	6:45
Region 5	17140	6593	1516	594	22895	00:40	3:15	4:10	5:30	3:30	5:30	4:25	5:50	1:15	6:30	6:45
Region 6	5027	1934	562	220	9522	00:40	3:15	4:10	5:30	3:30	5:30	4:25	5:50	1:15	6:30	6:45
Region 21	23661	9102	1756	688	20163	00:40	3:15	4:10	5:30	3:30	5:30	4:25	6:00	1:15	6:30	6:45
Within Ten Miles																
Region 7	17908	6889	2122	832	16390	00:40	3:15	4:10	5:30	3:30	5:30	4:25	5:50	1:15	6:30	6:45
Region 8	30021	11548	3474	1362	28332	00:40	3:15	4:10	5:30	3:30	5:30	4:30	6:00	1:15	7:05	7:20
Region 9	48714	18738	3803	1491	28332	00:40	3:15	4:10	5:30	3:30	5:30	4:45	6:20	1:15	7:05	7:20
Region 10	42329	16282	2212	867	28332	00:40	3:15	4:10	5:30	3:30	5:30	4:45	6:20	1:15	7:05	7:20
Region 11	50283	19342	2212	867	29524	00:40	3:15	4:10	5:30	3:30	5:30	4:45	6:20	1:15	7:05	7:20
Region 12	54997	21155	2614	1025	29524	00:40	3:15	4:10	5:30	3:30	5:30	5:15	6:50	1:15	7:05	7:20
Region 13	69765	26835	2950	1156	37415	00:40	3:15	4:10	5:30	3:30	5:30	5:15	6:50	1:15	7:05	7:20
Region 14	63354	24369	2621	1027	37415	00:40	3:15	4:10	5:30	3:30	5:30	5:05	6:50	1:15	7:05	7:20
Region 15	51072	19645	2223	871	33202	00:40	3:15	4:10	5:30	3:30	5:30	4:50	6:50	1:15	7:05	7:20
Region 16	51097	19655	2494	977	33202	00:40	3:15	4:10	5:30	3:30	5:30	4:50	6:50	1:15	7:05	7:20
Region 17	52954	20370	2999	1175	33202	00:40	3:15	4:10	5:30	3:30	5:30	4:50	6:50	1:15	7:05	7:20
Region 18	45000	17310	2919	1143	33202	00:40	3:15	4:10	5:30	3:30	5:30	4:45	6:20	1:15	7:05	7:20
Region 19	21652	8329	1403	549	21519	00:40	3:15	4:10	5:30	3:30	5:30	4:30	6:05	1:15	5:50	6:05
Region 20	6884	2649	1067	418	21519	00:40	3:15	4:10	5:30	3:30	5:30	4:30	6:05	1:15	5:50	6:05
Region 22	84553	32525	5557	2178	39042	00:40	3:15	4:10	5:30	3:30	5:30	5:15	6:50	1:15	7:05	7:20

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Table 9-10E: Summary of Results of Evacuation Time Analysis
Scenarios 8 and 9

Areas	Permanent Pop.	Permanent Vehs.	Transient Pop.	Transient Vehs.	Evacuation Capacity	Relative To Siren Alert: Notify Time	Prep. Time	Permanent Response Time Clear	Permanent Response Time Adv.	Transient Response Time Clear	Transient Response Time Adv.	From Directive To Evacuate: General Pop. Evacuation Time Clear	General Pop. Evacuation Time Adv.	Confirm Time	Special Population Evacuation Time Clear	Special Population Evacuation Time Adv.
Within Two Miles																
Region 1	5002	1924	291	114	6921	00:40	3:15	3:30	3:30	3:30	3:30	3:50	3:50	1:00	6:30	6:45
Within Five Miles																
Region 2	11523	4433	531	208	12843	00:40	3:15	3:30	3:30	3:30	3:30	3:50	3:50	1:15	6:30	6:45
Region 3	23636	9092	1485	582	21123	00:40	3:15	3:30	3:30	3:30	3:30	3:50	3:50	1:15	6:30	6:45
Region 4	17115	6583	1245	488	17690	00:40	3:15	3:30	3:30	3:30	3:30	3:50	3:50	1:15	6:30	6:45
Region 5	17140	6593	1516	594	22895	00:40	3:15	3:30	3:30	3:30	3:30	3:50	3:50	1:15	6:30	6:45
Region 6	5027	1934	562	220	9522	00:40	3:15	3:30	3:30	3:30	3:30	3:50	3:50	1:15	6:30	6:45
Region 21	23661	9102	1756	688	20163	00:40	3:15	3:30	3:30	3:30	3:30	3:50	3:50	1:15	6:30	6:45
Within Ten Miles																
Region 7	17908	6889	2122	832	16390	00:40	3:15	3:30	3:30	3:30	3:30	3:50	3:55	1:15	6:30	6:45
Region 8	30021	11548	3474	1362	28332	00:40	3:15	3:30	3:30	3:30	3:30	4:15	5:15	1:15	7:05	7:20
Region 9	48714	18738	7577	2971	28332	00:40	3:15	3:30	3:30	3:30	3:30	4:15	5:30	1:15	7:05	7:20
Region 10	42329	16282	5986	2347	28332	00:40	3:15	3:30	3:30	3:30	3:30	4:20	5:30	1:15	7:05	7:20
Region 11	50283	19342	5986	2347	29524	00:40	3:15	3:30	3:30	3:30	3:30	4:20	5:30	1:15	7:05	7:20
Region 12	54997	21155	6388	2505	29524	00:40	3:15	3:30	3:30	3:30	3:30	4:25	5:30	1:15	7:05	7:20
Region 13	69765	26835	6724	2636	37415	00:40	3:15	3:30	3:30	3:30	3:30	4:25	5:25	1:15	7:05	7:20
Region 14	63354	24369	2621	1027	37415	00:40	3:15	3:30	3:30	3:30	3:30	4:20	5:15	1:15	7:05	7:20
Region 15	51072	19645	2223	871	33202	00:40	3:15	3:30	3:30	3:30	3:30	4:10	5:00	1:15	7:05	7:20
Region 16	51097	19655	2494	977	33202	00:40	3:15	3:30	3:30	3:30	3:30	4:10	5:10	1:15	7:05	7:20
Region 17	52954	20370	2999	1175	33202	00:40	3:15	3:30	3:30	3:30	3:30	4:10	5:05	1:15	7:05	7:20
Region 18	45000	17310	2919	1143	33202	00:40	3:15	3:30	3:30	3:30	3:30	3:55	4:45	1:15	7:05	7:20
Region 19	21652	8329	1403	549	21519	00:40	3:15	3:30	3:30	3:30	3:30	3:55	3:55	1:15	5:50	6:05
Region 20	6884	2649	1067	418	21519	00:40	3:15	3:30	3:30	3:30	3:30	3:55	3:55	1:15	5:50	6:05
Region 22	84553	32525	9331	3658	39042	00:40	3:15	3:30	3:30	3:30	3:30	4:25	5:30	1:15	7:05	7:20

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Table 9-10F: Summary of Results of Evacuation Time Analysis
Scenarios 8 and 10

Areas	Permanent Pop.	Permanent Vehs.	Transient Pop.	Transient Vehs.	Evacuation Capacity	Relative To Siren Alert: Notify Time	Prep. Time	Permanent Response Time Clear	Permanent Response Time Adv.	Transient Response Time Clear	Transient Response Time Adv.	From Directive To Evacuate: General Pop. Evacuation Time Clear	General Pop. Evacuation Time Adv.	Confirm Time	Special Population Evacuation Time Clear	Special Population Evacuation Time Adv.
Within Two Miles																
Region 1	5002	1924	291	114	6921	00:40	3:15	3:30	5:30	3:30	5:30	3:50	5:45	1:00	6:30	6:45
Within Five Miles																
Region 2	11523	4433	531	208	12843	00:40	3:15	3:30	5:30	3:30	5:30	3:50	5:45	1:15	6:30	6:45
Region 3	23636	9092	1485	582	21123	00:40	3:15	3:30	5:30	3:30	5:30	3:50	5:45	1:15	6:30	6:45
Region 4	17115	6583	1245	488	17690	00:40	3:15	3:30	5:30	3:30	5:30	3:50	5:45	1:15	6:30	6:45
Region 5	17140	6593	1516	594	22895	00:40	3:15	3:30	5:30	3:30	5:30	3:50	5:45	1:15	6:30	6:45
Region 6	5027	1934	562	220	9522	00:40	3:15	3:30	5:30	3:30	5:30	3:50	5:45	1:15	6:30	6:45
Region 21	23661	9102	1756	688	20163	00:40	3:15	3:30	5:30	3:30	5:30	3:50	5:45	1:15	6:30	6:45
Within Ten Miles																
Region 7	17908	6889	2122	832	16390	00:40	3:15	3:30	5:30	3:30	5:30	3:50	5:50	1:15	6:30	6:45
Region 8	30021	11548	3474	1362	28332	00:40	3:15	3:30	5:30	3:30	5:30	4:15	5:50	1:15	7:05	7:20
Region 9	48714	18738	7577	2971	28332	00:40	3:15	3:30	5:30	3:30	5:30	4:15	6:15	1:15	7:05	7:20
Region 10	42329	16282	5986	2347	28332	00:40	3:15	3:30	5:30	3:30	5:30	4:20	6:15	1:15	7:05	7:20
Region 11	50283	19342	5986	2347	29524	00:40	3:15	3:30	5:30	3:30	5:30	4:20	6:15	1:15	7:05	7:20
Region 12	54997	21155	6388	2505	29524	00:40	3:15	3:30	5:30	3:30	5:30	4:25	6:15	1:15	7:05	7:20
Region 13	69765	26835	6724	2636	37415	00:40	3:15	3:30	5:30	3:30	5:30	4:25	6:10	1:15	7:05	7:20
Region 14	63354	24369	2621	1027	37415	00:40	3:15	3:30	5:30	3:30	5:30	4:20	5:50	1:15	7:05	7:20
Region 15	51072	19645	2223	871	33202	00:40	3:15	3:30	5:30	3:30	5:30	4:10	5:50	1:15	7:05	7:20
Region 16	51097	19655	2494	977	33202	00:40	3:15	3:30	5:30	3:30	5:30	4:10	5:50	1:15	7:05	7:20
Region 17	52954	20370	2999	1175	33202	00:40	3:15	3:30	5:30	3:30	5:30	4:10	5:50	1:15	7:05	7:20
Region 18	45000	17310	2919	1143	33202	00:40	3:15	3:30	5:30	3:30	5:30	3:55	5:50	1:15	7:05	7:20
Region 19	21652	8329	1403	549	21519	00:40	3:15	3:30	5:30	3:30	5:30	3:55	5:50	1:15	5:50	6:05
Region 20	6884	2649	1067	418	21519	00:40	3:15	3:30	5:30	3:30	5:30	3:55	5:50	1:15	5:50	6:05
Region 22	84553	32525	9331	3658	39042	00:40	3:15	3:30	5:30	3:30	5:30	4:25	6:15	1:15	7:05	7:20

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10. EVACUATION TIME ESTIMATES (ETE) FOR TRANSIT OPERATIONS

This section details the analyses applied to obtain evacuation time estimates for persons who evacuate on 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 Develop ETE

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 and cannot drive themselves.

Each of these groups will be considered in turn.

Residents and Transients With No Vehicles Available

The demand estimates for these three groups were developed using a number of techniques. Surveys of schools and special facilities yielded demand data for item 2. A "Special Needs Survey[1]" to determine the number of people who need rides was conducted by Boston Edison to develop estimates of items 1 and 3. The "Special Needs Survey" yielded the following data:

Town	People Who Need Rides Transit-dependents
Plymouth	1336
Kingston	435
Carver	0
Duxbury	195
Marshfield	0
	1966

[1] The "Special Needs Survey" was used as one source of information concerning the transportation needs of the general population. It was not used to estimate the needs of special (e.g. handicapped or home-bound) populations.

The telephone survey conducted in Autumn of 1986 (see Appendices F and G) acquired a data base which can be used to estimate the population group of item 1. This group is divided into two subgroups:

- Those persons who belong to households which do not have a vehicle available. (This information corresponds to the transit-dependents identified in the special needs survey.)

- Those persons who belong to households which normally do have at least one vehicle available, but would not have a vehicle available at the time the evacuation is directed.

The persons belonging to the latter subgroup are in households where the vehicle(s) have been driven away from home for commuting purposes. These vehicles would not be available for evacuation if the driver(s) of the vehicle(s) refuse to return home to gather the household members. Other factors include the possibilities that the vehicle is non-functioning or that the commuter is willing, but unable, to return home.

Tables 10-1 through 10-4, obtained from the telephone survey results, 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 10-5 presents the summary of this data.

There are several factors which influence the accuracy of these estimates of persons with no vehicle available in Table 10-5:

1. These estimates 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 estimates 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 estimates do take into account the prospect that vehicles may not be available due to malfunction.

Table 10-1. Number of Cars per Household by Household Size

Plymouth

Pers. per H.H.	Number of Cars per Household					Total
	0	1	2	3	4	
1	6	31	4	1	0	42
2	1	43	62	3	2	111
3	0	11	39	17	3	70
4	0	5	29	8	1	43
5	1	9	38	9	5	62
6	0	3	18	1	3	25
7	0	1	5	0	4	10
8	0	1	0	1	1	3
9	0	0	1	0	0	1
10	0	0	0	0	1	1
Total	8	104	196	40	20	368
Mean Pers. per H.H.	1.6	2.4	3.6	3.7	5.3	3.3

Table 10-2. Number of Cars per Household by Household Size

Kingston

	Number of Cars per Household					
Pers. per H.H.	0	1	2	3	4	Total
1	1	6	0	0	0	7
2	0	7	14	2	1	24
3	0	2	6	1	0	9
4	0	1	9	5	0	15
5	0	3	3	5	2	13
6	0	0	4	1	0	5
7	0	0	0	0	1	1
8	0	0	0	0	0	0
9	0	0	0	0	0	0
10	0	0	0	0	0	0
Total	1	19	36	14	4	74
Mean Pers. per H.H.	1.0	2.4	3.4	4.1	4.8	3.3

Table 10-3. Number of Cars per Household by Household Size

Carver

	Number of Cars per Household					
Pers. per H.H.	0	1	2	3	4	Total
1	0	0	0	0	0	0
2	0	8	5	0	0	13
3	0	1	4	3	0	8
4	0	0	8	1	0	9
5	0	0	4	2	1	7
6	0	0	0	0	0	0
7	0	0	0	0	0	0
8	0	0	0	0	0	0
9	0	0	0	0	0	0
10	0	0	0	0	0	0
Total	0	9	21	6	1	37
Mean Pers. per H.H.	-	2.1	3.5	3.8	5.0	3.3

Table 10-4. Number of Cars per Household by Household Size

Duxbury

	Number of Cars per Household					
Pers. per H.H.	0	1	2	3	4	Total
1	0	13	4	0	0	17
2	0	3	19	3	3	28
3	0	3	15	6	1	25
4	0	4	15	2	2	23
5	0	0	9	5	1	15
6	0	0	4	3	0	7
7	0	0	1	0	1	2
8	0	0	1	0	1	2
9	0	0	0	1	0	1
10	0	0	0	0	0	0
Total	0	23	68	20	9	120
Mean Pers. per H.H.	-	1.9	3.4	4.2	4.1	3.3

Table 10-5. Estimates of Ambulatory Persons Requiring Transit Who Do Not Reside in Special Facilities

Community	Sample Factor	Persons in Households with			
		No. Vehs Available	Non-Returnees(1)	One, Non Functioning Vehicle(2)	Total Persons
Plymouth	43.22	554	854	114	1565
Kingston	46.05	46	191	23	306
Carver	52.98	0	109	11	173
Duxbury	37.29	0	251	18	306
Marshfield	(3)	38	32	10	77
Totals					2426

Notes: (1) No information concerning the number of people who would need transportation in the event a commuter could not return home in a timely fashion was available. However, based upon results of a KLD survey performed within the Seabrook EPZ, a factor of 1.7 percent of population was used. It should be noted that this factor was developed on the basis of a question dealing with presumed behavior during an emergency.

(2) Based on telephone surveys with fleet operators, it is estimated that a car is non-functioning approximately 4 days per year, on average. This is equivalent to 1.1 percent of the time. Thus, the number of vehicles that are non-functioning, that belong to households with only one car normally available is computed as Proportion of Households with One Car X Total Number of Households X 0.011. For example, for Plymouth, (104/368) (50262/3.31) (0.011) = 47 X 2.4 = 114; where, avg. household size is 3.31 persons and there are 2.4 persons per household with one vehicle.

(3) KLD Telephone Survey values were not available for Marshfield. Population estimates presented are taken from Boston Edison's Special Needs Survey.

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.

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

$$\frac{180 \times 7}{365 \times 24} = 0.144 \text{ or } 14.4 \text{ percent.}$$

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[1], 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 would evacuate via ride-sharing.

We will adopt a 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.

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[1] "The Mississauga Evacuation - Final Report to the Ontario Ministry of the Solicitor General", Institute for Environmental Studies, University of Toronto, June 1981.

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

$$p \pm \frac{d}{2} = \{(r+c) \pm [(r+c)^2 - (n+c)r^2/n]^{1/2}\} / (n+c)$$

where

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

d = Extent of confidence interval at level, a, in percent

n = Sample size, households

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

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

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

We will select a = 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 10-6 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 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 (p+d/2)/p

where E_T is in the last column of Table 10-5.

Table 10-6. Calculated Number of Persons Requiring Transit

	(1)	(2)	(3)	(4)	(5)	(6)
					No. of Residents	
Community	**n**	**r-np**	**p**	**p+d/2**	**No Car Available**	**Requiring Transit**
Plymouth	368	13	0.035	0.060	2236	1118
Kingston	74	1	0.014	0.036	786	393
Carver	37	0	0.000	0.044	311	155
Duxbury	120	0	0.000	0.024	407	204
Marshfield	-	-	-	-	108	54
	599	14	0.0233	0.033	3849	1924

Note: (1) For Carver and Duxbury, the computed value of (P+d/2) was applied to the total number of households in the town and then multiplied by the number of persons in households with no cars (1.6 persons). The resultant value was added to the last column of table 10-5. For Carver: .044 (6411/3.27) 1.6 + 173 = 311. For Duxbury: .014 (14768/3.3) 1.6 + 306 = 406.

(2) For Marshfield, we multiplied the number in the last column of Table 10-5, by the ratio 0.033/0.0233.

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

where E_T is in the last column of Table 10-5.

B. For Marshfield where Telephone Survey results were not available, then estimate of persons needing assistance is calculated as:

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

agg

where E_T is obtained from the Special Needs Survey and presented in Table 10-5 and $[\ldots]_{agg}$ is the aggregate values of column 4/column 3 in Table 10-6.

Column 6 contains the estimates of people requiring transportation assistance and who do not share a ride with friends or neighbors. These persons must be provided with transit.

Bus Transit Concept of Operations

Transit operations in support of an evacuation of the area surrounding Pilgrim Station are designed to be a mix of two approaches. First, a number of fixed, bus pickup points will be identified. These points, located in the more densely populated areas of the EPZ, will be locations within walking distance where people may find the required transit resources. Secondly, for areas of the EPZ which are not as densely populated, buses will traverse fixed routes, stopping on demand to pick up passengers.

In support of these operations a number of bus staging areas/transfer points will be established at the periphery of the EPZ. At these locations buses will be designated one of two categories:

- Pickup Point Buses - After receiving instructions, maps, and dosimetry at bus staging areas, these buses will proceed to the assigned fixed bus pickup point. There, they wait for passengers to board, and, on schedule, or when full, return to the staging area and then proceed directly to Reception Centers.

- Route Buses - After receiving instructions, maps, and dosimetry at bus staging areas, these buses will traverse assigned routes in accordance with a predefined schedule. Individual bus routes will be traversed several times. At the conclusion of the traverse, buses will return to the staging area and then depart for Reception Centers.

Appendix O contains additional details of the Transit Operations Plan including proposed bus staging area locations, bus pickup points, and route maps and descriptions.

Table 10-7 presents the transit requirements for all communities, based on the estimates of Table 10-6, and on the number of bus staging areas. The number of persons serviced by each bus route and pickup point within a community may be estimated by dividing the total number of transit-dependent persons by the number of routes and pickup points. This estimate, however, assumes that people are uniformly distributed over a community, by area -- an assumption which will overestimate the actual demand for some areas and underestimate the actual demand for others. Since the overriding need is to provide transit service for all who need it, it is necessary to assign a factor of safety to the estimated demand for transit to account for a non-uniform spatial (i.e. area-specific) distribution of population. Thus, all area-specific estimates of transit demand will be increased 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 completion of each trip 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) x 100 = 64 percent. Thus, even if the actual demand for service at a bus staging area exceeds the estimates in column 3 of Table 10-7 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 allocating additional buses.

As can be seen in Table 10-7, a total of 83 buses is required to provide sufficient capacity to transport transit-dependent people within an acceptable time frame. Estimates of evacuation times for this population group are predicated on a number of factors:

1. Where will these buses originate?
2. How long will it take to mobilize bus drivers?
3. How long will it take to travel to staging areas?
4. How long will it take to traverse bus routes?

Table 10-7. Estimated Transit Requirements

	(1)	(2)	(3)	(4)	(5)	(6)
Community	**People Requiring Transit**	**No. of Bus Routes (Note 1)**	**Pass. Per Route**	**Bus Trips per Route**	**Total Bus Trips**	**Buses Required (Note 2)**
Plymouth	1118	8	168	6	48	51
Kingston	393	2	236	8	16	12
Carver	155	2	94	3	6	5
Duxbury	204	4	62	2	8	12
Marshfield	54	1	65	2	2	3
	1924				80	83

Column	Explanation
1	From column 6 of Table 10-6
2	See Appendix O
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

Notes: (1) The number of bus routes for Plymouth includes the use of 3 bus pickup points; the number for Duxbury, 1 bus pickup point. A portion of Plymouth (Subarea 6) is primarily served by one of the Carver routes and partially served by another. A portion of Northern Plymouth (Subarea 7) is also served by one Kingston bus route.

(2) Buses leave staging area and return to the staging area. Only full buses are sent to the Reception Centers

The information needed to address these issues may be obtained from letters of agreement (LOA) with bus operators. When the last set of LOAs were obtained, a survey requesting mobilization information was distributed to all transportation organizations. The analysis of results of the survey respondents allow us to make a reasonable estimate for transit mobilization activities.

Figure 10-1 presents the geographic distribution of transportation resources. Over 400 buses from survey respondents are available within 30 miles of the EPZ boundary. If extrapolated to all organizations with which LOA's exist, then it is likely that there are more than a sufficient number of buses to meet all emergency needs.

The survey indicated that unscheduled driver mobilization times ranged up to 3 hours. Inbound bus travel times were estimated by assuming that bus speeds are 30 miles per hour under clear weather conditions and 23 miles per hour (a 25 percent reduction in speed) during adverse weather conditions. These estimates assume that most travel is along two-lane two-way rural roads.

Mobilization times and bus travel times may be combined statistically to form a distribution of the time buses arrive at staging areas on the EPZ boundary. The results of this analysis are presented in Figure 10-2 for clear weather scenarios and Figure 10-3 for adverse weather scenarios. The figures indicate that 90 percent of the buses will arrive at the staging areas on the EPZ boundary by 2:45 after the start of bus mobilization in clear weather and by 3:00 after the start of bus mobilization under adverse weather conditions. Letters of Agreement with transportation providers reflect the estimated ability to have all vehicles arrive at schools and TSA's within 3 hours after the start of mobilization.

The average elapsed time after the start of mobilization, that buses will be ready to depart the bus staging areas on the periphery of the EPZ is presented in Table 10-8.

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.

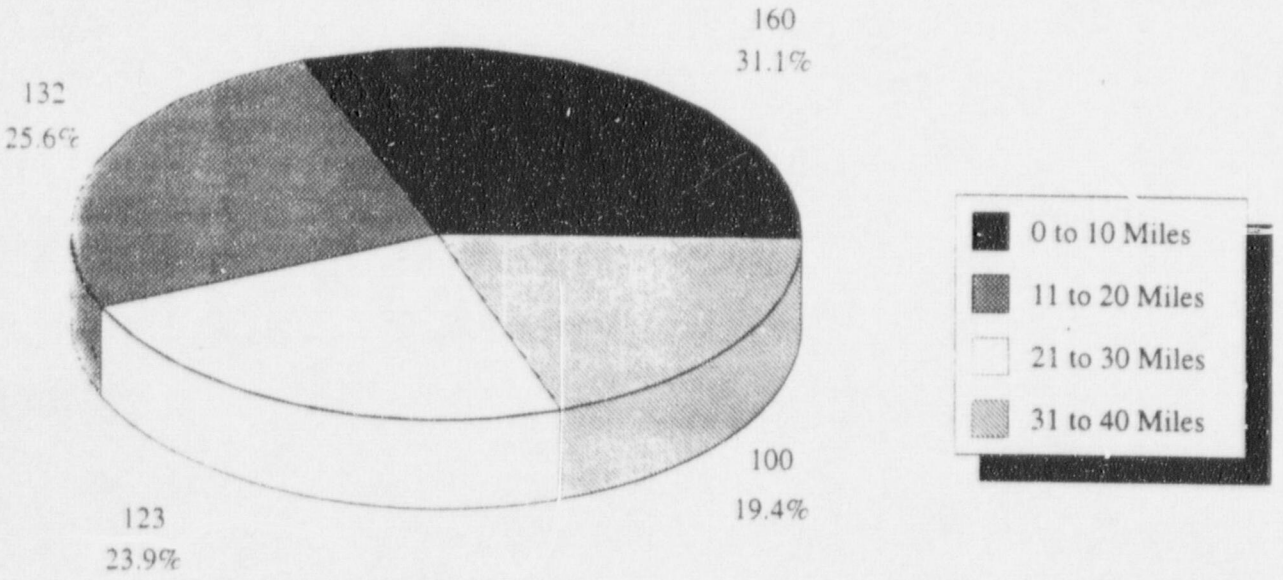


Figure 10-1. Distance Travelled for Buses Arriving at the EPZ Boundary

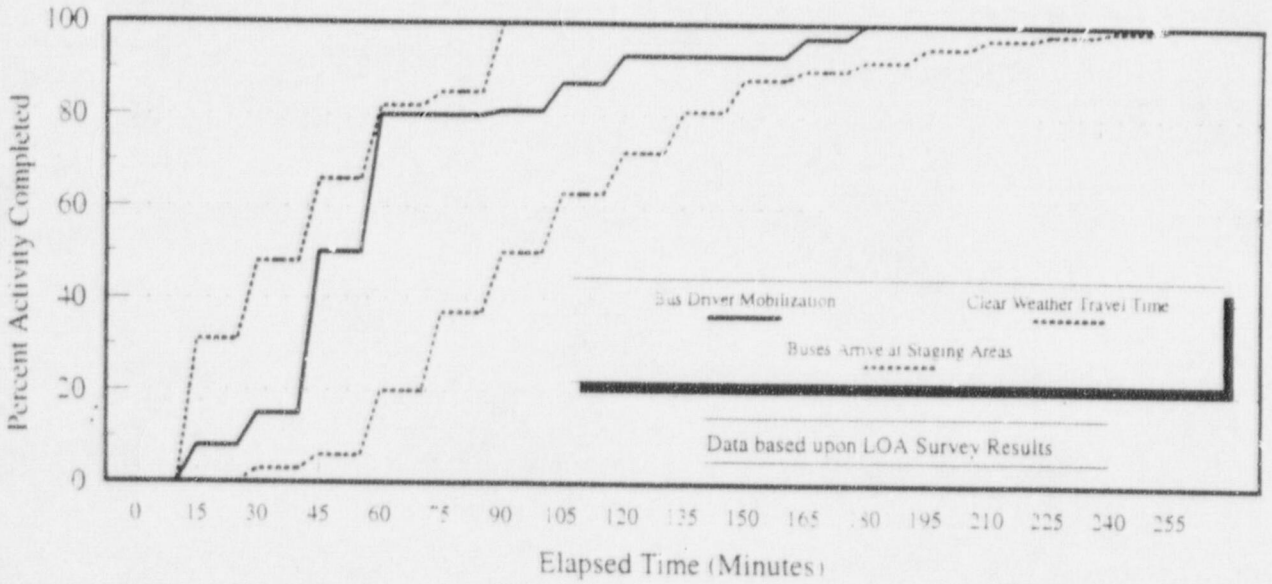


Figure 10-2. Bus Mobilization (Clear Weather)

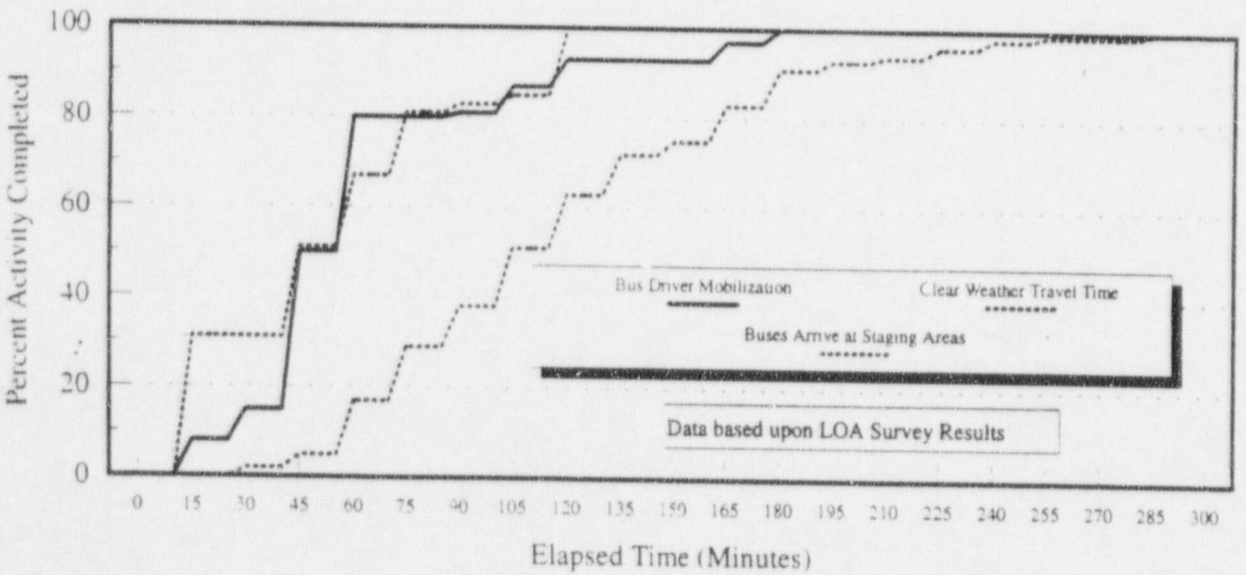


Figure 10-3. Bus Mobilization (Adverse Weather)

Table 10-8. Time Estimates for Supplemental Bus Evacuation Activities

Activity	Time Estimates (Hrs.:Mins.) Weather Conditions	
	Clear	Adverse
50th Percentile Bus Arrives at the Staging Area	1:30	1:45
Delays Associated with Access Control	:15	:15
Distribution of Maps, Dosimetry to Drivers	:30	:30
Time Most Buses Arrive	2:15	2:30

Times are referenced from the Site Area Emergency level, which is assumed to precede the Directive to Evacuate by 25 minutes.

Supplementary buses assigned to support a one-wave evacuation of schools have no delays associated with access control because these buses are dispatched to schools prior to the establishment of access control. School bus assignments have priority over buses sent to the EPZ for other purposes.

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 10-7.

n = Number of bus trips along each route, r, within the community; r = 1,2,...,R. See column 4 of Table 10-7.

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. A more detailed discussion will be presented later.

$T_r(X_r)$ = Total elapsed time 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.

Definitionally,

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

for $(p_r-1)X_r < n \leq p_r X_r$; $p_r = 1, 2, \ldots$

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 $p_r = \text{Int}[n/X_r+1]$

Clearly, $X_r \leq n$. That is, it makes no sense to assign more buses to a route than the number of trips to be completed.

Also, by definition,

$H_r = t_r/X_r$ 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,

$$\text{Sum}_r[X_r] = N$$

Procedure

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

1. Select the longest route, $r = r_1$. 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:

   $X_r = [t_r/t_{rL}] X_{rL}$

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

5. Compare $T_r(X_r)$ with T_r (X_r). 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: Kingston, N = 10, n = 5 (from Table 10-7)

r =	1	2
t_r =	1.33	2.08

Step	Procedure
1	Choose $r = r_1 = 2$; Assign $X_2 = n = 5$
2	$P_2 = 5/5 = 1$
	$H_2 = \min[2.08/5, 0.2] = 0.2$
	$T_2(5) = 1(2.08) + [5 - (1 - 1)5 - 1](0.2) = 2.88$
	$N_{rem} = 10 - 5 = 5$
3	$r = 1$
	$X_1 = (1.33/2.08)5 = 3.19$, say 3
4	$p_1 = \text{int}[5/3 - 1] = 2$
	$H_1 = 1.33/2 = 0.44$
	$T_1(2) = 2(1.33) + [5 - (2 - 1)3 - 1](0.44) = 3.10$

Since $T_1(2)$ and $T_2(5)$ are similar, accept this solution

$N_{rem} = N_{rem} - X_1 = 5 - 3 = 2$

Results:

r	X_r	$T_r(X_r)$	
1	3	2.49	3 buses (2 - 2 trips, 1 - 1 trips)
2	5	2.56	5 buses (5 - 1 trip)
	8		2 buses used as a reserve

Discussions with emergency planners have indicated that sufficient bus resources are available so that multiple bus runs on selected routes are not required; additionally, the use of transfer buses are available if required. Consequently, the procedure described above was implemented by assuming $X_r = n$ for all routes.

A summary of the results of the transit analysis described previously is presented in Table 10-9. Bus routes were subdivided into three segments:

Table 10-9. Results of Analysis to Obtain Bus Route Times for Transit-Dependent Persons Within the EPZ

Community	Route	Route Length (miles) Inbound	Service Area	Outbound	Total Travel Time T_r (hours)	Buses per Route X_r[3]	Route Time $T_r(X_r)$ (hours)
Plymouth	P-1	14.7	5.3	10.0	2.07	7	2.87
	P-2	7.0	8.7	6.7	2.07	7	2.87
	P-3	14.0	8.7	7.0	1.60	7	2.40
	P-4a	4.7	14.0	5.3	1.65	5	2.05
	P-4b	2.3	15.3	5.3	1.72	5	2.12
Pickup Points	Cordage Pk Court St. & Robbins Rd.	13.0	-	10.0	1.26	5	1.26
	Sheraton Plaza	13.0	-	10.0	1.26	5	1.26
		13.0	-	10.0	1.26	5	1.26
Plymouth/ Carver	C-2	-	26.6	-	2.96	5	3.36[4]*
						51	
Carver	C-1	-	16.7	2.7	2.09	2	2.29
	C-3	-	18.5	-	2.31	2	2.51
						4	
Kingston	K-1	-	13.3	-	1.33	6	2.13
	K-2	-	20.0	-	2.08	6	2.88
						12	
Duxbury	M-1	8.3	9.7	3.7	1.79	3	2.19
	M-2	9.0	8.0	2.0	1.08	3	1.48
	M-3	2.7	11.7	2.7	1.63	3	2.03
Pickup Point	Powder Pt. Bridge	6.0	-	6.0	0.75	3	0.75
						12	
Marshfield	M-4	4.0	10.0	4.0	1.91	3	2.31
						3	

[3] Buses leave Staging Area and return to Staging Area. Only full buses are sent to Reception Centers

[4] Three bus runs are required; Runs 1 and 2 use two buses per run, Run 3 utilizes one bus.

- Inbound - This is the route segment between the bus staging/transfer point and the start of the transit service area. Travel speeds along this segment are dependent on the roadways used for this leg of the route. A speed of 50 mph was used for limited access highways (Route 3); 40 mph was used for other roads.

- Service Area - This is the portion of the bus route where transit dependent persons are picked up on demand. It is possible for the entire bus route to lie within a service area. Speeds within the service area are assumed to be the minimum of speeds computed by IDYNEV for segments of the bus route along evacuation routes and 10 mph. Ten miles per hour was taken as the average speed of a bus which stops periodically to pick up passengers.

- Outbound - Following the traverse of the service area buses will return to the bus staging area/transfer point. Speeds on the outbound leg are determined by IDYNEV, if the outbound leg is an evacuation route, or 40 mph on roads not used for evacuation.

Buses assigned to fixed pickup points have the lowest bus route times. Consequently, these buses should be dispatched from the pickup points and proceed to Reception Centers when they are full, or nearly full. The last bus to leave the bus pickup point should be dispatched near the conclusion of the evacuation of the general public (see Table 9-8).

The transit-dependent ETE can be estimated by summing the bus preparatory activity times (Table 10-8) and the total route times presented in Appendix O. The results are shown below in Table 10-10.

Schools and Special Facilities

The Transportation Coordinator has the responsibility for assigning available transport to service the needs of transit-dependent persons, according to some system of prioritization. It is reasonable to expect that the first arriving buses will be sent to the schools.

It is essential that the local Transportation Officer determine the actual transportation needs (buses, lift vans, and/or station wagons) required at each school, day care, and/or camp at the time of the emergency. If any additional resources above the default numbers are required, the Transportation Officer must provide these transportation needs to the MEMA Area II Transportation Officer by phone.

Table 10-10. Evacuation Time Estimates for the Transit-Dependent Population Within the Entire EPZ

	Elapsed Time (hrs:min) from Start of Mobilizaticn at the Declaration of a Site Area Emergency		Elapsed Time (hrs:min) from the the Directive to Evacuate	
Community	**Good Weather**	**Adverse Weather**	**Good Weather**	**Adverse Weather**
Plymouth	7:30	7:45	7:05	7:20
Kingston	6:55	7:10	6:30	6:45
Carver	6:55	7:10	6:30	6:45
Duxbury	6:15	6:30	5:50	6:05
Marshfield	6:25	6:40	6:00	6:15

Figure 10-4 presents the identification and location of all schools within the Pilgrim EPZ. Table 10-11 presents enrollments and maximum transportation requirements for each school in the EPZ.

Discussions with school district personnel have indicated that Plymouth, Duxbury, Kingston, and Carver schools require additional transportation to execute their early dismissal plans in a single bus run. Marshfield has sufficient transportation resources to execute their early dismissal plans in a single bus run.

In the event an evacuation is directed, current policy is to dispatch to the schools all transportation resources that have been previously requested by the town based upon total school requirements. Several factors would tend to reduce the need for buses, vans, and station wagons identified in the town's initial request

Each activity for local buses is discussed below; the estimated times for the supplemental buses were given earlier.

Activity: Mobilize Drivers

Mobilization may be defined as the 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. Mobilization of transportation resources for schools, day cares, and camps is scheduled to begin at the Alert Emergency Level.

Discussions with local school district personnel yield the following estimates of average bus driver mobilization time:

Plymouth	30 minutes	Duxbury	90 minutes
Kingston	60 minutes	Marshfield	60 minutes
Carver	45 minutes		

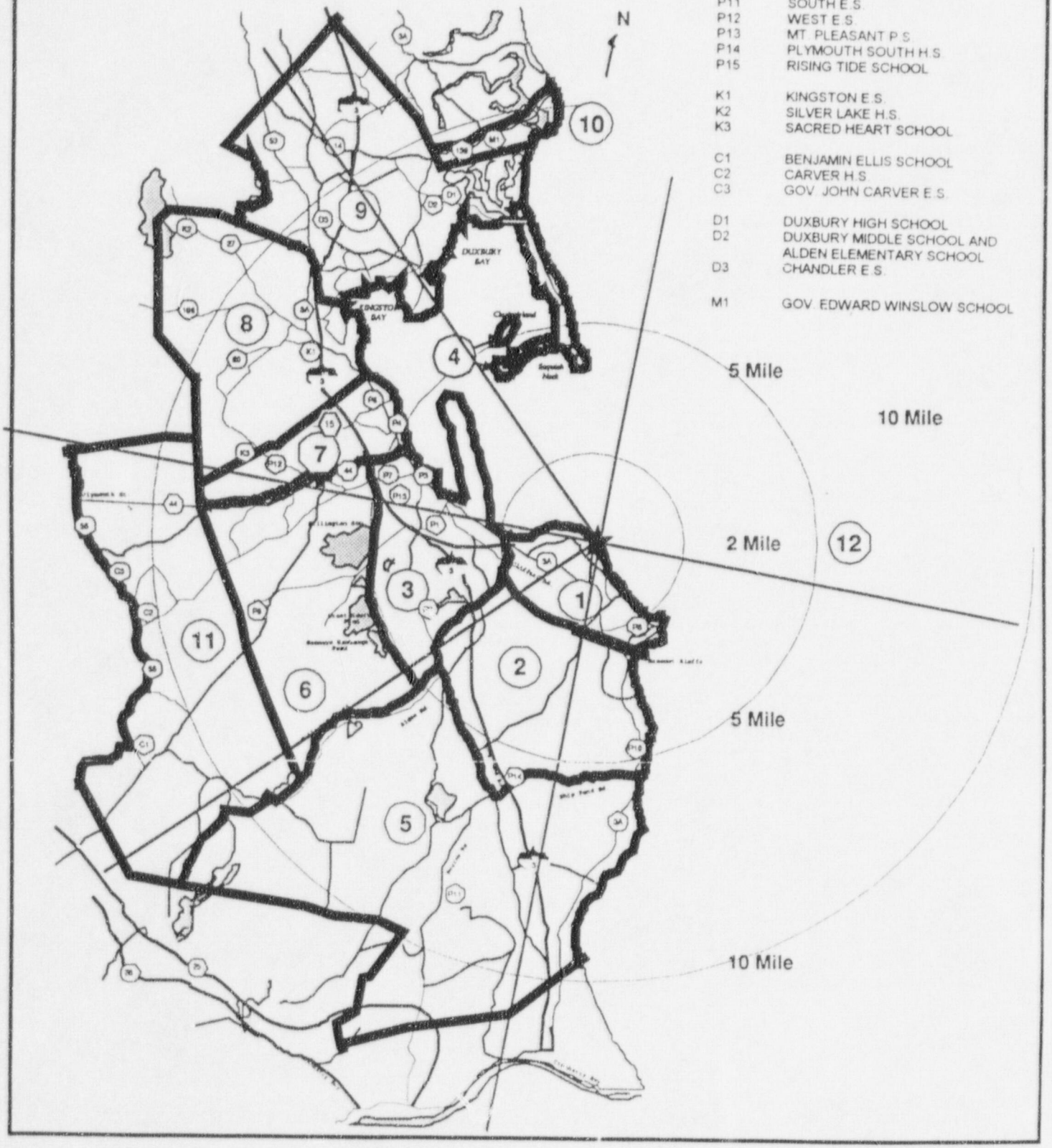
Mobilization of supplemental buses required to accomplish the one-wave school evacuation was defined in Table 10-8.

Activity: Proceed to Schools

In general, buses are stored at a central bus depot owned by the bus company, at drivers homes, or at town facilities. Distances between bus storage areas and schools are generally under 5 miles. Trip times for local buses from the storage areas to the schools are approximately 10 minutes.

Figure 10-4.

Location of Public Schools in the Pilgrim EPZ



P1	PLYMOUTH NORTH H.S.
P2	PLYMOUTH COMMUNITY I.S.
P3	NATHANIEL MORTON E.S.
P4	COLD SPRINGS SCHOOL
P5	OPEN
P6	HEDGE SCHOOL
P7	OAK STREET SCHOOL
P8	MANOMET E.S.
P9	FEDERAL FURNACE SCHOOL
P10	INDIAN BROOK SCHOOL
P11	SOUTH E.S.
P12	WEST E.S.
P13	MT. PLEASANT P.S.
P14	PLYMOUTH SOUTH H.S.
P15	RISING TIDE SCHOOL
K1	KINGSTON E.S.
K2	SILVER LAKE H.S.
K3	SACRED HEART SCHOOL
C1	BENJAMIN ELLIS SCHOOL
C2	CARVER H.S.
C3	GOV. JOHN CARVER E.S.
D1	DUXBURY HIGH SCHOOL
D2	DUXBURY MIDDLE SCHOOL AND ALDEN ELEMENTARY SCHOOL
D3	CHANDLER E.S.
M1	GOV. EDWARD WINSLOW SCHOOL

Table 10-11. School Enrollment and Maximum Transportation Requirements

		1995-1996		1996-1997		1997-1998		Three-Year Avg.		Avg. Buses
Subarea	Agency Name	Students	Staff	Students	Staff	Students	Staff	Students	Staff	Requ'd
	Carver Schools									
11	Benjamin Ellis School	59	8	45	5	58	5	54	6	2
11	Gov. John Carver Elem. (K-2)	666	81	676	70	484	63	609	71	15
11	Gov. John Carver Elem. (3-5)	461	45	424	44	520	48	468	46	11
11	Carver Middle School	-	-	-	-	561	54	187	18	5
11	Carver High School	863	115	910	120	547	81	773	105	19
	Carver Subtotal	**2049**	**249**	**2055**	**239**	**2170**	**251**	**2091**	**246**	**52**
	Duxbury Schools									
9	Chandler Elem/Preschool	706	43	693	70	749	88	716	67	17
9	Duxbury Jr/Sr. High School	1216	102		-	-	-	405	34	10
9	Duxbury Middle School	-	-	960	80	952	108	637	63	15
9	Alden Elementary	916	57	-	-	478	49	465	35	11
9	Duxbury High School			1251	140	833	135	695	92	17
	Duxbury Subtotal	**2838**	**202**	**2904**	**290**	**3012**	**380**	**2918**	**291**	**79**
	Kingston Schools									
8	Kingston Elementary	1025	18	1056	23	1113	23	1065	21	24
8	Silver Lake High School	1152	27	1638	38	1677	38	1489	34	33
8	Sacred Heart Schools	1023	24	1059	28	1065	28	1049	27	23
	Kingston Subtotal	**3200**	**69**	**3753**	**89**	**3855**	**89**	**3603**	**82**	**80**
	Marshfield Schools									
10	Governor Edward Winslow	665	40	535	29	527	50	576	40	14
	Marshfield Subtotal	**665**	**40**	**535**	**29**	**527**	**50**	**576**	**40**	**14**
	Plymouth Schools									
7	Cold Spring Elementary	248	34	260	38	262	47	257	40	7
6	Federal Furnace Elementary	490	49	508	42	500	41	499	44	12
7	Hedge Elementary	268	22	279	22	270	30	272	25	7
2	Indian Brook Elementary	801	45	776	55	797	65	791	55	19
1	Manomet Elementary	420	44	425	47	427	48	424	46	11
3	Mt. Pleasant Elementary	55	9	56	17	56	17	56	14	2
3	Nathaniel Morton	651	50	651	50	651	50	651	50	15
3	Oak Street Elementary	46	5	52	6	50	4	49	5	2
7	Rising Tide Charter School	-	-	-	-	-	-	162	5	4
3	Plymouth Community Inter.	1929	94	1990	152	2126	76	2015	107	46
3	Plymouth North High School	1019	115	1070	121	1026	121	1038	119	25
3	Plymouth South High School	1288	157	1356	112	1337	120	1327	130	32
5	South Elementary	651	61	603	55	631	55	628	57	15
7	West Elementary	555	60	491	58	493	64	513	61	13
	Plymouth Subtotal	**8421**	**745**	**8517**	**775**	**8626**	**738**	**8682**	**758**	**210**

Notes: A bus will accommodate 65 students at an 8th grade level or below. Adult seating is required by all students above the 8th grade and staff members assigned to escort evacuees. A bus will accommodate 44 adults. The need for lift vans, ambulances, and other special transportation resources for school evacuation must be made at the time of the evacuation. Plymouth Schools, in general, maintain class integrity when utilizing vehicles, where possible, and therefore the actual number of buses required may exceed that stated here.

Activity: Load/Unload Passengers

Studies have shown that passengers can board a bus at headways of 2-4 seconds (Ref. 1994 Highway Capacity Manual). A bus can be loaded with school children in about five minutes. Allow another five minutes for organizing and monitoring the children.

Activity: Travel from School to EPZ Boundary

School buses moving out of the EPZ will be evacuating before the general public. Therefore, the assumption that speeds of buses within the EPZ are governed by traffic conditions during the evacuation are conservative. Table 10-12 presents a summary of average route speeds for the winter Midweek, Midday, Good Weather Scenario (Scenario 5). Values shown in the table were computed by using a weighted average of individual link speeds on paths from schools to the EPZ boundary.

A summary of estimated times for these activities is presented in Table 10-13. Schools ETEs are presented for local and supplemental buses. It is expected that most buses required for school evacuation will be obtained from the transportation resource providers operating in accordance with the Letter of Agreement. ETEs are presented for these buses as well.

Note that the ETE for school buses are less than that for the general public -- compare the figures in Table 10-13 with those in Table 9-8. It should be noted that these estimates assume a rapidly escalating event. Under other [slowly escalating accident] scenarios, school children are transported to host schools beginning at a Site Area Emergency.

Special Facilities

Figures 10-5, 10-6 and 10-7 present identification and location of special facilities in the Pilgrim EPZ.

The time to load ambulatory passengers at special facilities is comprised of 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 increase these headways to account for elderly 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).

Table 10-12. Average Route Speeds During Evacuation; Winter, Midweek, Midday, Good Weather (Scenario 5)

Path	Average speed (miles/hour) at indicated elapsed times from Directive to Evacuate. 1 hour	2 hours	3 hours	4 hours
Route 44 West from Plymouth Center	7.9	8.2	26.0	39.9
Route 3A South, Manomet	7.7	7.3	35.9	40.0
Bourne Road South	34.0	34.1	35.0	35.0
Route 106 Kingston	36.8	40.5	40.9	40.9
Route 27 Kingston	40.0	40.0	40.0	40.0
Route 58 North Carver	45.6	45.8	49.4	49.8
Route 3A North Duxbury	31.3	35.0	35.0	35.0
Route 53/14 Duxbury	46.6	46.6	46.6	46.6

Table 10-13. School Evacuation Time Estimates for One Round Trip

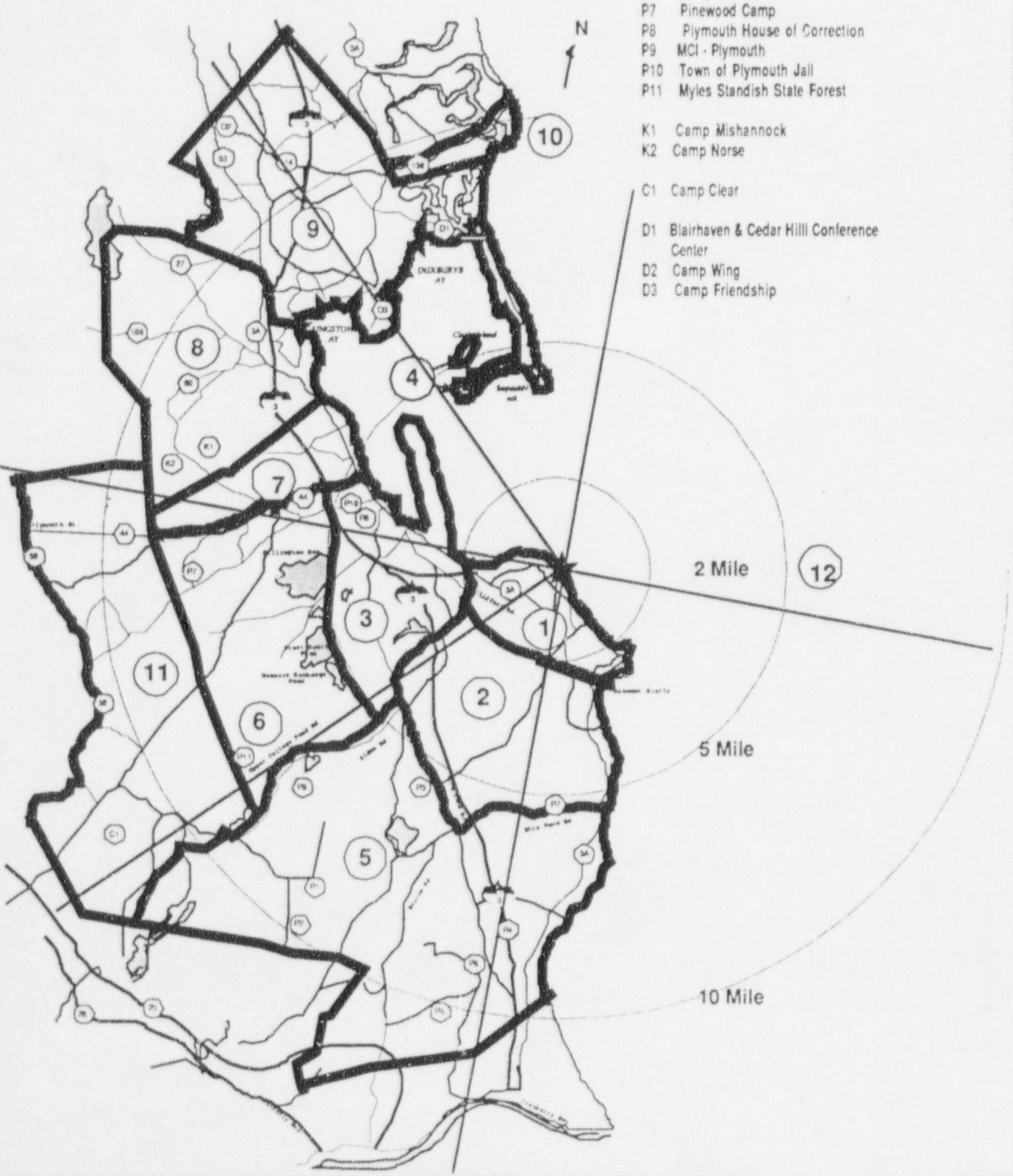
Activity	Supp. Buses	Community Plymouth	Kingston	Carver	Duxbury	Marshfield
Mobilize Drivers	1:30	:30	1:00	:45	1:30	1:00
Proceed to Schools	:30	:10	:10	:10	:10	:10
Driver Preparation	-	:15	:15	:15	:15	:15
Elapsed Time to Arrive at School (average)	2:00	:55	1:25	1:10	1:55	1:25
Board Students	:10	:10	:10	:10	:10	:10
Travel to EPZ Bdry	:15	1:15	1:15	:05	:10	:05
Elapsed Time from Site Area Level	2:25	2:20	2:50	1:25	2:15	1:40
ETE	2:00	1:55	2:25	1:00	1:50	1:15

Notes: Use of supplementary buses are required to avoid multiple bus runs. Supplemental bus mobilization is discussed in Table 10-8. Current Massachusetts Emergency Management Agency commitments with bus providers call for buses to arrive at schools within 3 hours. Driver preparation involves the distribution of dosimetry and maps and is performed at the home location of buses.

It is assumed that the mobilization process begins at the ALERT which, according to the Planning Basis, occurs 25 minutes prior to the Directive to Evacuate.

Figure 10-5.

Location of Special Facilities Children's Camps and Jails in the Pilgrim EPZ



P1 Cachalot Scout Reservation
P2 Camp Squanto
P3 Wind in the Pines Girl Scout Center
P4 Camp Clark
P5 Camp Massasoit
P6 Camp Bournedale
P7 Pinewood Camp
P8 Plymouth House of Correction
P9 MCI - Plymouth
P10 Town of Plymouth Jail
P11 Myles Standish State Forest

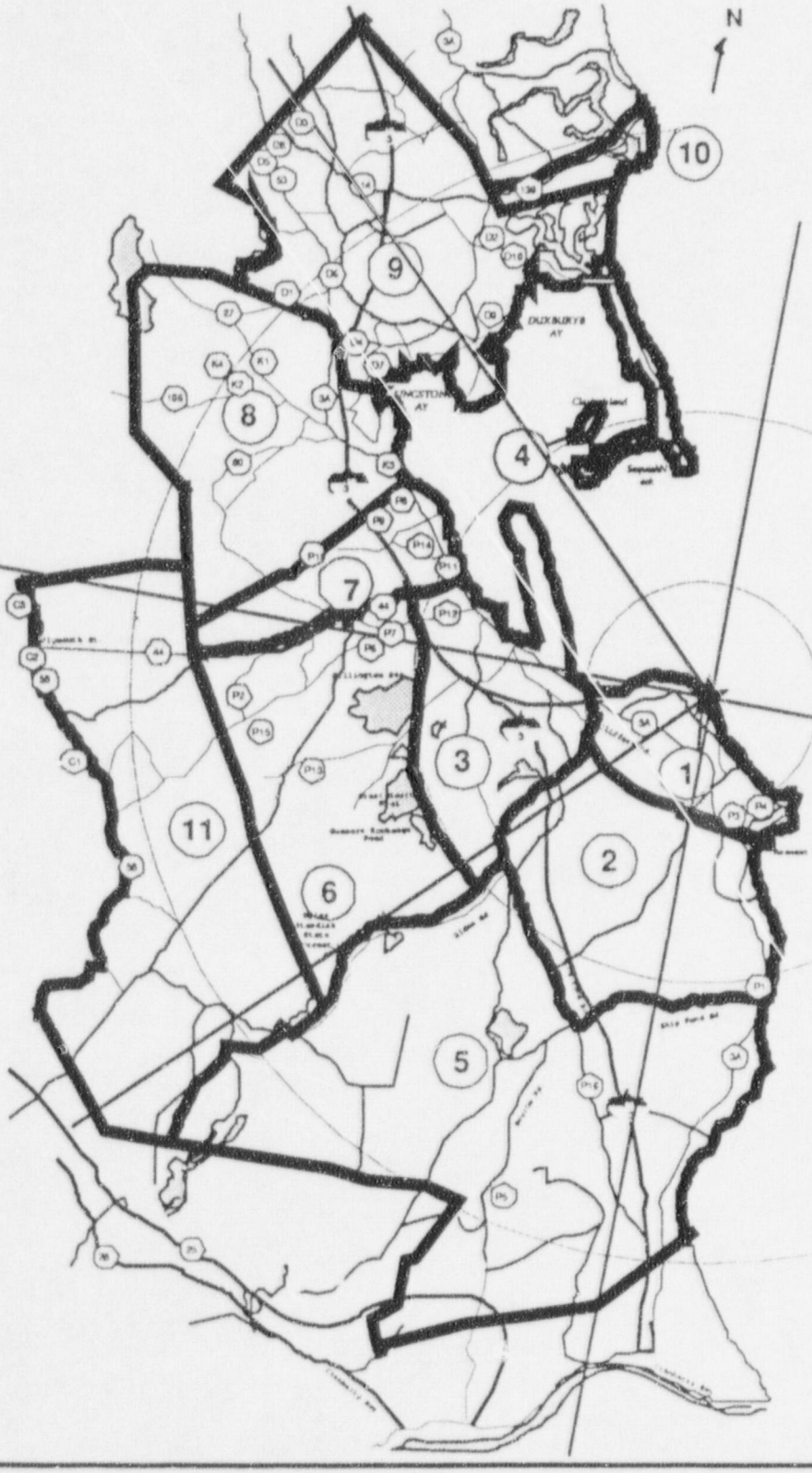
K1 Camp Mishannock
K2 Camp Norse

C1 Camp Clear

D1 Blairhaven & Cedar Hilli Conference Center
D2 Camp Wing
D3 Camp Friendship

Figure 10-6.

Location of Special Facilities Day Care Centers in the Pilgrim EPZ



P1 Tiny Town Childcare
P2 Kidsport
P3 Kinder Kollege
P4 Busy Bee Nursery and Day Care
P5 Ponds Child Care Center
P6 Seven Hills Nursery School
P7 Methodist Nursery School
P8 Superkids of Plymouth
P9 Zion Christian Pre-school
P10 Plymouth Discovery Center
P11 Happy Day Nursery
P12 Pilgrim Manor Day Care
P13 Pinewood School of Montessori
P14 Little Red School House
P15 South Shore Head Start
P16 New Testament

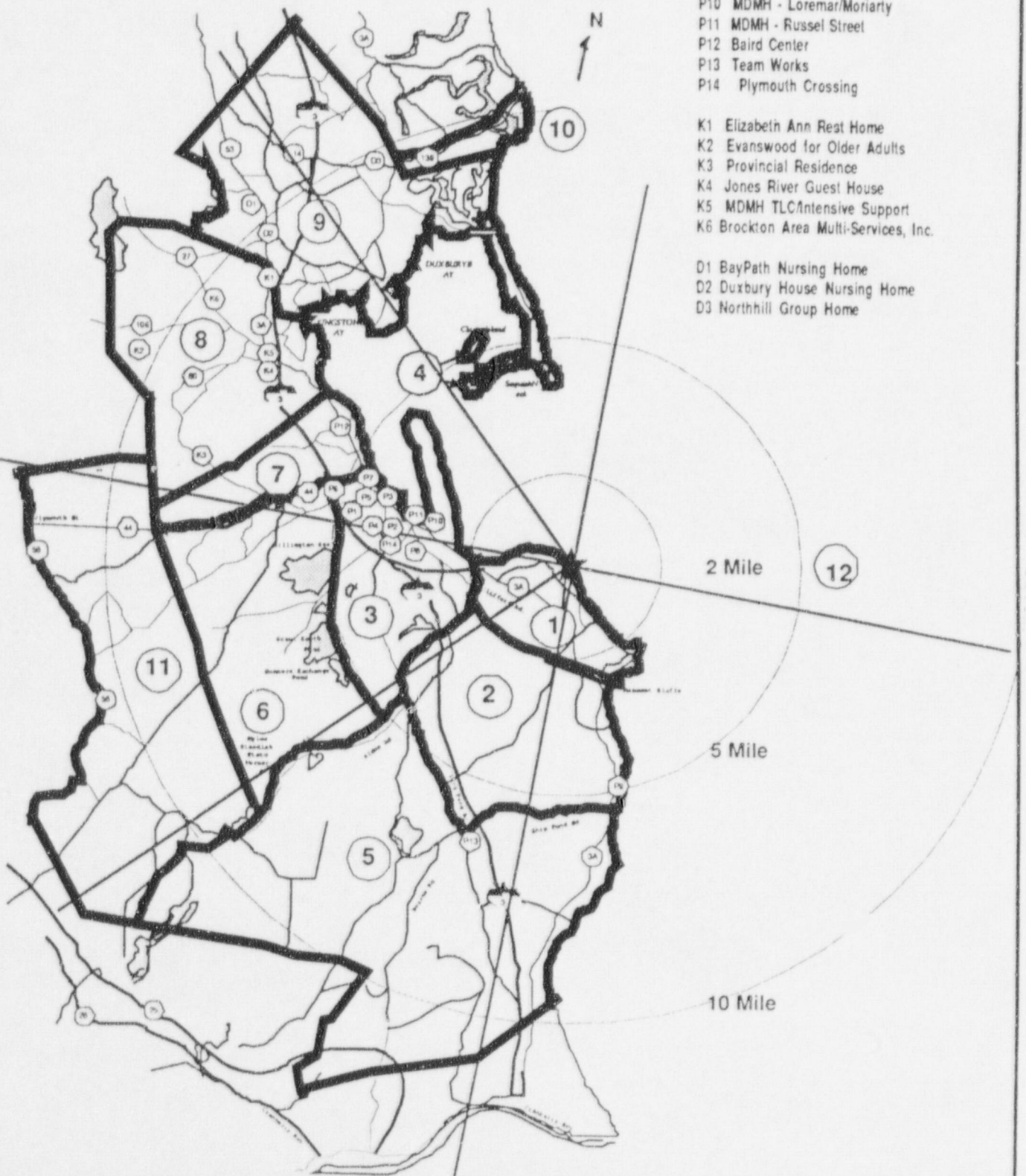
K1 Growth Unlimited
K2 Plymouth Bay Childcare
K3 South Shore Day Care
K4 Children's Center at Evanswood

D1 Berry Brook
D2 Magic Dragon Children's Center
D3 Little Log Cabin
D4 Good Shehpard Nursery
D5 Learn in Play Pre-School
D6 Pied Piper Pre-School
D7 Munchkin Montessori/Bay Farm
D8 Noah's Ark Day School Academy
D9 Pilgrim Day Care
D10 Ellison Center Day Care

C1 Captain Pal
C2 Cranberry Crossing
C3 Kids Count

Figure 10-7.

Location of Special Facilities Nursing Homes, Hospitals and Habilitation Centers in the Pilgrim EPZ



P1 Life Care Nursing Home
P2 Beverly Manor Nursing Home
P3 Chilton House Rest Home
P4 Mayflower House Nursing Home
P5 Pilgrim Manor Nursing Home
P6 Newfield House Convelescent Home
P7 Plymouth Day Habilitation
P8 Jordan Hospital
P9 High Point
P10 MDMH - Loremar/Moriarty
P11 MDMH - Russel Street
P12 Baird Center
P13 Team Works
P14 Plymouth Crossing

K1 Elizabeth Ann Rest Home
K2 Evanswood for Older Adults
K3 Provincial Residence
K4 Jones River Guest House
K5 MDMH TLC/Intensive Support
K6 Brockton Area Multi-Services, Inc.

D1 BayPath Nursing Home
D2 Duxbury House Nursing Home
D3 Northhill Group Home

The time to travel to the facility from the staging area depends on the distance traveled and on whether the bus will be traveling with, or counterflow, the evacuating public. If we assume the former, and apply the mean speed of 8.6 mph obtained for Scenario 1, Region 1, as computed by the IDYNEV simulation, then for a distance of say, 6 miles within the community, the travel time will be about 40 minutes.

Thus the total time to load passengers at special facilities is approximately 50 minutes.

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, in the context of the estimates given in Table 10-8, has identified that a reasonable estimate of the elapsed time from the Directive To Evacuate to the time that a bus servicing a special facility is loaded, is about 4.5 hours. Reference to Table 9-8 indicates that this time is approximately 1 hour longer than the shortest evacuation time estimate. Thus it is seen that the buses and vans used to evacuate special facilities will, for the most part, join with, and be embedded within, the overall traffic streams evacuating the EPZ.

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 (e.g. those confined to wheel chairs), ambulettes and ambulances. Since they are generally available on an emergency basis, it is reasonable to expect that their mobilization times 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 Boston area would travel a total of about 40 miles to a community within the EPZ and thence to a facility to pick-up passengers. A mean inbound travel speed of 50 mph on limited access highways is assumed.

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

Arrival of 90th Percentile Vehicle	2:45
Delays at EPZ Boundary and Staging Areas	0:45
Travel from Staging Area to Facility 10 miles/25 mph	0:25
Loading Passengers:	0:10
	4:05

The time to load up to two passengers into an EMS vehicle assumes that these passengers have been prepared for transportation prior to the arrival of the vehicle.

Outbound travel would be controlled by the speed of evacuating general traffic since all EMS vehicles will begin evacuation prior to the ETE for those in private vehicles. Using Table 10-12, a conservative outbound speed may be set at 8 miles per hour. Further, assuming an EMS vehicle travels, on average 5 miles to the EPZ boundary, the outbound travel time is approximately 0:40. Consequently the ETE, referenced from the Evacuation Directive, is 4:05 + 0:40 - 0:25 or 4:20.

For slowly escalating accidents, EMS vehicles are ready to be dispatched from staging areas when the Evacuation Directive is issued. Consequently, the ETE is comprised of the time required to travel to the facility, load passengers, and leave the EPZ. Under these conditions, the ETE is: 0:25 + 0:10 + 0:40 or 1:15.

Plymouth County Prison

A new prison facility has been constructed in Subarea 3, approximately 2.5 miles from Pilgrim Station. Access to the new prison is from Long Pond Road. The prison has a capacity of 1600 inmates versus the 560-600 inmate capacity of the current facility. Approximately 45 buses are required to evacuate 1600 inmates. However the actual number of inmates must be ascertained at the time of the emergency. The need for security, additional personnel on each bus, police escort for the convoy of buses, etc. must be assessed. It is anticipated that the inmate population could be evacuated within the same time frame as the special facility population.

Conclusions

The evacuation time estimates for transit-dependents, special facilities, and emergency medical services are all within the period of time during which the general public is evacuating. The last vehicles departing special facilities within the EPZ will leave the area after the last of the general population has departed. The results of these analyses are summarized in Tables 9-10 under the columns labeled Special Population Evacuation Time.

11. 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. Arrangements may be made with the Civil Air Patrol to provide aerial surveillance, using fixed-wing aircraft. Such surveillance is effective both day and night, weather permitting. The aircraft must have a communication link to the State EOC and the pilots must be trained to utilize dosimetry equipment and be informed so that he can avoid the plume, if any.

2. Ground patrol can be undertaken by State police along well-defined paths to ensure coverage of those highways which serve as major evacuation routes. Such patrols are not essential in the presence of air surveillance and multiple TCP; however, they should be undertaken if personnel resources permit. Figure 11-1 depicts 6 patrol routes, identified as PR-1 through PR-6. Each such closed path is delineated on Figure 11-1 by cross- hatching the enclosed area.

3. Fixed-point surveillance is provided by all traffic guides located at the Traffic Control Posts (TCP -- See Appendix I) and at the Access Control Posts (ACP -- See Appendix L).

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.

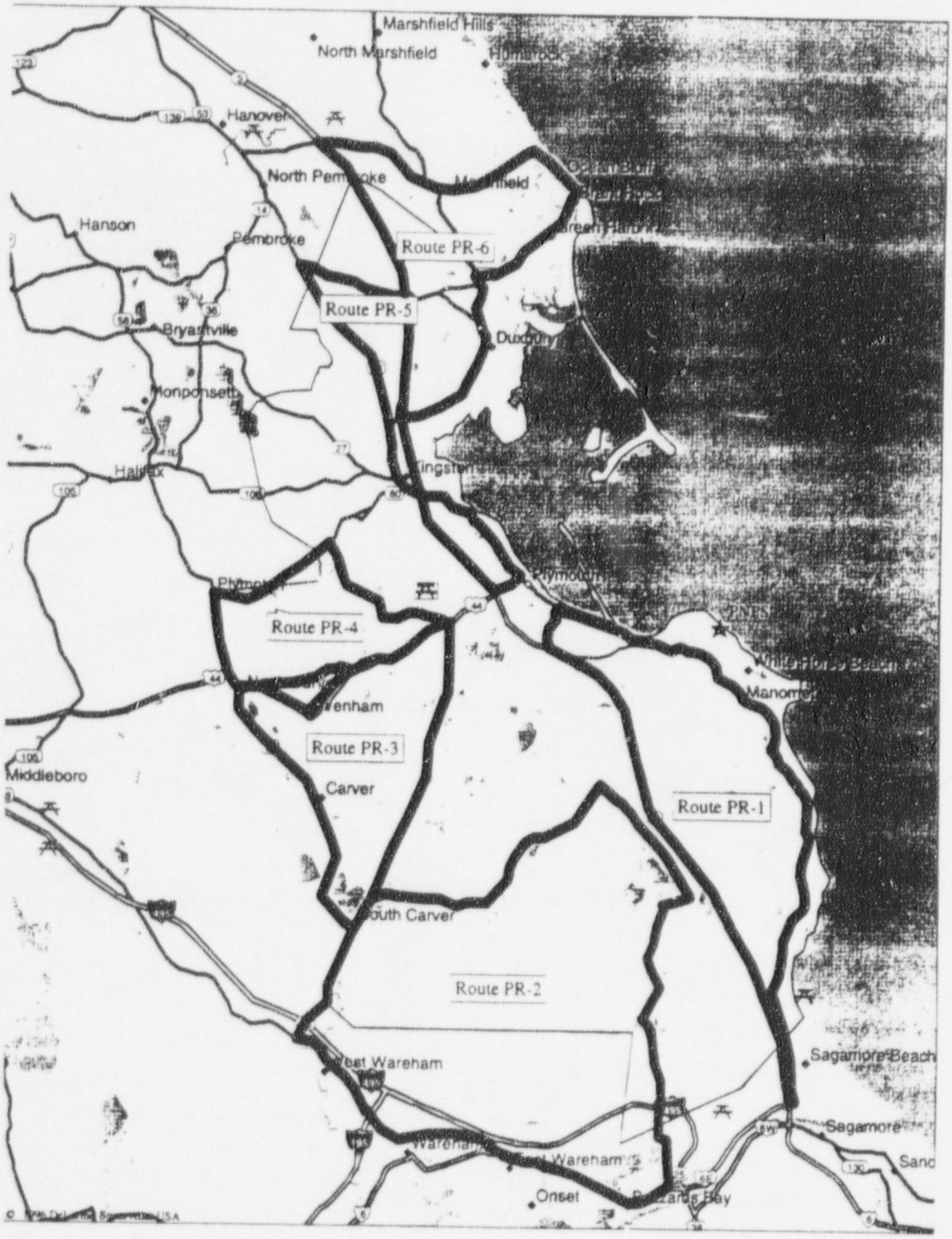


Figure 11-1. Surveillance Patrol Routes

- The patrol cars, manned by experienced police personnel, should be able to travel faster than the general public along those portions of their routes which are in the outbound direction. These patrol routes are designed so that the patrols travel counter-flow, relative to the evacuees, on these roads which are most heavily congested. For example, Patrol Route 3 (PR-3) travels inbound along Route 44 and outbound (i.e. with the evacuating traffic) along the lesser congested Tremont Road.

  Most patrol routes are approximately 15-20 miles in length. This length, in combination with skillful driving by experienced police personnel, should permit one cycle over the route to be completed well within one hour. A blockage would be identified visually using the same criteria of density discontinuity described above, or directly.

  While such patrols are somewhat redundant if aerial surveillance is available, we recommend its implementation if resources permit. Certainly, as traffic volumes decrease with time, some personnel at lightly-loaded TCP could assume this role of patrolling the indicated routes.

- 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 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. If a police car is patrolling the route, then that car can be assigned to investigate.

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.

Most accidents involving vehicles traveling at low speeds[1] will not result in a vehicle disablement; most of those that are disabled can be pushed onto the shoulder. 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. We therefore recommend that tow trucks be deployed at strategic locations within, or just outside, the EPZ. These locations should be selected so that:

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

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

Tow trucks to aid vehicles involved in the evacuation are on-call as part of the Town RERP Plans. 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. Of course, if another call for assistance is received by a tow truck while responding to an earlier call, it would proceed directly to the second location after completing the removal of the disabled vehicle, or other obstruction, from the roadway. 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.

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[1] For example, the average vehicle speed for the case of Scenario 1 and Region 1, is about 9 miles per hour.

12. CONFIRMATION TIME

It is necessary to confirm that the evacuation process is effective, in the sense that the public is complying with the directive to evacuate. Since it is not feasible to confirm the compliance of every household within the EPZ in a timely manner, a procedure which employs a stratified random sample may be considered. The following discussion outlines such a procedure.

The size of the sample is dependent on the expected number of households which do not comply with the directive to evacuate. We believe it is reasonable to assume, for the purpose of estimating sample size, that at least 80 percent of the population within the EPZ will comply with the directive to evacuate. On this basis, an analysis was undertaken (see Exhibit 12-1) which yielded an estimated sample size of approximately 300.

The confirmation process should start at about 3 hours after the directive to evacuate is announced or 1 ½ hours prior to the ETE value, whichever is later. For example, if the ETE, referenced to the directive to evacuate, is 5:30, then the confirmation process should begin 4 hours after the directive. If the ETE is 3:30, then the confirmation process should begin 3 hours after the directive to evacuate. At these times, for either case, virtually all evacuees will have departed on their respective trips and the local telephone system will be largely free of traffic.

As indicated in Exhibit 12-1, almost 8 ½ person hours are needed to complete the telephone survey. If 7 people are assigned to this task, each dialing a different set of telephone exchanges, then the confirmation process will extend over a time frame of about 75 minutes. Thus, the confirmation should be completed about 15 minutes before the evacuated area is cleared (for those cases where the ETE exceeds 4:30) or up to 45 minutes after the area is cleared, for situations with shorter ETE. Of course, fewer people would be needed for this survey if only a portion of the EPZ is directed to evacuate.

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

Summary of ETE

Confirmation times, as tabulated in Tables 9-10a through 9-10d are calculated on the basis that two persons are involved in the telephone survey if Region 9 is evacuated, four persons if Regions 5-8 are evacuated, and one person per ERPA for Regions 1-4.

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

Problem Definition

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

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

Given: No. of households plus other facilities, N, within the EPZ (est.) = 25,000
Est. proportion, F, of households that will not evacuate = 0.20
Allowable error margin, e: 0.05
Confidence level, : 0.95 (implies A = 1.96)

Applying Table 10 of cited reference,

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

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

Finite population correction: $n_F = \frac{nN}{n+N-1} = 304$

Thus, some 300 telephone calls will confirm that approximately 20 percent of the population has not evacuated. If only 10 percent of the population does not comply with the directive to evacuate, then the required sample size, $n_F = 215$.

Est. Person Hours to complete 300 telephone calls

Assume: Time to dial using touch-tone (random selection of listed numbers): 30 seconds
Time for 8 rings (no answer): 48 seconds
Time for 4 rings plus short conversation: 60 sec.
Interval between calls: 20 sec.

Person Hours: $300[30+20+0.8(48)+0.2(60)]/3600 = 8.4$

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	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.
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.

Term	Definition
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 Effect.	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.
Network	A graphical representation of the geometric topology of a physical roadway system, which is comprised of directional links and nodes.
Prevailing 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.).

Term	Definition
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,	The total elapsed time to display all signal indications, in sequence. The cycle length is expressed in seconds.
Signal Interval	A single combination of signal indications. The interval duration is expressed in seconds. 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.
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.

Term	Definition
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	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.
Turning Capacity	The capacity associated with that component of the traffic stream which executes a specified turn maneuver from an approach at an intersection.

APPENDIX B

Traffic Assignment Model

Appendix B: Traffic Assignment Model

The traffic assignment program which is employed in this study is an elaboration of an existing model developed by Dr. Sang Nguyen[1]. This model is an equilibrium assignment model which employs mathematical programming methodology to search for, and attain, a global optimum solution. The term, "optimum", implies that the solution is unique and that it minimizes a specified cost function.

This cost function, in our application, is expressed directly in terms of aggregate travel time. That is, the model formulation relates travel time to the assigned volumes on each network link according to the following formulation:

$$T_i = T_{o,i}[1 + a(\frac{v_i}{c_i})^b]$$

where

T_i = Travel Time on link, i, sec

$T_{o,i}$ = Specified free-flow (zero delay) travel time on link, i, sec

V_i = Volume of traffic on a link, i, vph

C_i = Capacity of link, i, vph

a,b = Specified calibration parameters

The cost function, then, is formulated in terms of travel time along each path from each origin to each respective destination. Minimizing this path-specific travel time (i.e. the so-called User Optimization), all vehicles are assured of being routed along the shortest (in travel time) possible path to their respective destinations.

The computational algorithm assigns traffic over the network in such a way as to minimize this aggregate cost. That is, the allocation of volumes, V, to the network links, i = 1, 2, ..., N is accomplished in such a way as to:

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[1] Nguyen, S. and James, L., "TRAFFIC - An Equilibrium Traffic Assignment Program", Publication No. 17, Centre de Reserche sur les Transports, March 1975.

- Satisfy all specified origin-destination demands,
- Satisfy the minimum-cost (travel time) objective,
- Satisfy any specified control treatment and turn restrictions designed to:
  - Expedite the evacuation process
  - Minimize radiation exposure of the vehicle occupants.

Most applications of traffic assignment employ constant, estimated, values of link capacity C_i. It is well known, however, that link capacity is a function of many factors including the (unknown) turn volumes on all links serviced by a common intersection. Consequently, the assumption of constant link capacity compromises the efficacy of the assignment results.

To resolve this problem, KLD has expanded the existing TRAFFIC model to incorporate a model, named the TRAFLO CAPACITY model. This model computes accurate estimates of capacity, C_i, that are always consistent with the assigned volumes, V_i, on each link. This capacity model consists of three integrated components

- A formulation which calculates the service rates for through and left-turning vehicles in a lane, given, among other data, the proportion of left-turners in the lane,

- Another formulation for through and right-turner service rates,

- A formulation which calculates the lateral deployment of traffic on an approach, yielding the proportion of through and turning vehicles in each lane.

These three components are exercised in an iterative manner to produce accurate and self-consistent estimates of service rates for approaches of general configuration and for all types of control devices. Many tests have confirmed that this solution procedure is rapid, accurate and unconditionally convergent.

In summary, the Traffic Assignment Model used in this project represents the latest state-of-the-art and provides accurate estimates of link volumes, stratified by turn movement at the downstream mode (intersection). These turn volumes on each link are subsequently input into the Traffic Simulation Program.

Another output provided by the Traffic Assignment model is the estimated travel times on each link. These estimates are not particularly accurate -- they are usually optimistic -- but they do identify the "hot spots" in the network: those links which are severely congested. This permits the analyst to identify candidate solutions to relieve the congestions and to expedite the flow of traffic.

APPENDIX C

Traffic Simulation Model: IDYNEV

Appendix C: Traffic Simulation Model: IDYNEV

A model, named IDYNEV, is an adaptation of the TRAFLO Level II simulation model, developed by KLD for the Federal Highway Administration (FHWA), with extensions in scope to accommodate all types of facilities. This model produces an extensive set of output MOE as shown in Table C-1.

The traffic stream is described in terms of a set of link-specific statistical flow histograms. These histograms describe the platoon structure of the traffic stream on each network link. The simulation logic identifies five types of histograms:

- The ENTRY histogram which describes the platoon flow at the upstream end of the subject link. This histogram is simply an aggregation of the appropriate OUTPUT turn-movement-specific histograms of all feeder links.

- The INPUT histograms which describe the platoon flow pattern arriving at the stop line. These are obtained by first disaggregating the ENTRY histogram into turn-movement-specific component ENTRY histograms. Each such component is modified to account for the platoon dispersion which results as traffic traverses the link. The resulting INPUT histograms reflect the specified turn percentages for the subject link.

- The SERVICE histogram which describe the service rates for each turn movement. These service rates reflect the type of control device servicing traffic on this approach; if it is a signal, then this histogram reflects the specified movement-specific signal phasing. A separate model was developed to estimate service rates for each turn movement, given that the control is GO.

- The QUEUE histogram which describe the time-varying ebb and growth of the queue formation at the stop line. These histograms are derived from the interaction of the respective IN histograms with the SERVICE histograms.

- The OUT histograms which describe the pattern of traffic discharging from the subject link. Each of the IN histograms is transformed into an OUT histogram by the control applied to the subject link. Each of these OUT histograms is added into the (aggregate) ENTRY histogram of its receiving link.

Table C-1. Measures of Effectiveness Output by IDYNEV

Measure	Units
Travel	Vehicle-Miles and Vehicle-Trips
Moving Time	Vehicle-Minutes
Delay Time	Vehicle-Minutes
Total Travel Time	Vehicle-Minutes
Efficiency: Moving Time/ Total Travel Time	Percent
Mean Travel Time per Vehicle	Seconds
Mean Delay per Vehicle	Seconds
Mean Delay per Vehicle-Mile	Seconds/Mile
Mean Speed	Miles/Hour
Mean Occupancy	Vehicles
Mean Saturation	Percent
Vehicle Stops	Percent

These data are provided for each network link and are also aggregated over the entire network.

Note that this approach provides the IDYNEV model with the ability to identify the characteristics of each turn-movement-specific component of the traffic stream. Each component is serviced at a different saturation flow rate as is the case in the real world. Furthermore, the IDYNEV logic will be able to recognize when one component of the traffic flow is encountering saturation conditions even if the others are not.

Algorithms provide estimates of delay and stops reflecting the interaction of the IN histograms with the SERVICE histograms. The IDYNEV logic also provides for properly treating spillback conditions reflecting queues extending from one link into its upstream feeder links.

A valuable feature of IDYNEV is its ability to internally generate functions which relate mean speed to density on each link, given user-specified estimates of free-flow speed and saturation service rates for each link. Such relationships are essential in order to simulate traffic operations on freeways and rural roads, where the signal control does not exist or where its effect is not the dominant factor in impeding traffic flow.

All traffic simulation models are data-intensive. Table C-2 outlines the input requirements of the IDYNEV Model.

In order to apply the IDYNEV Model, the physical traffic environment must be specified by the user. This input data describes:

- Topology of the roadway system
- Geometries of each roadway component
- Channelization of traffic on each roadway component
- Motorist behavior which, in aggregate, determines the operational performance of vehicles in the system
- 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-1 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 IDYNEV model followed directly after DYNEV was completed. The perceived need for IDYNEV 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 IDYNEV is that the latter model directly calculates the integral 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 IDYNEV, 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 IDYNEV 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 IDYNEV, 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, IDYNEV is used exclusively for the EESF system, to calculate evacuation time estimates.

Table C-2. Input Requirements for the IDYNEV Model

GEOMETRICS

Links defined by upstream downstream node numbers
Links lengths
Number of lanes (up to 6)
Turn pockets
Grade
Network topology defined in terms of target nodes for each receiving link

TRAFFIC VOLUMES

On all entry links and sink/source nodes stratified by vehicle type: auto, car pool, bus, truck
Link-specific turn movements or O-D matrix (Trip Table)

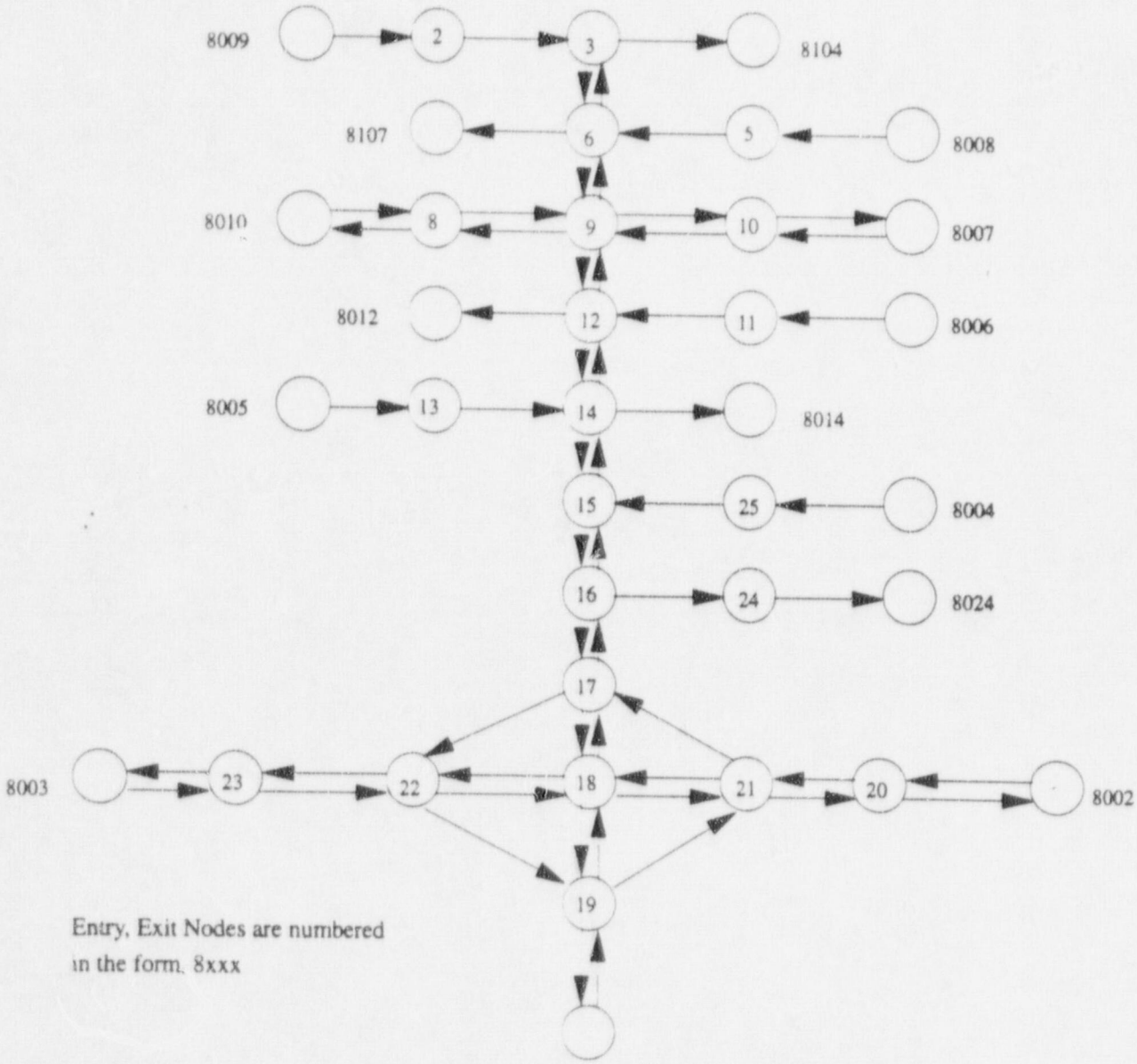
TRAFFIC CONTROL SPECIFICATIONS

Traffic signals: link-specific, turn movement specific
Control may be fixed-time or traffic-actuated
Stop and Yield signs
Right-turn-on-red (RTOR)
Route diversion specifications
Turn restrictions
Lane control (i.e. lane closure)

DRIVER'S AND OPERATIONS CHARACTERISTICS

Drivers (vehicle-specific) response mechanisms: free-flow speed, aggressiveness, discharge headway
Link-specific mean speed for free-flowing (unimpeded) traffic
Vehicle-type operational characteristics: acceleration, deceleration
Such factors as bus route designation, bus station location, dwell time, headway, etc.

Figure C-1. Representative Analysis Network



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.

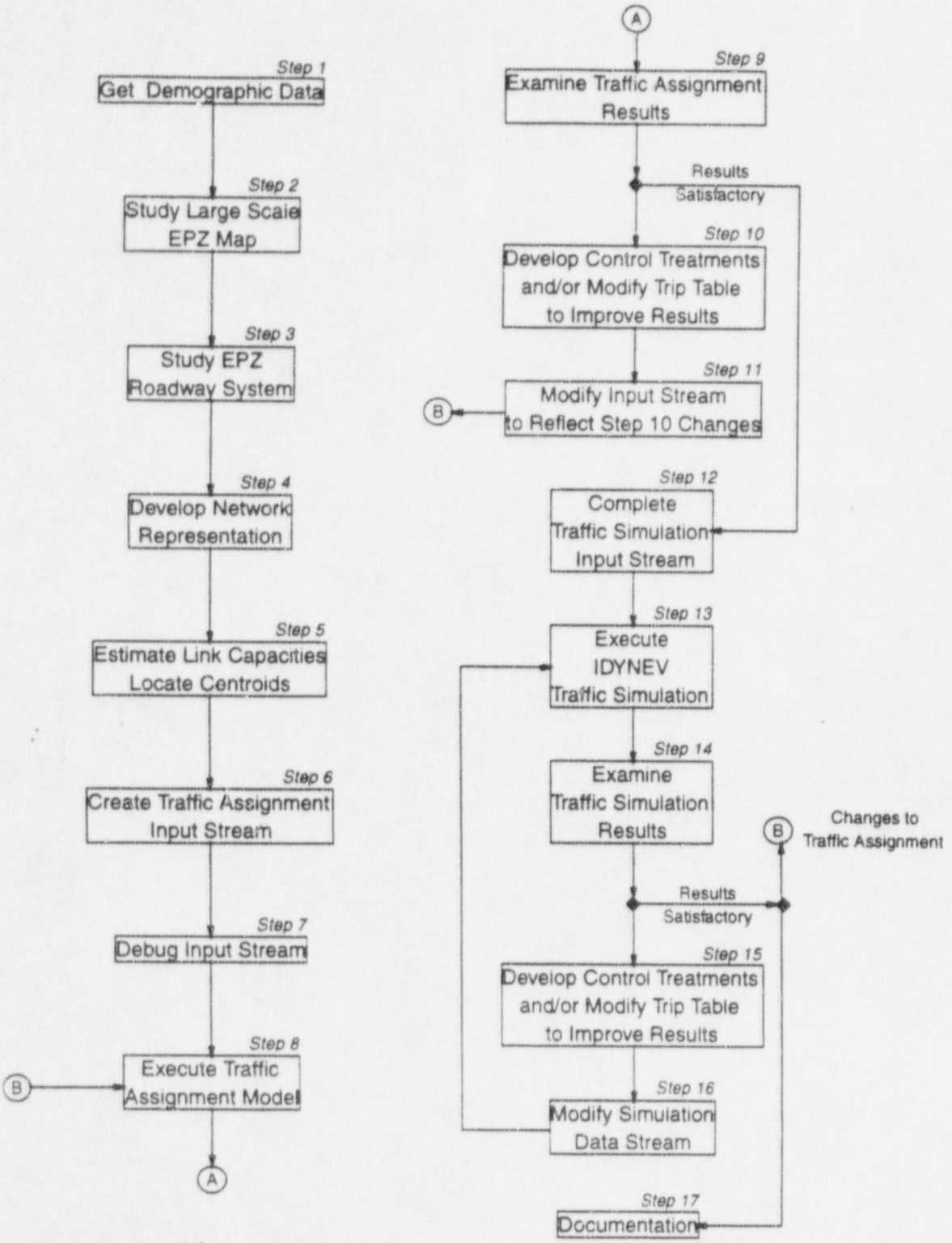


Figure D-1. Flow Diagram of Activities

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 effort. 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:

- The results are as satisfactory as could be expected at this stage of the analysis process, or
- 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 models 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.

Step 15. This activity implements the changes in control treatments or in the assignment of destinations associated with one or more origins in order to improve the flow of traffic over the network. These treatments can also include the consideration of additional roadway segments to the existing analysis network in order to disperse the traffic demand and thus avoid the focusing of traffic demand which can produce high levels of congestion.

Step 16. Once the treatments have been identified, it is necessary to modify the input stream accordingly. At the completion of this effort, the procedure returns to Step 13 to execute the simulation model once more.

Step 17. The simulation results are then analyzed, tabulated and graphed. The results are then documented, as required.

APPENDIX E

Supporting Data

Permanent Population

Town	1990 Census Estimates	1998 Town Estmates	1999 Population Projection
Plymouth	45,608	49,700	50,262
Kingston	9,045	10,976	11,235
Carver	6,142	6,380	6,411
Duxbury	13,895	14,700	14.768
Marshfield	1,722	1,841	1,857

Population growth rates were computed for each town based upon the Current Town estimates and the 1990 Census results. These growth rates were used to interpolate 1999 estimates.

Employee Populations
Massachusetts Department of Employment and Training

Employment for towns within the EPZ

Town	1990	1996
Plymouth	16,064	17,438
Kingston	4,657	5,118
Carver	1,298	1,579
Duxbury	2,255	2,255
Marshfield	4,200	4,224

These figures were used to compute growth rates and subsequently projected 1999 populations.

NOTE: These figures are counts of employees covered by insurance, and excludes certain job types. There are also other uncertainties.

General References

1. NYNEX yellow pages Plymouth, Marshfield area.

2. Evacuation Times Estimates for areas near Pilgrim Station. HMM Document No. 79-048 revised September 18, 1980 (Hereafter, refered to as the HMM report)

3. Rand McNally Campground and Trailer Park Directory.

4. Redbook 1986 Official American Hotel and Motel Directory.

5. Chamber of Commerce tourism pamphlets.

6. Various town government departments.

It is estimated that on average there are 2.2 evacuating vehicles per summer home within the EPZ. Assume 2.6 persons per vehicle.

Plymouth: The Water Authority reports 330 summer homes and officials from Duxbury beach in Duxbury report an additional 200 summer homes in the Saquish Neck area. There are 530 x 2.2 = 1166 summer home vehicles, and 1166 x 2.6 = 3032 summer home people present in Plymouth.

Kingston: The Water Authority reports between 300 and 400 people as the peak number occupying summer homes in Kingston. There are 400 / 2.6 = 154 summer home vehicles and 154 / 2.2 = 70 summer homes in Kingston.

Carver: Averaging figures that the 1980 Census reports for tracts within Carver yields 3.28 persons per household in Carver. This determines that the 6983 Carver residents occupy 2129 households. The Duxbury tax assessor's office reports 4284 single family homes in Duxbury. The follcwing proportion yields 107 summer homes in Carver and within the EPZ:

$$\frac{\text{216 summer homes in Duxbury}}{\text{4284 single family homes in Duxbury}} = \frac{\text{X summer homes in Carver}}{\text{2129 single family homes in Carver}}$$

There are 107 x 2.2 = 235 summer home vehicles, and 235 x 2.6 = 611 summer home people present in the portion of Carver within the EPZ.

Duxbury: The Water Authority reports 216 summer homes in Duxbury. There are 216 x 2.2 = 475 summer home vehicles, and 475 x 2.6 = 1235 summer home people present in Duxbury.

Marshfield: 6946 households in Marshfield stopped delivery on the widely distributed South Shore News. Thus there are 6946 summer homes in the entire town of Marshfield. In order to estimate the number of summer homes in the portion of Marshfield within the EPZ, the following proportion was used:

$$\frac{\text{6946 summer homes in Marsh.}}{\text{22904 permanent residents in Marshfield}} = \frac{\text{X Marsh. summer homes in EPZ}}{\text{1877 Marshfield permanent residents in EPZ}}$$

This proportion yields 569 Marshfield summer homes within the EPZ. There are 569 x 2.2 = 1252 summer home vehicles, and 1252 x 2.6 = 3255 summer home people present in the portion of Marshfield within the EPZ.

NOTE: The Plymouth edition of the South Shore News (since closed) reported that no one in Plymouth stopped delivery during the summer. As such, the Water Authority and Duxbury Beach officials remain the best source available.

Motels and Hotels

Community	Facility	# of Units	Summer-Weekend Occupancy Rate	# of Occupied Units
Plymouth	Blue Anchor Motel	4	100%	4
"	Breezy Hill Motel	9	80%	7
"	Cold Spring Motel	31	100%	31
"	Colonial House Inn	6	100%	6
"	Red Oaks Motel	22	100%	22
"	White Horse Motel	8	95%	8
"	Sleepy Pilgrim Motel	12	100%	--
"	Governor Brad. Motor Inn	94	85%	80
"	Pilgrim Sands Motel	64	100%	64
"	Sheraton	175	100%	175
"	Clear Pond Motel	9	100%	9

Motels and Hotels

Community	Facility	# of Units	Summer-Weekend Occupancy Rate	# of Occupied Units
Plymouth (conc.)	Governor Carver Motor Inn	79	100%	79
	Plymouth Motel	23	100%	23
Duxbury	Winsor Inn	4	100%	4
"	Duxbury Motor Inn	16	95%	15
Kingston	Bay View Motel	12	100%	12
"	Riverview Efficiencies	7	100%	7
"	Capeway Traveler Motel	12	100%	12
"	Inn at Plymouth Bay	66	100%	66
		687		670

NOTE: The number of rooms and occupancy rate was reported by the manager of the particular facility. The number of occupied units is converted to vehicles by the factor .85 vehicles per unit, and to people by the factor 2.4 persons/vehicles.

Special Cases

I. In the case of the Blue Spruce Motel in Plymouth the manager reports an occupancy rate of 100% for 32 rooms and 4 townhouse units. Hence, this facility has 32 occupied rooms and 4 occupied cabins. This facility is distinguished from the others because the cabins are converted to vehicles by a factor of 1.0 instead of .85.

Campgrounds

Community		Peak Facility Population
Plymouth	Sandy Pond Campground	600
"	Myles Standish State Forest Campground	1590
"	Indianhead Resorts	600
"	Pinewood Lodge Trailer Park	400
"	Pinewood Camp	550
"	Blueberry Hill Campground	300
"	Camp Dennen	350
Carver	Pine-Wood Way	200
"	Shady Acres	500

Peak population figures were obtained by BECo through telephone contacts with the facility managers.

Special Cases

Community	Facility	# of units	# of vehicles
Plymouth	Ellis Haven	70	70

The number of units was obtained from the 1986 Rand McNally Campground and Trailer Park Directory. An occupancy rate of 100 percent is assumed. The number of occupied units is converted to vehicles by the factor 1.0 vehicle per unit and to people by the factor 2.4 persons per vehicle.

Camps

Community	Facility	Peak Number of Children Present
Plymouth	Wind in the Pines	850
"	Camp Bournedale	100
"	Camp Child	45
"	Cachalot Scout Reservation	160
"	Camp Clark	244
"	Camp Massasoit	50
"	Camp Squanto	325
Kingston	Camp Mishannock	175
"	Camp Norse Boy Scout Camp	200
Carver	Camp Clear	50
Duxbury	Camp Wing	315
"	Blairhaven/Cedar Hill Conference Center	30
"	St. Margaret's Camp	25
"	Art Association Camp	20
"	Magic Dragon	100
"	Camp Friendship	100

Historic Sites

Community	Facility	Visitors Summer Day	Avg. Stay (minutes)	Visitor Turn-Over
Plymouth	Mayflower Society House	75	45	5
"	Pilgrim Hall Museum	200	120	3
"	William Harlow House	25	60-90	4
"	Sparrow House	75	30-45	5
"	Howland House	75	30	5
"	Spooner House	25	60-90	4
"	Antiquarian House	75	60-90	4
"	Cranberry World	2500	30-45	5
"	Jenny Grist Mill	300	60-120	3
"	1749 Towne Court House	100	30-90	4
"	Plymouth Colony Winery	75	45	5
Duxbury	John Alden House	40	60	4
"	Art Complex Inc.	50	60	4
"	King Caesar House	25	45-60	3

The number of visitors and their average stay was supplied by the manager of each facility listed. The number of visitors present at any one time is computed by dividing the number of visitors per day by the number of times the facility's population is turned over. To convert the number of people present at any one time to the number of vehicles generated by a particular facility assume 2.5 persons per vehicle.

Special Case

I. In some cases, the only information available was listed in the HMM report, table B-7.

Community	Facility	Peak Number of People
Plymouth	Plymouth National Wax Museum	300
"	Mayflower Experience	200
Kingston	John Bradford House	80

Assume for these facilities that the population turns over 4 times per day.

Town: Plymouth
Facility: Plymouth Plantation-Pilgrim Village
Source: Judith Ingral, Director of Marketing Services
Data: Parking lot capacity is 300 vehicles. She reports that all of her patrons use this parking lot.
Conclusion: 300 vehicles

Town: Plymouth
Facility: Plymouth Plantation-Mayflower II
Source: Judith Ingral, Director of Marketing Services
Data: The number of visitors is the same for Mayflower II and Pilgrim Village.
Conclusion: 300 Vehicles

Town: Plymouth
Facility: White Horse Beach
Source: Aerial Photographs (July 5, 1987)
Data: Population count of 2387 and average vehicle occupancy of 2.54.
Conclusion: 940 Vehicles

Town: Plymouth
Facility: Morton Park
Source: BECO telephone contact with facility manager
Data: 200 vehicles with 3 persons per vehicle.
Conclusion: 200 vehicles

Town: Plymouth
Facility: Myles Standish State Park
Source: BECO telephone contact with facility manager
Data: The summer weekend population is 1530 day use visitors, 222 registered non-profit group visitors, and an estimated 3000 additional visitors.
Source: facility manager
Data: 3.5 persons per vehicle
Calculations: (1530 + 222 + 3000)/3.5 = 1358 vehicles
Conclusion: 1358 vehicles

Town: Plymouth
Facility: Plymouth Rock
Source: Mr. MacKinzie, Supervisor Wompatuck State Park
Department of Environmental Management
Division of Forests and Parks
Data: On a good day, Plymouth Rock attracts 6500-8000 visitors
Calculations: Assume 7500 people per day, and 2.5 persons per vehicle. There are 7500/2.5 = 3000 vehicles per day. Distributing the 3000 vehicles over five two hour periods, we determine that there are 600 vehicles present at any one time.
Conclusions: 600 Vehicles

Town: Plymouth
Facility: Plymouth Beach
Source: Aerial Photographs (July 5, 1987)
Data: Population count of 1960 and average vehicle occupancy of 2.54
Conclusions: 772 vehicles

Town: Plymouth
Facility: Saquish Neck
Source: Aerial Photographs (July 5, 1987)
Data: Population count of 654 and average vehicle occupancy of 2.54 (approximately 257 vehicles)
Note: The aerial photography of the Saquish Neck Area yielded a vehicle count of 358 vehicles (approximately 910 people). A very conservative approach to the estimation of evacuation vehicles from this area was used; the sum of 257 and 358 vehicles was assumed to evacuate Saquish. (257 + 358 = 615 vehicles)
Conclusion: 615 vehicles

Town: Plymouth
Facility: Priscilla Beach
Source: Aerial Photographs (July 5, 1987)
Data: Population count of 430 and average vehicle occupancy of 2.54
Conclusion: 169 vehicles

Town: Plymouth
Facility: Manomet Beach
Source: Aerial Photographs (July 5, 1987)
Data: Population count of 655 and average vehicle occupancy of 2.54
Conclusion: 258 vehicles

Town: Kingston
Facility: Gray's Beach
Source: Aerial Photographs (July 5, 1987)
Data: 41 vehicles
Conclusions: 41 vehicles

Town: Carver
Facility: Sampson Pond
Source: Joanne Henderson, Recreation Committee
Data: Maximum of 300 people
Calculations: Assuming 2.5 persons per vehicle, there are 300/2.5 = 120 vehicles generated by this facility at peak attendance.
Conclusions: 120 vehicles

Town: Carver
Facility: Sampson Pond
Source: Joanne Henderson, Recreation Committee
Data: Maximum of 300 people
Calculations: Assuming 2.5 persons per vehicle, there are 300/2.5 = 120 vehicles generated by this facility at peak attendance.
Conclusions: 120 vehicles

Town: Carver
Facility: Edaville Railroad
Source: BECO telephone contact with facility manager
Data: Parking lot capacity is 800 vehicles
Conclusion: 800 vehicles

Town: Carver
Facility: King Richard's Faire
Source: BECO telephone contact with facility manager
Data: 1000 vehicles
Conclusion: 1000 vehicles

Town: Duxbury
Facility: Myles Standish Monument
Source: Mr. MacKinzie, Supervisor Wompatuck State Park
Department of Environmental Management
Division of Forests and Parks
Data: During the summer season the park attracts 8000 people per month
Calculations: Assume that 75% of 8000 or 6000 visitors attend this facility on a weekend day. Then, since there are 4 weekends per month, there are 6000/4 = 1500 visitors on a typical weekend. Hence, there are 1500/2 = 750 visitors on a typical weekend day. Assuming 2.5 persons per vehicle, there are 750/2.5 or 300 vehicles generated by this facility on a typical weekend day. Distributing 300 vehicles over two 4 1/2 hour time periods, we determine that there are 150 vehicles present at any one time.
Conclusions: 150 vehicles

Town: Duxbury
Facility: Duxbury Beach
Source: Aerial Photographs (July 5, 1987)
Data: Population count of 4583 and average vehicle occupancy of 2.54
Conclusions: 1804 vehicles

Town: Marshfield
Facility: Green Harbor Beach
Source: Aerial Photographs (July 5, 1987)
Data: Population count of 2609 and average vehicle occupancy of 2.54
Conclusions: 1027 Vehicles

Town: Marshfield
Facility: Brant Rock
Source: Aerial Photographs (July 5, 1987)
Data: Population count of 1211 and average vehicle occupancy of 2.54
Conclusions: 477 Vehicles

Town: Plymouth
Facility: Plymouth Marine, Inc.
Source: Brewer, Plymouth Marine, Inc.
Data: Facility supports 90 boats in slips and 24 boats in dry storage. On a good boating day, approximately 50% of member owned boats are in use.
Conclusion: 57 boats

Town: Plymouth
Facility: Plymouth Yacht Club
Source: Steward, Plymouth Yacht Club
Data: Facility supports 150 boats in moorings. On a good boating day, approximately 75 member owned boats are in use.
Conclusion: 75 boats

Town: Plymouth
Facility: Town Moorings
Source: Plymouth Harbor Master
Data: There are a total of 550 boats moored in Plymouth Harbor.
Calculations: 550 - 150 (boats moored at the Plymouth Yacht Club) = 400 additional boats. 400 x .5 (cited by Plymouth Marine, Inc. an Plymouth Yacht Club) = 200 additional boats.
Conclusion: 200 boats

Town: Plymouth
Facility: Town ramp at town wharf
Source: Aerial Photographs (July 5, 1987)
Data: There are 131 vehicles with boat trailers parked at the town wharf ramp parking lot.
Conclusion: 131 boats

Town: Kingston
Facility: Town ramp and moorings at River Street
Source: Kingston Harbor Master
Data: On a good boating day, 200 boats launch from the River Street area.
Conclusion: 200 boats

Town: Duxbury
Facility: Duxbury Yacht Club
Source: Waterfront Master, Duxbury Yacht Club
Data: Facility supports 150 boats in moorings and 150 boats using the town ramp at Matakeeset Court. On a good boating day, approximately 50% of member owned boats are in use.
Calculations: 50% (150) = 75 boats launch from town ramp
50% (150) = 75 boats launch from moorings
Conclusion: 150 boats

Town: Duxbury
Facility: Town ramp at Matakeeset Court
Source: Duxbury Harbor Master
Data: There are a total of 500 boats moored in the Matakeeset Court area.
Calculations: 500 - 150 (boats moored at Duxbury Yacht Club) = 350 additional boats. 350 x .5 (cited by the Duxbury Yacht Club) = 175 additional boats.
Conclusion: 175 boats

Town: Duxbury
Facility: Remainder of Duxbury mooring sites
Source: Duxbury Harbor Master
Data: There are a total of 1500 boats moored in Duxbury.
Calculations: 1500 - 500 (boats moored in Matakeeset Court area) = 1000 additional boats. 1000 x .5 (cited by the Duxbury Yacht Club) = 500 additional boats.
Conclusion: 500 boats

Town: Marshfield
Facility: Taylor Marina
Source: Manager, Taylor Marina
Data: Facility supports 140 boats in slips. On a good boating day, approximately 50% of member owned boats are in use.
Conclusion: 70 boats

Town: Marshfield
Facility: Town ramp and moorings at Brant Rock
Source: Marshfield Harbor Master, aerial photographs (July 5, 1987).
Data: Aerial photographs reveal 80 vehicles with trailers parked at the Brant Rock town ramp parking lot and 110 boats present in moorings. The Harbor Master reports 160 boats in moorings.
Calculations: 160 - 110 (boats launching from moorings) + 80 (boats launching from the town ramp) = 130 boats in use on a good boating day.
Conclusion: 130 boats

Town: Marshfield
Facility: Green Harbor Yacht Club
Source: Manager, Green Harbor Yacht Club
Data: On a good boating day, 10 boats are in use.
Conclusion: 10 boats

Town: Marshfield
Facility: Green Harbor Marina
Source: Aerial photographs (July 5, 1987)
Data: 60 of the 110 slips at the Green Harbor Marina were vacated on July 5, 1987.
Conclusion: 60 boats

Independence Mall
Trip Generation Second Edition - 1979

Average Trip Rate per 1000 Square Feet
for Shopping Center 500,000 to 999,999 Gross Square Feet

Time Period	Enter	Exit
7 AM - 9 AM	0.64	0.32
4 PM - 6 PM	1.23	1.29
Peak Hour	2.22	1.92

Traffic Impact Study - Proposed Independence Mall

Direction Split of Vehicles Leaving Mall

Direction	
Northbound	50
Eastbound	5
Southbound	45

Independence Mall

Estimation of Parking Accumulation at Independence Mall

Time Period	Average Trip Rate Enter	Exit	Net Inflow per 1000 sq.ft.	Net Inflow 500,000 sq.ft.	Parking Accum.
7 AM	0.64	0.32	0.32	160	160
8 AM	0.64	0.32	0.32	160	320
9 AM	0.64	0.32	0.32	160	480
10 AM	1.04	0.72	0.32	160	640
11 AM	1.43	1.12	0.31	155	795
12 PM	1.83	1.52	0.31	155	950
* 1 PM	2.22	1.92	0.30	150	1100
2 PM	1.89	1.71	0.18	90	1190
3 PM	1.56	1.50	0.06	30	1220
4 PM	1.23	1.29	-0.06	-30	1190
5 PM	1.23	1.29	-0.06	-30	1160
6 PM	1.23	1.29	-0.06	-30	1130

Flow rates between 9 AM and 12 PM and 2 PM and 4 PM are obtained via interpolation.

* 1 PM is the assumed mid-day peak hour for the shopping center.

The estimated number of vehicles present in the Independence Mall parking lot is 1200 for the mid-day scenarios. This estimate was used for all scenarios. Discussion with the developers indicated that they expected "most" of the shoppers at the mall to be area residents. Consequently, we propose that 0.6 x 1200 = 720 vehicles are those of area residents, while 0.4 x 1200 = 480 vehicles belong to people who live outside of the EPZ. Assuming 2.54 persons per vehicle, there are an estimated 480 X 2.54 = 1219 day-trippers at the Independence Mall.

Appendix F

Telephone Survey Instrument

Survey Instrument

Hello, my name is _____ and I'm working on a survey being made for [insert marketing firm name] designed to identify local travel patterns in your area. The information obtained will be used in a traffic engineering study and in connection with the annual update of preparedness plans for Pilgrim Station.

___COL.1 Unused
___COL.2 Unused
___COL.3 Unused
___COL.4 Unused
___COL.5 Unused

Sex COL. 6

1 Male
2 Female

INTERVIEWER: ASK TO SPEAK TO THE HEAD OF HOUSEHOLD OR THE SPOUSE OF THE HEAD OF HOUSEHOLD. (Terminate call if not a residence)

DO NOT ASK:

1. Record exchange number.

COL. 9

1 224
2 585
3 746
4 747
5 866
6 934

---

2. In total, how many cars, or other vehicles are usually available to the household? (DO NOT READ ANSWERS.)

COL. 10

1 ONE
2 TWO
3 THREE
4 FOUR
5 FIVE
6 SIX
7 SEVEN
8 EIGHT
9 NINE OR MORE
0 ZERO (NONE)
X REFUSED

---

3. How many people usually live in this household? (DO NOT READ ANSWERS.)

COL. 11

1 ONE
2 TWO
3 THREE
4 FOUR
5 FIVE
6 SIX
7 SEVEN
8 EIGHT
9 NINE

COL. 12

0 TEN
1 ELEVEN
2 TWELVE
3 THIRTEEN
4 FOURTEEN
5 FIFTEEN
6 SIXTEEN
7 SEVENTEEN
8 EIGHTEEN
9 NINETEEN OR MORE
X REFUSED

---

4. How many children living in this household go to local public, private, or parochial schools? (DO NOT READ ANSWERS.)

COL.13
0 ZERO
1 ONE
2 TWO
3 THREE
4 FOUR
5 FIVE
6 SIX
7 SEVEN
8 EIGHT
9 NINE OR MORE
X REFUSED

---

5. How many summer vacation days and nights does the family generally spend away from home and outside Plymouth County?

Col.14
0 ZERO DAYS
1 ONE DAY
2 TWO DAYS
3 THREE DAYS
4 FOUR DAYS
5 FIVE DAYS
6 SIX DAYS
7 SEVEN DAYS
8 EIGHT DAYS
9 NINE DAYS
X DON'T KNOW

Col.15
0 TEN DAYS
1 11-15 DAYS
2 16-20 DAYS
3 21-30 DAYS
4 OVER 30 DAYS
5 REFUSED

---

6. How many people in the household commute to a job, or to college, at least 4 times a week?

		COL. 16	SKIP TO
0	ZERO		Q. 11
1	ONE		Q. 7
2	TWO		Q. 7
3	THREE		Q. 7
4	FOUR OR MORE		Q. 7
5	DON'T KNOW/REFUSED		Q. 11

INTERVIEWER: For each person identified in Question 6, ask Questions 7, 8, 9, and 10.

7. Thinking about commuter #1, how does that person usually travel to work or college? (REPEAT QUESTION FOR EACH COMMUTER.)

	Commuter #1 COL. 17	Commuter #2 COL. 18	Commuter #3 COL. 19	Commuter #4 COL. 20
Rail	1	1	1	1
Bus	2	2	2	2
Walk/Bicycle	3	3	3	3
Driver Car/Van	4	4	4	4
Passenger Car/Van	5	5	5	5
Driver Carpool-3 or more people	6	6	6	6
Passenger Carpool-3 or more people	7	7	7	7
Taxi	8	8	8	8
Refused	9	9	9	9

8. What is the name of the city, town or community in which Commuter #1 works or attends school? (REPEAT QUESTION FOR EACH COMMUTER.) (FILL IN ANSWER.)

COMMUTER #1			COMMUTER #2			COMMUTER #3			COMMUTER #4		
City/Town		State	City/Town		State	City/Town		State	City/Town		State
COL. 21	COL. 22	COL. 23	COL. 24	COL. 25	COL. 26	COL. 27	COL. 28	COL. 29	COL. 30	COL. 31	COL. 32
0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9	9	9	9	9

9. How long would it take Commuter #1 to travel home from work or college? (REPEAT QUESTION FOR EACH COMMUTER.) (DO NOT READ ANSWERS.)

COMMUTER #1

COL.33

1 5 MINUTES OR LESS
2 6-10 MINUTES
3 11-15 MINUTES
4 16-20 MINUTES
5 21-25 MINUTES
6 26-30 MINUTES
7 31-35 MINUTES
8 36-40 MINUTES
9 41-45 MINUTES

COL.34

1 46-50 MINUTES
2 51-55 MINUTES
3 56 - 1 HOUR
4 OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
5 BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
6 BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
7 BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
8 OVER 2 HOURS (SPECIFY _____)
9
0
X DON'T KNOW/REFUSED

COMMUTER #2

COL.35

1 5 MINUTES OR LESS
2 6-10 MINUTES
3 11-15 MINUTES
4 16-20 MINUTES
5 21-25 MINUTES
6 26-30 MINUTES
7 31-35 MINUTES
8 36-40 MINUTES
9 41-45 MINUTES

COL.36

1 46-50 MINUTES
2 51-55 MINUTES
3 56 - 1 HOUR
4 OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
5 BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
6 BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
7 BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
8 OVER 2 HOURS (SPECIFY _____)
9
0
X DON'T KNOW/REFUSED

COMMUTER #3

COL.37

1 5 MINUTES OR LESS
2 6-10 MINUTES
3 11-15 MINUTES
4 16-20 MINUTES
5 21-25 MINUTES
6 26-30 MINUTES
7 31-35 MINUTES
8 36-40 MINUTES
9 41-45 MINUTES

COL.38

1 46-50 MINUTES
2 51-55 MINUTES
3 56 - 1 HOUR
4 OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
5 BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
6 BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
7 BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
8 OVER 2 HOURS (SPECIFY _____)
9
0
X DON'T KNOW/REFUSED

COMMUTER #4

COL.39

1 5 MINUTES OR LESS
2 6-10 MINUTES
3 11-15 MINUTES
4 16-20 MINUTES
5 21-25 MINUTES
6 26-30 MINUTES
7 31-35 MINUTES
8 36-40 MINUTES
9 41-45 MINUTES

COL.40

1 46-50 MINUTES
2 51-55 MINUTES
3 56 - 1 HOUR
4 OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
5 BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
6 BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
7 BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
8 OVER 2 HOURS (SPECIFY _____)
9
0
X DON'T KNOW/REFUSED

10. Approximately how long does it take Commuter #1 to complete preparation for leaving work or college prior to starting the trip home? (REPEAT QUESTION FOR EACH COMMUTER.) (DO NOT READ ANSWERS.)

COMMUTER #1

COL.41
1 5 MINUTES OR LESS
2 6-10 MINUTES
3 11-15 MINUTES
4 16-20 MINUTES
5 21-25 MINUTES
6 26-30 MINUTES
7 31-35 MINUTES
8 36-40 MINUTES
9 41-45 MINUTES

COL.42
1 46-50 MINUTES
2 51-55 MINUTES
3 56 - 1 HOUR
4 OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
5 BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
6 BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
7 BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
8 OVER 2 HOURS (SPECIFY _____)
9
0
X DON'T KNOW/REFUSED

COMMUTER #2

COL.43
1 5 MINUTES OR LESS
2 6-10 MINUTES
3 11-15 MINUTES
4 16-20 MINUTES
5 21-25 MINUTES
6 26-30 MINUTES
7 31-35 MINUTES
8 36-40 MINUTES
9 41-45 MINUTES

COL.44
1 46-50 MINUTES
2 51-55 MINUTES
3 56 - 1 HOUR
4 OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
5 BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
6 BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
7 BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
8 OVER 2 HOURS (SPECIFY _____)
9
0
X DON'T KNOW/REFUSED

COMMUTER #3

COL.45
1 5 MINUTES OR LESS
2 6-10 MINUTES
3 11-15 MINUTES
4 16-20 MINUTES
5 21-25 MINUTES
6 26-30 MINUTES
7 31-35 MINUTES
8 36-40 MINUTES
9 41-45 MINUTES

COL.46
1 46-50 MINUTES
2 51-55 MINUTES
3 56 - 1 HOUR
4 OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
5 BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
6 BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
7 BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
8 OVER 2 HOURS (SPECIFY _____)
9
0
X DON'T KNOW/REFUSED

COMMUTER #4

COL.47
1 5 MINUTES OR LESS
2 6-10 MINUTES
3 11-15 MINUTES
4 16-20 MINUTES
5 21-25 MINUTES
6 26-30 MINUTES
7 31-35 MINUTES
8 36-40 MINUTES
9 41-45 MINUTES

COL.48
1 46-50 MINUTES
2 51-55 MINUTES
3 56 - 1 HOUR
4 OVER 1 HOUR, BUT LESS THAN 1 HOUR 15 MINUTES
5 BETWEEN 1 HOUR 16 MINUTES AND 1 HOUR 30 MINUTES
6 BETWEEN 1 HOUR 31 MINUTES AND 1 HOUR 45 MINUTES
7 BETWEEN 1 HOUR 46 MINUTES AND 2 HOURS
8 OVER 2 HOURS (SPECIFY _____)
9
0
X DON'T KNOW/REFUSED

11. When the commuters are away from home, is there a vehicle at home that is available for evacuation?

COL.49
1 YES
2 NO
3 DON'T KNOW/REFUSED

12. How long would it take the family to pack clothing, secure the house, load the car, and complete preparations prior to evacuating the area? (DO NOT READ ANSWERS.)

COL.50

1 LESS THAN 15 MINUTES
2 15-30 MINUTES
3 31-45 MINUTES
4 46 MINUTES - 1 HOUR
5 1 HOUR TO 1 HOUR 15 MINUTES
6 1 HOUR 16 MINUTES TO 1 HOUR 30 MINUTES
7 1 HOUR 31 MINUTES TO 1 HOUR 45 MINUTES
8 1 HOUR 46 MINUTES TO 2 HOURS
9 2 HOURS TO 2 HOURS 15 MINUTES
0 2 HOURS 16 MINUTES TO 2 HOURS 30 MINS.
X 2 HOURS 31 MINUTES TO 2 HOURS 45 MINS.
Y 2 HOURS 46 MINUTES TO 3 HOURS

COL.51

1 3 HOURS TO 3 HOURS 15 MINUTES
2 3 HOURS 16 MINUTES TO 3 HOURS 30 MINUTES
3 3 HOURS 31 MINUTES TO 3 HOURS 45 MINUTES
4 3 HOURS 46 MINUTES TO 4 HOURS
5 4 HOURS TO 4 HOURS 15 MINUTES
6 4 HOURS 16 MINUTES TO 4 HOURS 30 MINUTES
7 4 HOURS 31 MINUTES TO 4 HOURS 45 MINUTES
8 4 HOURS 46 MINUTES TO 5 HOURS
9 5 HOURS TO 5 HOURS 15 MINUTES
0 5 HOURS 16 MINUTES TO 5 HOURS 30 MINUTES
X 5 HOURS 31 MINUTES TO 5 HOURS 45 MINUTES
Y 5 HOURS 46 MINUTES TO 6 HOURS

COL.52

1 DON'T KNOW

12A. How long would it take you to clear 6-8" of snow to move the car from the driveway or curb to begin the evacuation trip? Assume the roads are passable. (DO NOT READ RESPONSES.)

COL.53

1 LESS THAN 15 MINUTES
2 15-30 MINUTES
3 31-45 MINUTES
4 46 MINUTES - 1 HOUR
5 1 HOUR TO 1 HOUR 15 MINUTES
6 1 HOUR 16 MINUTES TO 1 HOUR 30 MINUTES
7 1 HOUR 31 MINUTES TO 1 HOUR 45 MINUTES
8 1 HOUR 46 MINUTES TO 2 HOURS
9 2 HOURS TO 2 HOURS 15 MINUTES
0 2 HOURS 16 MINUTES TO 2 HOURS 30 MINS.
X 2 HOURS 31 MINUTES TO 2 HOURS 45 MINS.
Y 2 HOURS 46 MINUTES TO 3 HOURS

COL.54

1 MORE THAN 3 HOURS
2 DON'T KNOW

Thank you very much.

_____
(TELEPHONE NUMBER CALLED)

APPENDIX G

TABULATION OF TELEPHONE SURVEY DATA

PERSONS PER HOUSEHOLD VS. CARS PER HOUSEHOLD

PERSONS PER HOUSEHOLD		NUMBER OF CARS PER HOUSEHOLD					
		0	1	2	3	4	TOTAL
1	Total	7	50	8	1	0	66
	Pct.	10.6	75.8	12.1	1.5	0	100
2	Total	1	61	100	8	6	176
	Pct.	0.6	34.7	56.8	4.5	3.4	100
3	Total	0	17	64	27	4	112
	Pct.	0	15.2	57.1	24.1	3.6	100
4	Total	0	16	82	20	5	123
	Pct.	0	13	66.7	16.3	4.1	100
5	Total	1	8	45	17	10	81
	Pct.	1.2	9.9	55.6	21	12.3	100
6	Total	0	1	18	5	2	26
	Pct.	0	3.8	69.2	19.2	7.7	100
7	Total	0	2	2	0	5	9
	Pct.	0	22.2	22.2	0	55.6	100
8	Total	0	0	1	1	1	3
	Pct.	0	0	33.3	33.3	33.3	100
9	Total	0	0	1	1	0	2
	Pct.	0	0	50	50	0	100
10	Total	0	0	0	0	1	1
	Pct.	0	0	0	0	100	100

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	66	0	0	0	0	0	0	66
	Pct.	100	0	0	0	0	0	0	100
2	Total	169	7	7	7	7	7	7	211
	Pct.	80.1	3.3	3.3	3.3	3.3	3.3	3.3	100
3	Total	60	45	7	0	0	0	0	112
	Pct.	53.6	40.2	6.3	0	0	0	0	100
4	Total	35	27	57	4	0	0	0	123
	Pct.	28.5	22	46.3	3.3	0	0	0	100
5	Total	14	15	21	30	1	0	0	81
	Pct.	17.3	18.5	25.9	37	1.2	0	0	100
6	Total	2	2	3	9	10	0	0	26
	Pct.	7.7	7.7	11.5	34.6	38.5	0	0	100
7	Total	1	1	2	2	1	2	0	9
	Pct.	11.1	11.1	22.2	22.2	11.1	22.2	0	100
8	Total	0	0	0	3	0	0	0	3
	Pct.	0	0	0	100	0	0	0	100
9	Total	0	0	0	1	0	0	1	2
	Pct.	0	0	0	50	0	0	50	100
10	Total	0	0	0	0	1	0	0	1
	Pct.	0	0	0	0	100	0	0	100

PERSONS PER HOUSEHOLD VS. OUT OF AREA VACATIONERS PER HOUSEHOLD

PERSONS PER HOUSEHOLD		NUMBER OF DAYS PER SUMMER					
		0	1-5	6-10	11-15	16+	TOTAL
1	Total	28	3	6	11	12	60
	Pct.	46.7	5	10	18.3	20	100
2	Total	56	17	31	31	22	157
	Pct.	35.7	10.8	19.7	19.7	14	100
3	Total	25	16	25	29	11	106
	Pct.	23.6	15.1	23.6	27.4	10.4	100
4	Total	28	11	27	33	17	116
	Pct.	24.1	9.5	23.3	28.4	14.7	100
5	Total	23	11	21	17	5	77
	Pct.	29.9	14.3	27.3	22.1	6.5	100
6	Total	10	3	7	2	3	25
	Pct.	40	12	28	8	12	100
7	Total	2	3	2	0	2	9
	Pct.	22.2	33.3	22.2	0	22.2	100
8	Total	1	0	2	0	0	3
	Pct.	33.3	0	66.7	0	0	100
9	Total	2	0	0	0	0	2
	Pct.	100	0	0	0	0	100
10	Total	0	0	0	1	0	1
	Pct.	0	0	0	100	0	100

PERSONS PER HOUSEHOLD VS. COMMUTERS PER HOUSEHOLD

PERSONS PER HOUSEHOLD		NUMBER OF COMMUTERS PER HOUSEHOLD					
		0	1	2	3	4	TOTAL
1	Total	40	25	1	0	0	66
	Pct.	60.6	37.9	1.5	0	0	100
2	Total	63	52	61	0	0	176
	Pct.	35.8	29.5	34.7	0	0	100
3	Total	9	53	40	10	0	112
	Pct.	8	47.3	35.7	8.9	0	100
4	Total	7	64	37	12	3	123
	Pct.	5.7	52	30.1	9.8	2.4	100
5	Total	9	30	28	7	6	80
	Pct.	11.3	37.5	35	8.8	7.5	100
6	Total	2	11	8	3	2	26
	Pct.	7.7	42.3	30.8	11.5	7.7	100
7	Total	0	3	3	0	2	8
	Pct.	0	37.5	37.5	0	25	100
8	Total	0	2	1	0	0	3
	Pct.	0	66.7	33.3	0	0	100
9	Total	0	1	0	1	0	2
	Pct.	0	50	0	50	0	100
10	Total	0	0	0	0	1	1
	Percent	0	0	0	0	100	100

COMMUTER TRAVEL TIMES BETWEEN WORK (SCHOOL) AND HOME

TIME RANGE (IN MINUTES)	NUMBER OF COMMUTERS	PERCENT OF COMMUTERS
1-5	88	11.7
6-10	99	13.1
11-15	82	10.9
16-20	81	10.8
21-25	28	3.7
26-30	64	8.5
31-35	25	3.3
36-40	33	4.4
41-45	68	9
46-50	15	2
51-55	4	0.5
56-60	68	9
61-75	27	3.6
76-90	32	4.2
91-105	5	0.7
106-120	6	0.8
121+	3	0.4
Varies	0	0
Unknown	25	3.3
Totals	753	100

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	16	16.2
6-10	12	12.1
11-15	10	10.1
16-20	9	9.1
21-25	7	7.1
26-30	13	13.1
31-35	1	1
36-40	4	4
41-45	3	3
46-50	4	4
51-55	0	0
56-60	4	4
61-75	6	6.1
76-90	4	4
91-105	1	1
106-120	0	0
121+	0	0
Varies	0	0
Unknown	5	5.1
Totals	99	100

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	49	11.5
6-10	49	11.5
11-15	44	10.3
16-20	47	11.0
21-25	15	3.5
26-30	36	8.4
31-35	15	3.5
36-40	21	4.9
41-45	41	9.6
46-50	10	2.3
51-55	1	0.2
56-60	44	10.3
61-75	14	3.3
76-90	16	3.7
91-105	1	0.2
106-120	5	1.2
121+	3	0.7
Varies	0	0.0
Unknown	16	3.7

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	15	10.1
6-10	29	19.6
11-15	15	10.1
16-20	17	11.5
21-25	5	3.4
26-30	11	7.4
31-35	4	2.7
36-40	4	2.7
41-45	13	8.8
46-50	0	0.0
51-55	3	2.0
56-60	16	10.8
61-75	4	2.7
76-90	7	4.7
91-105	1	0.7
106-120	1	0.7
121+	0	0.0
Varies	0	0.0
Unknown	3	2.0

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	8	10.3
6-10	9	11.5
11-15	13	16.7
16-20	8	10.3
21-25	1	1.3
26-30	4	5.1
31-35	5	6.4
36-40	4	5.1
41-45	10	12.8
46-20	1	1.3
51-55	0	0.0
56-60	4	5.1
61-75	4	5.1
76-90	4	5.1
91-105	2	2.6
106-120	0	0.0
121+	0	0.0
Varies	0	0.0
Unknown	1	1.3

CARS PER HOUSEHOLD VS COMMUTERS PER HOUSEHOLD

CARS PER HOUSEHOLD		NUMBER OF COMMUTERS PER HOUSEHOLD					
		0	1	2	3	4	TOTAL
0	TOTAL:	7	2	0	0	0	9
	Pct.	77.8	22.2	0.0	0.0	0.0	100.0
1	Total	76	64	13	2	0	155
	Pct.	49.0	41.3	8.4	1.3	0.0	100.0
2	Total	39	151	119	10	2	321
	Pct.	12.1	47.0	37.1	3.1	0.6	100.0
3	Total	6	19	36	16	3	80
	Pct.	7.5	23.8	45.0	20.0	3.8	100.0
4	Total	2	5	11	5	9	32
	PCT.	6.3	15.6	34.4	15.6	28.1	100.0

MINIMUM AND MAXIMUM COMMUTER TRAVEL TIMES FOR HOUSEHOLDS WITH 1 COMMUTER(S)

	MINIMUM TIME RANGE		MAXIMUM TIME RANGE	
TIME RANGE (IN MINUTES)	NUMBER OF COMMUTERS	PERCENT OF COMMUTERS	NUMBER OF COMMUTERS	PERCENT OF COMMUTERS
1-5	26	10.8	26	10.8
6-10	20	8.3	20	8.3
11-15	26	10.8	26	10.8
16-20	26	10.8	26	10.8
21-25	11	4.6	11	4.6
26-30	25	10.4	25	10.4
31-35	7	2.9	7	2.9
36-40	19	7.9	19	7.9
41-45	23	9.5	23	9.5
46-50	6	2.5	6	2.5
51-55	1	0.4	1	0.4
56-60	22	9.1	22	9.1
61-75	6	2.5	6	2.5
76-90	11	4.6	11	4.6
91-105	2	0.8	2	0.8
106-120	4	1.7	4	1.7
121+	0	0.0	0	0.0
Varies	0	0.0	0	0.0
Unknown	6	2.5	6	2.5

MINIMUM AND MAXIMUM COMMUTER TRAVEL TIMES FOR HOUSEHOLDS WITH 2 COMMUTER(S)

	MINIMUM TIME RANGE		MAXIMUM TIME RANGE	
TIME RANGE (IN MINUTES)	NUMBER OF COMMUTERS	PERCENT OF COMMUTERS	NUMBER OF COMMUTERS	PERCENT OF COMMUTERS
1-5	40	11.2	11	3.1
6-10	33	9.2	11	3.1
11-15	24	6.7	10	2.6
16-20	27	7.6	14	3.9
21-25	6	1.7	7	2.0
26-30	12	3.4	14	3.9
31-35	6	1.7	7	2.0
36-40	4	1.1	8	2.2
41-45	8	2.2	20	5.6
46-50	1	0.3	5	1.4
51-55	0	0.0	3	0.3
56-60	8	2.2	26	7.3
61-75	3	0.8	11	3.1
76-90	5	1.4	13	3.6
91-105	0	0.0	2	0.6
106-120	0	0.0	2	0.6
121+	0	0.0	2	0.6
Varies	0	0.0	0	0.0
Unknown	2	0.6	13	3.6

MINIMUM AND MAXIMUM COMMUTER TRAVEL TIMES FOR HOUSEHOLDS WITH 3 COMMUTER(S)

	MINIMUM TIME RANGE		MAXIMUM TIME RANGE	
TIME RANGE (IN MINUTES)	NUMBER OF COMMUTERS	PERCENT OF COMMUTERS	NUMBER OF COMMUTERS	PERCENT OF COMMUTERS
1-5	8	8.3	0	0.0
6-10	10	10.4	2	2.1
11-15	6	6.3	3	3.1
16-20	2	2.1	5	6.2
21-25	2	2.1	0	0.0
26-30	2	2.1	0	0.0
31-35	0	0.0	1	1.0
36-40	0	0.0	1	1.0
41-45	2	2.1	7	7.3
46-50	0	0.0	1	1.0
51-55	0	0.0	0	0.0
56-60	1	1.0	7	7.3
61-75	0	0.0	4	4.2
76-90	0	0.0	0	0.0
91-105	0	0.0	0	0.0
106-120	0	0.0	0	0.0
121+	0	0.0	1	1.0
Varies	0	0.0	0	0.0
Unknown	0	0.0	1	1.0

MINIMUM AND MAXIMUM COMMUTER TRAVEL TIMES FOR HOUSEHOLDS WITH 4 COMMUTER(S)

	MINIMUM TIME RANGE		MAXIMUM TIME RANGE	
TIME RANGE (IN MINUTES)	NUMBER OF COMMUTERS	PERCENT OF COMMUTERS	NUMBER OF COMMUTERS	PERCENT OF COMMUTERS
1-5	1	1.8	0	0.0
6-10	7	12.5	2	3.6
11-15	3	5.4	0	0.0
16-20	2	3.6	1	1.8
21-25	0	0.0	1	1.3
26-30	0	0.0	2	3.6
31-35	0	0.0	1	1.3
36-40	0	0.0	0	0.0
41-45	1	1.8	1	1.8
46-50	0	0.0	0	0.0
51-55	0	0.0	0	0.0
56-60	0	0.0	0	0.0
61-75	0	0.0	2	3.6
76-90	0	0.0	2	3.6
91-105	0	0.0	1	1.3
106-120	0	0.0	0	0.0
121+	0	0.0	0	0.0
Unknown	0	0.0	1	1.8

COMMUTER PREPARATION TIMES FOR LEAVING WORK (SCHOOL)

TIME RANGE (IN MINUTES)	NUMBER OF COMMUTERS	PERCENT OF COMMUTERS
1-5	368	49.1
6-10	104	13.9
11-15	61	8.1
16-20	19	2.5
21-25	3	0.4
26-30	55	7.3
31-35	3	0.4
36-40	2	0.3
41-45	16	2.1
46-50	2	0.3
51-55	0	0.0
56-60	12	1.6
61-75	3	0.4
76-90	0	0.0
91-105	7	0.9
106-120	1	0.1
121+	1	0.1
Varies	0	0.0
Unknown	93	12.4

HOME PACKING TIMES NEEDED TO PREPARE FOR DEPARTURE

TIME RANGE (IN MINUTES)	NUMBER OF HOUSEHOLDS	PERCENT OF HOUSEHOLDS
1-15	152	25.3
16-30	160	26.7
31-45	38	6.3
46-60	61	10.2
61-75	37	6.2
76-90	7	1.2
91-105	1	0.2
106-120	14	2.3
121-135	20	3.3
136-150	0	0.0
151-165	2	0.3
166-180	4	0.7
181-195	3	0.5
196-210	0	0.0
211-225	0	0.0
226-240	3	0.5
241-255	2	0.3
256-270	2	0.3
271-285	0	0.0
286-300	0	0.0
301-315	1	0.2
316-330	0	0.0
331-345	1	0.2
346-360	5	0.8
Unknown	87	14.5

CARS PER HOUSEHOLD VS SCHOOL CHILDREN PER HOUSEHOLD

CARS PER HOUSEHOLD		NUMBER OF SCHOOL CHILDREN PER HOUSEHOLD							
		0	1	2	3	4	5	6	TOTAL
0	Total	9	0	0	0	0	0	0	9
	Pct.	100.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
1	Total	126	10	11	7	0	1	0	155
	Pct.	81.3	6.5	7.1	4.5	0.0	0.6	0.0	100.0
2	Total	160	61	63	28	8	0	1	321
	Pct.	49.8	19.0	19.6	8.7	2.5	0.0	0.0	100.0
3	Total	34	20	12	11	3	0	0	80
	Pct.	42.5	25.0	15.0	13.8	3.8	0.0	0.0	100.0
4	Total	18	7	4	3	2	1	0	35
	Pct.	51.4	20.0	11.4	8.6	5.7	2.9	0.0	100.0

SNOW CLEARANCE TIMES

TIME RANGE (IN MINUTES)	NUMBER OF HOUSEHOLDS	PERCENT OF HOUSEHOLDS
1-15	149	24.8
16-30	113	18.8
31-45	48	8.0
46-60	54	9.0
61-75	51	8.5
76-90	25	4.2
91-105	9	1.5
106-120	9	1.5
121-135	14	2.3
136-150	2	0.3
151-165	2	0.3
166-180	10	1.7
181-195	34	5.7
Unknown	80	13.3

Number of Commuters Working within EPZ = 309
Total Number of Commuters = 753

SURVEY SCALE FACTORS

TOWN	SURVEY SAMPLE POPULATION	1999 EST. POPULATION	SURVEY SCALE FACTOR
Plymouth	1,163	50,262	43.22
Kingston	244	11,235	46.05
Carver	121	6,411	52.98
Duxbury	396	14,768	37.29

APPENDIX H

Census Data

Town	1990 Census Population Within EPZ
Plymouth	45,608
Kingston	9,045
Carver (58%)	6,142
Duxbury	14,168
Marshfield (8%)	1,722

Plymouth

P5. HOUSEHOLDS(1)
UNIVERSE: Households

Total	15,889
1 person	3,174
2 persons	4,858
3 persons	2,837
4 persons	3,073
5 persons	1,386
6 persons	423
7 or more persons	138

P49. MEANS OF TRANSPORTATION TO WORK(13)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	17,285
Carpooled	2,411
Public transportation:	
Bus or trolley bus	436
Streetcar or trolley car	0
Subway or elevated	43
Railroad	5
Ferryboat	0
Taxicab	0
Motorcycle	0
Bicycle	20
Walked	598
Other means	184
Worked at home	537

P53. PRIVATE VEHICLE OCCUPANCY(8)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	17,285
In 2-person carpool	1,993
In 3-person carpool	273
In 4-person carpool	47
In 5-person carpool	19
In 6-person carpool	5
In 7-or-more person carpool	74
Other means	1,823

P79. CLASS OF WORKER(7)
UNIVERSE: Employed persons 16 years and over

Private for profit wage and salary workers	15,873
Private not-for-profit wage and salary workers	1,473
Local government workers	1,899
State government workers	641
Federal government workers	458
Self-employed workers	1,534
Unpaid family workers	43

P77. INDUSTRY(17)
UNIVERSE: Employed persons 16 years and over

Agriculture, forestry, and fisheries (000-039)	364
Mining (040-059)	16
Construction (060-099)	1,781
Manufacturing, nondurable goods (100-229)	1,180
Manufacturing, durable goods (230-399)	1,304
Transportation (400-439)	1,002
Communications and other public utilities (440-499)	900
Wholesale trade (500-579)	911
Retail trade (580-699)	4,411
Finance, insurance, and real estate (700-720)	1,962
Business and repair services (721-760)	911
Personal services (761-799)	648
Entertainment and recreation services (800-811)	301
Professional and related services (812-899):	
Health services (812-840)	2,259
Educational services (842-860)	1,490
Other professional and related services (841, 861-899)	1,388
Public administration (900-939)	1,093

P78. OCCUPATION(13)
UNIVERSE: Employed persons 16 years and over

Managerial and professional specialty occupations (000-202):	
Executive, administrative, and managerial occupations (000-042)	2,783
Professional specialty occupations (043-202)	3,081
Technical, sales, and administrative support occupations (203-402):	
Technicians and related support occupations (203-242)	821
Sales occupations (243-302)	3,326
Administrative support occupations, including clerical (303-402)	3,692
Service occupations (403-472):	
Private household occupations (403-412)	45
Protective service occupations (413-432)	577
Service occupations, except protective and household (433-472)	2,485
Farming, forestry, and fishing occupations (473-502)	327
Precision production, craft, and repair occupations (503-702)	2,497
Operators, fabricators, and laborers (703-902):	
Machine operators, assemblers, and inspectors (703-802)	771
Transportation and material moving occupations (803-863)	877
Handlers, equipment cleaners, helpers, and laborers (864-902)	639

Kingston

P5. HOUSEHOLDS(1)
UNIVERSE: Households

Total	3,245
1 person	644
2 persons	1,055
3 persons	570
4 persons	596
5 persons	286
6 persons	69
7 or more persons	25

P49. MEANS OF TRANSPORTATION TO WORK(13)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	3,725
Carpooled	504
Public transportation:	
Bus or trolley bus	127
Streetcar or trolley car	7
Subway or elevated	6
Railroad	0
Ferryboat	0
Taxicab	0
Motorcycle	0
Bicycle	0
Walked	49
Other means	66
Worked at home	170

P53. PRIVATE VEHICLE OCCUPANCY(8)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	3,725
In 2-person carpool	412
In 3-person carpool	45
In 4-person carpool	8
In 5-person carpool	0
In 6-person carpool	0
In 7-or-more person carpool	39
Other means	425

P79. CLASS OF WORKER(7)
UNIVERSE: Employed persons 16 years and over

Private for profit wage and salary workers	3,369
Private not-for-profit wage and salary workers	334
Local government workers	438
State government workers	79
Federal government workers	98
Self-employed workers	371
Unpaid family workers	15

P77. INDUSTRY(17)
UNIVERSE: Employed persons 16 years and over

Agriculture, forestry, and fisheries (000-039)	95
Mining (040-059)	5
Construction (060-099)	409
Manufacturing, nondurable goods (100-229)	285
Manufacturing, durable goods (230-399)	353
Transportation (400-439)	172
Communications and other public utilities (440-499)	222
Wholesale trade (500-579)	234
Retail trade (580-699)	972
Finance, insurance, and real estate (700-720)	379
Business and repair services (721-760)	207
Personal services (761-799)	101
Entertainment and recreation services (800-811)	28
Professional and related services (812-899):	
Health services (812-840)	373
Educational services (842-860)	322
Other professional and related services (841, 861-899)	301
Public administration (900-939)	246

P78. OCCUPATION(13)
UNIVERSE: Employed persons 16 years and over

Managerial and professional specialty occupations (000-202):	
Executive, administrative, and managerial occupations (000-042)	656
Professional specialty occupations (043-202)	510
Technical, sales, and administrative support occupations (203-402):	
Technicians and related support occupations (203-242)	139
Sales occupations (243-302)	603
Administrative support occupations, including clerical (303-402)	763
Service occupations (403-472):	
Private household occupations (403-412)	23
Protective service occupations (413-432)	136
Service occupations, except protective and household (433-472)	547
Farming, forestry, and fishing occupations (473-502)	80
Precision production, craft, and repair occupations (503-702)	701
Operators, fabricators, and laborers (703-902):	
Machine operators, assemblers, and inspectors (703-802)	199
Transportation and material moving occupations (803-863)	183
Handlers, equipment cleaners, helpers, and laborers (864-902)	164

Carver

P5. HOUSEHOLDS(1)
UNIVERSE: Households

Total	3,551
1 person	602
2 persons	1,061
3 persons	576
4 persons	739
5 persons	429
6 persons	117
7 or more persons	27

P49. MEANS OF TRANSPORTATION TO WORK(13)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	4,029
Carpooled	452
Public transportation:	
Bus or trolley bus	26
Streetcar or trolley car	0
Subway or elevated	5
Railroad	0
Ferryboat	0
Taxicab	0
Motorcycle	0
Bicycle	0
Walked	18
Other means	42
Worked at home	115

P53. PRIVATE VEHICLE OCCUPANCY(8)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	4,029
In 2-person carpool	393
In 3-person carpool	27
In 4-person carpool	23
In 5-person carpool	0
In 6-person carpool	0
In 7-or-more person carpool	9
Other means	206

P79. CLASS OF WORKER(7)
UNIVERSE: Employed persons 16 years and over

Private for profit wage and salary workers	3,472
Private not-for-profit wage and salary workers	253
Local government workers	450
State government workers	183
Federal government workers	121
Self-employed workers	252
Unpaid family workers	9

P77. INDUSTRY(17)
UNIVERSE: Employed persons 16 years and over

Agriculture, forestry, and fisheries (000-039)	176
Mining (040-059)	25
Construction (060-099)	318
Manufacturing, nondurable goods (100-229)	287
Manufacturing, durable goods (230-399)	420
Transportation (400-439)	236
Communications and other public utilities (440-499)	202
Wholesale trade (500-579)	122
Retail trade (580-699)	945
Finance, insurance, and real estate (700-720)	365
Business and repair services (721-760)	228
Personal services (761-799)	142
Entertainment and recreation services (800-811)	23
Professional and related services (812-899):	
Health services (812-840)	409
Educational services (842-860)	353
Other professional and related services (841, 861-899)	225
Public administration (900-939)	264

P78. OCCUPATION(13)
UNIVERSE: Employed persons 16 years and over

Managerial and professional specialty occupations (000-202):	
Executive, adZpi hrative, and managerial occupations (000-042)	596
Professional specialty occupations (043-202)	389
Technical, sales, and administrative support occupations (203-402):	
Technicians and related support occupations (203-242)	258
Sales occupations (243-302)	507
Administrative support occupations, including clerical (303-402)	928
Service occupations (403-472):	
Private household occupations (403-412)	6
Protective service occupations (413-432)	121
Service occupations, except protective and household (433-472)	565
Farming, forestry, and fishing occupations (473-502)	90
Precision production, craft, and repair occupations (503-702)	710
Operators, fabricators, and laborers (703-902):	
Machine operators, assemblers, and inspectors (703-802)	255
Transportation and material moving occupations (803-863)	179
Handlers equipment cleaners, helpers, and laborers (864-902)	136

Duxbury

P5. HOUSEHOLDS(1)
UNIVERSE: Households

Total	4,643
1 person	707
2 persons	1,336
3 persons	870
4 persons	1,064
5 persons	478
6 persons	158
7 or more persons	30

P49. MEANS OF TRANSPORTATION TO WORK(13)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	5,377
Carpooled	538
Public transportation:	
Bus or trolley bus	165
Streetcar or trolley car	0
Subway or elevated	62
Railroad	0
Ferryboat	0
Taxicab	0
Motorcycle	19
Bicycle	35
Walked	103
Other means	84
Worked at home	367

P53. PRIVATE VEHICLE OCCUPANCY(8)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	5,377
In 2-person carpool	465
In 3-person carpool	28
In 4-person carpool	0
In 5-person carpool	0
In 6-person carpool	0
In 7-or-more person carpool	45
Other means	835

P79. CLASS OF WORKER(7)
UNIVERSE: Employed persons 16 years and over

Private for profit wage and salary workers	4,607
Private not-for-profit wage and salary workers	586
Local government workers	718
State government workers	123
Federal government workers	64
Self-employed workers	699
Unpaid family workers	62

P77. INDUSTRY(17)
UNIVERSE: Employed persons 16 years and over

Agriculture, forestry, and fisheries (000-039)	124
Mining (040-059)	0
Construction (060-099)	402
Manufacturing, nondurable goods (100-229)	385
Manufacturing, durable goods (230-399)	380
Transportation (400-439)	192
Communications and other public utilities (440-499)	191
Wholesale trade (500-579)	354
Retail trade (580-699)	1,068
Finance, insurance, and real estate (700-720)	959
Business and repair services (721-760)	364
Personal services (761-799)	128
Entertainment and recreation services (800-811)	186
Professional and related services (812-899):	
Health services (812-840)	551
Educational services (842-860)	789
Other professional and related services (841, 861-899)	574
Public administration (900-939)	212

P78. OCCUPATION(13)
UNIVERSE: Employed persons 16 years and over

Managerial and professional specialty occupations (000-202):	
Executive, administrative, and managerial occupations (000-042)	1,526
Professional specialty occupations (043-202)	1,488
Technical, sales, and administrative support occupations (203-402):	
Technicians and related support occupations (203-242)	165
Sales occupations (243-302)	1,390
Administrative support occupations, including clerical (303-402)	899
Service occupations (403-472):	
Private household occupations (403-412)	16
Protective service occupations (413-432)	117
Service occupations, except protective and household (433-472)	339
Farming, forestry, and fishing occupations (473-502)	128
Precision production, craft, and repair occupations (503-702)	481
Operators, fabricators, and laborers (703-902):	
Machine operators, assemblers, and inspectors (703-802)	142
Transportation and material moving occupations (803-863)	111
Handlers, equipment cleaners, helpers, and laborers (864-902)	57

Marshfield

P5. HOUSEHOLDS(1)
UNIVERSE: Households

Total	7,530
1 person	1,442
2 persons	2,138
3 persons	1,422
4 persons	1,502
5 persons	727
6 persons	233
7 or more persons	66

P49. MEANS OF TRANSPORTATION TO WORK(13)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	9,241
Carpooled	1,305
Public transportation:	
Bus or trolley bus	140
Streetcar or trolley car	0
Subway or elevated	79
Railroad	0
Ferryboat	41
Taxicab	5
Motorcycle	0
Bicycle	26
Walked	140
Other means	18
Worked at home	371

P53. PRIVATE VEHICLE OCCUPANCY(8)
UNIVERSE: Workers 16 years and over

Car, truck, or van:	
Drove alone	9,241
In 2-person carpool	1,101
In 3-person carpool	74
In 4-person carpool	39
In 5-person carpool	13
In 6-person carpool	14
In 7-or-more person carpool	64
Other means	820

P79. CLASS OF WORKER(7)
UNIVERSE: Employed persons 16 years and over

Private for profit wage and salary workers	8,123
Private not-for-profit wage and salary workers	683
Local government workers	1,012
State government workers	414
Federal government workers	335
Self-employed workers	919
Unpaid family workers	26

P77. INDUSTRY(17)
UNIVERSE: Employed persons 16 years and over

Agriculture, forestry, and fisheries (000-039)	184
Mining (040-059)	0
Construction (060-099)	787
Manufacturing, nondurable goods (100-229)	536
Manufacturing, durable goods (230-399)	630
Transportation (400-439)	538
Communications and other public utilities (440-499)	452
Wholesale trade (500-579)	708
Retail trade (580-699)	2,167
Finance, insurance, and real estate (700-720)	1,268
Business and repair services (721-760)	489
Personal services (761-799)	219
Entertainment and recreation services (800-811)	97
Professional and related services (812-899):	
Health services (812-840)	1,026
Educational services (842-860)	905
Other professional and related services (841, 861-899)	859
Public administration (900-939)	631

P78. OCCUPATION(13)
UNIVERSE: Employed persons 16 years and over

Managerial and professional specialty occupations (000-202):	
Executive, administrative, and managerial occupations (000-042)	1,955
Professional specialty occupations (043-202)	2,016
Technical, sales, and administrative support occupations (203-402):	
Technicians and related support occupations (203-242)	416
Sales occupations (243-302)	1,937
Administrative support occupations, including clerical (303-402)	1,792
Service occupations (403-472):	
Private household occupations (403-412)	13
Protective service occupations (413-432)	261
Service occupations, except protective and household (433-472)	953
Farming, forestry, and fishing occupations (473-502)	149
Precision production, craft, and repair occupations (503-702)	1,150
Operators, fabricators, and laborers (703-902):	
Machine operators, assemblers, and inspectors (703-802)	298
Transportation and material moving occupations (803-863)	285
Handlers, equipment cleaners, helpers, and laborers (864-902)	287

APPENDIX I

TRAFFIC AND ACCESS CONTROL

SUMMARY

BY

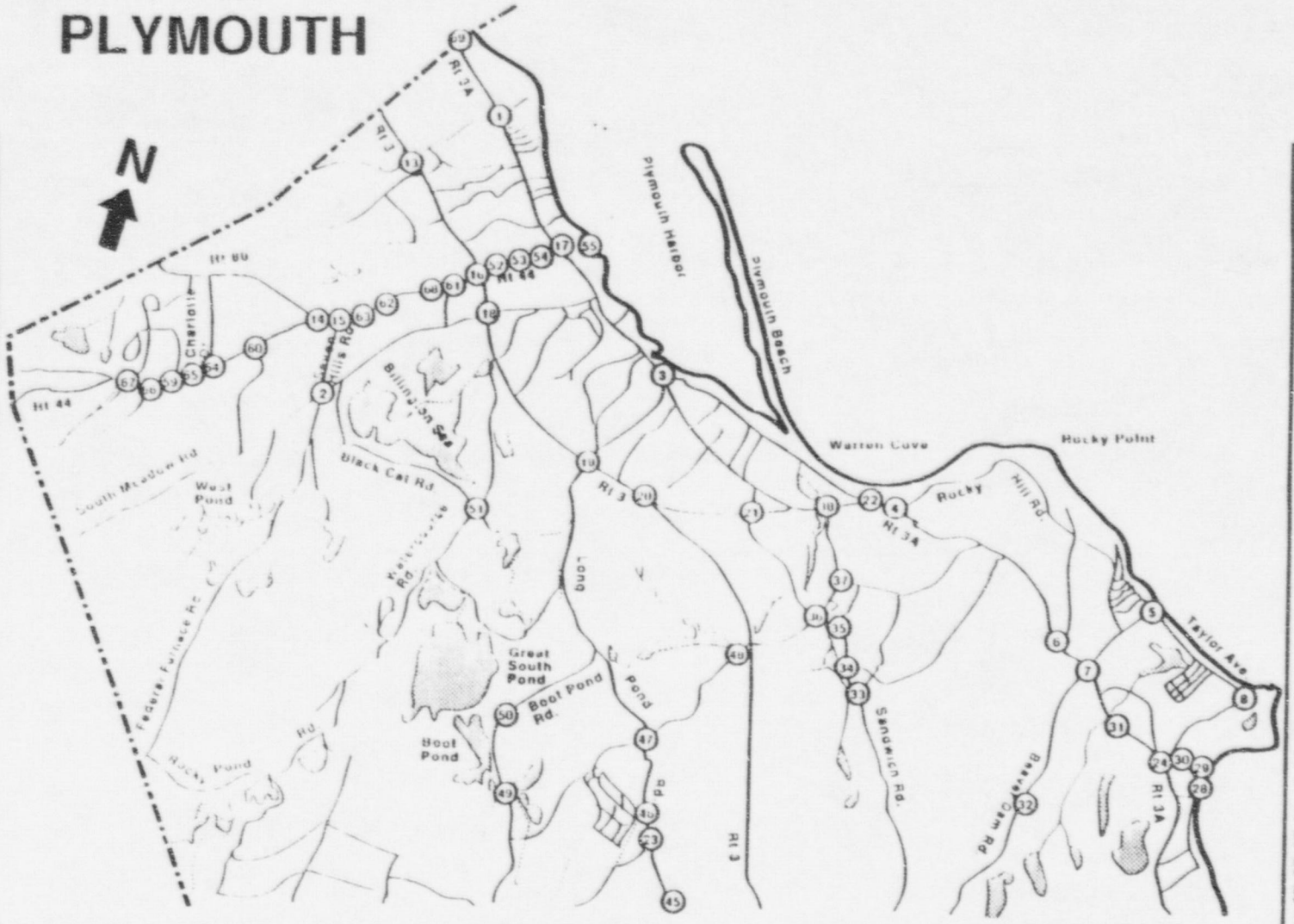
TOWN

Index to Traffic and Access Control Tables

	Sketches	Traffic & Access Control Maps	Location, Manpower & Equipment Summary	Access Control Allocation
Plymouth	I-P-10 through I-P-89	I-P-2,3	I-P-4	I-P-8
Myles Standish State Forest	I-MS-5 through I-MS-19	I-MS-2	I-MS-3	I-MS-4
Kingston	I-K-5 through I-K-33	I-K-2	I-K-3	I-K-4
Carver	I-C-5 through I-C-22	I-C-2	I-C-3	I-C-4
Duxbury	I-D-5 through I-D 18	I-D-2	I-D-3	I-D-4
Marshfield	I-M-5 through I-M-21	I-M-2	I-M-3	I-M-4
Route 3	I-RT3-4 through I-RT3-7	--	I-RT3-2	I-RT3-3
Pembroke	I-PE-5 through I-PE-12	I-PE-2	I-PE-3	I-PE-4
Plympton	I-PP-5 through I-PP-7	I-PP-2	I-PP-3	I-PP-4
Wareham	I-WA-5 through I-WA-10	I-WA-2	I-WA-3	I-WA-4
Bourne	I-BO-5 through I-BO-10	I-BO-2	I-BO-3	I-BO-4
Sandwich	I-SA-4	--	I-SA-2	I-SA-3

PLYMOUTH

PLYMOUTH



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CONTROL POINTS
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2 = P-T-02
3 = P-T-03
4 = P-T-04
5 = P-T-05
6 = P-T-06
7 = P-T-07
8 = P-T-08
9 = P-T-09
10= P-T-10
11= P-T-11
12= P-T-12
13= P-AT-13
14= P-AT-14
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LEGEND
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69= P-A-69

PLYMOUTH

LEGEND
CONTROL POINTS
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2 = P-T-02
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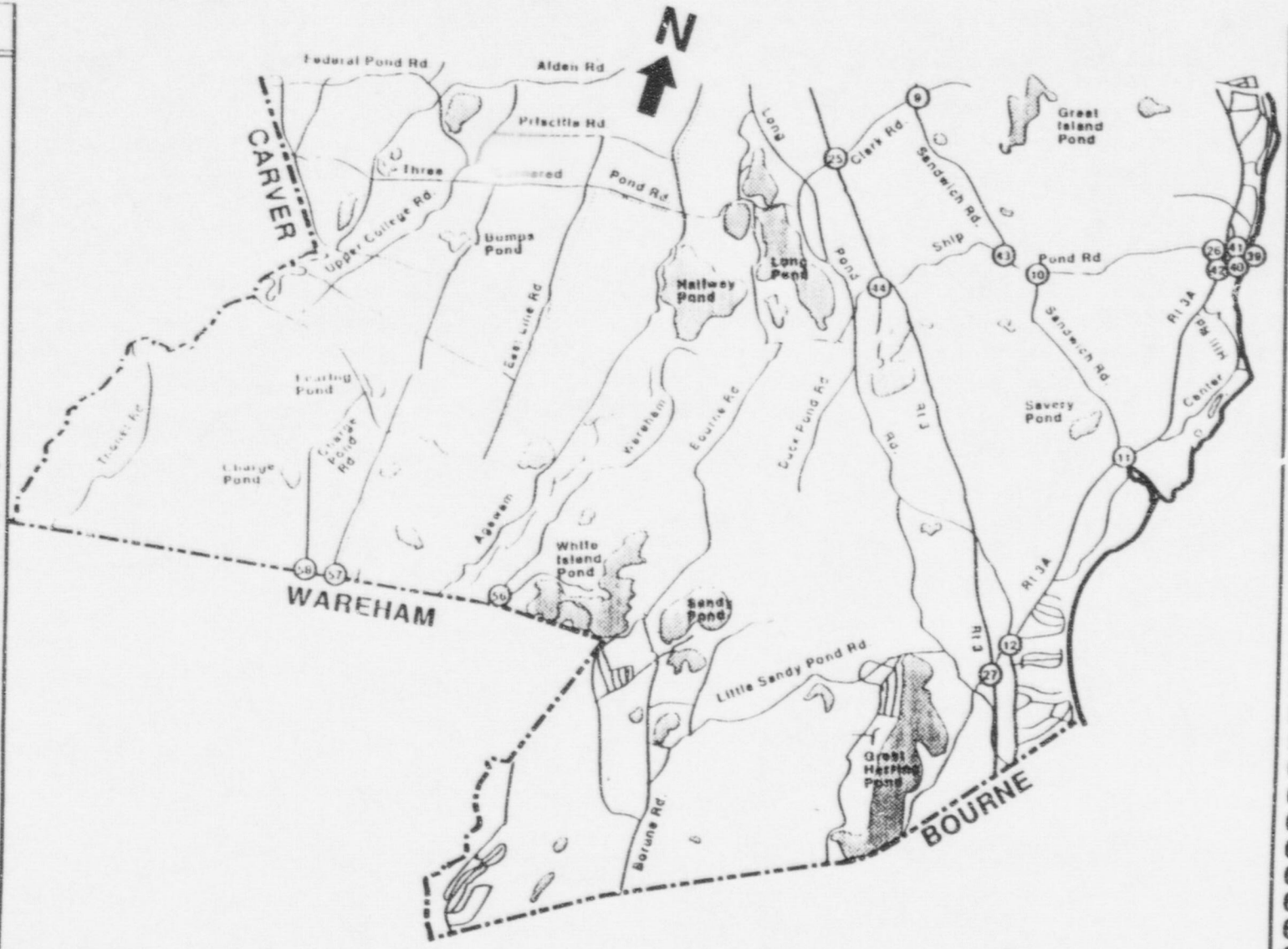

LEGEND
CONTROL POINTS
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38= P-A-38
39= P-A-39
40= P-A-40
41= P-A-41
42= P-A-42
43= P-A-43
44= P-A-44
45= P-A-45
46= P-A-46
47= P-A-47
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61= P-A-61
62= P-A-62
63= P-A-63
64= P-A-64
65= P-A-65
66= P-A-66
67= P-A-67
68= P-A-68
69= P-A-69

Table I-P-1. Location, Manpower, and Equipment Requirements for All Traffic and Access Control Points

TOWN: Plymouth

ACP	Location	Agency Priority	Guides	Cones	Barricades	Lights
P-T-01	Rte. 3A & Cherry St.	P-3	1	3		1
P-T-02	Federal Furnace Rd. & South Meadow Rd.	P-3	2	6	2	2
P-T-03	Obery St. & Rte. 3A	P-2	1	2	1	1
P-T-04	Rocky Hill Rd. & Rte. 3A	P-1	1	6		2
P-T-05	Whitehorse Rd. & Robbins Hill Rd.	P-1	1	3		1
P-T-06	Rte. 3A & PNPS Access	P-1	1	9	3	4
P-T-07	Whitehorse Rd. & Rte. 3A	P-1	1	6		2
P-T-08	Taylor Ave. & Manomet Point Road	P-1	1	6	3	3
P-T-09	Old Sandwich Rd. & Beaver Dam Rd.	P-3	1	6		2
P-T-10	Old Sandwich Rd. & Ship Pond Rd.	P-3	1	3		1
P-T-11	Old Sandwich Rd. & Rte. 3A	P-2	1	6		2
P-T-12	Rte. 3A & Herring Pond Rd.	P-2	1	4	2	2
P-AT-13A	Rte. 3 & Cherry St.,Exit 7	S-2	1	2	7	7
P-AT-13B	Rte. 3 & Cherry St.,Exit 7	S-2	1	2	7	7
P-AT-14A	Rte. 44 & Rte. 80	P-3	1	2	1	1
P-AT-14B	Rte. 44 & Rte. 80	P-3	1	2	1	1
P-AT-15A	Rte. 44 & Seven Hills Rd.	P-1	2	8	2	5
P-AT-15B	Rte. 44 & Seven Hills Rd.	P-1	2	6	2	5
P-AT-16A	Rte. 3 & Rte. 44	S-1	2	2	10	5
P-AT-16B	Rte. 3 & Rte. 44	S-2	2	2	9	5
P-AT-17	Rte. 3A & Rte. 44	S-2	1	4	2	2

Table I-P-1. Location, Manpower, and Equipment Requirements for All Traffic and Access Control Points (cont.)

TOWN: Plymouth (cont.)

ACP	Location	Agency Priority	Guides	Cones	Barricades	Lights
P-AT-18	Summer St. & Westerly Rd.	P-3	1	4	2	2
P-AT-19A	Rte. 3 & Long Pond Rd.	S-2	2	5	1	2
P-AT-19B	Rte. 3 & Long Pond Rd.	S-2	2	2	1	2
P-AT-20	Rte. 3 & "M" Rd.	S-2	1	20		6
P-AT-21A	"M" Rd. & Sandwich Rd.	P-2	1	4	8	8
P-AT-21B	"M" Rd. & Sandwich Rd.	P-2	1	1	8	9
P-AT-22A	"M" Rd. & Rte. 3A	S-2	2	4	2	2
P-AT-22B	"M" Rd. & Rte. 3A	S-2	2	8	4	4
P-AT-23A	Alden Rd. & Long Pond Rd.	P-2	1	2	1	1
P-AT-23B	Alden Rd. & Long Pond Rd.	P-2	1	2	1	1
P-AT-23C	Alden Rd. & Long Pond Rd.	P-2	1	4	2	2
P-AT-24	Rte. 3A & Manomet Pt. Rd.	P-1	1	4	2	2
P-AT-25	Rte. 3 & Clark Rd.	S-2	1	2	7	7
P-AT-26	State Rd. (Rte.3A) & Ship Pond Rd.	P-2	1	2	1	1
P-AT-27	Rte. 3 & Herring Pond Rd., Exit 2	S-2	1	2	7	7
P-A-28	Strand Ave. & Manomet Ave.	P-4		2	1	1
P-A-29	Strand Ave. & Holmes Rd.	P-4		2	1	1
P-A-30	Strand Ave. & Thrush Ave.	P-4		2	1	1
P-A-31	Bartlett Rd. & Presidents La.	P-3	1	2	1	1
P-A-32	Beaver Dam Rd. & Tideview Path	P-3	1	2	1	1
P-A-33	Sandwich Rd. & Cathedral Rd.	P-4		2	1	1

Table I-P-1. Location, Manpower, and Equipment Requirements for All Traffic and Access Control Points (cont.)

TOWN: Plymouth (cont.)

ACP	Location	Agency Priority	Guides	Cones	Barricades	Lights
P-A-34	Sandwich Rd. & Cathedral Rd.	P-4		2	1	1
P-A-35	Sandwich Rd. & Flowery La.	P-4		2	1	1
P-A-36A	Jordan Rd. & Sandwich Rd.	P-4		4	2	2
P-A-36B	Jordan Rd. & Sandwich Rd.	P-4		4	2	2
P-A-37	Clifford Rd. & Doten Rd.	P-4		4	2	2
P-A-38	River St. Extention & Clifford Rd.	P-4		4	2	2
P-A-39	Mayflower Dr. & Shore Dr.	P-4		2	1	1
P-A-40	Mayflower Dr. & Hillside Dr.	P-4		2	1	1
P-A-41	Mayflower Ave. & Silver Birch Ave.	P-4		2	1	1
P-A-42	Nautilus Pa. & West Wind St.	P-4		2	1	1
P-A-43	Old Sandwich Rd. & Ship Pond Rd.	P-4		2	1	1
P-A-44	Ship Pond Rd. & Bloody Pond Rd.	P-4		2	1	1
P-A-45	Long Pond Rd. & Bump Rock Rd.	P-4		2	1	1
P-A-46	Long Pond Rd. & Marion Way	P-4		2	1	1
P-A-47	Long Pond Rd. & Jordan Rd.	P-3	1	2	1	1
P-A-48	Jordan Rd. & Russell Mills Rd.	P-4		2	1	1
P-A-49	College Pond Rd. & Gunners Exchange Rd.	P-3	1	4	2	2

Table I-P-1. Location, Manpower, and Equipment Requirements for All Traffic and Access Control Points (conc.)

TOWN: Plymouth (conc.)

ACP	Location	Agency Priority	Guides	Cones	Barricades	Lights
P-A-50	Boot Pond Rd. & Fuller Farm Rd.	P-4		2	1	1
P-A-51	Black Cat Rd. & Water Course Rd.	P-4		2	1	1
P-A-52	Samoset St. & Chestnut St.	P-4		2	1	1
P-A-53	Samoset St. & Oak St.	P-4		2	1	1
P-A-54	Samoset St. & Allerton St.	P-4		2	1	1
P-A-55	Park Ave. & Water St.	P-4		3	1	2
P-A-56	Old Halfway Pond Rd. & Wareham Rd.	P-4		4	2	2
P-A-57	Maple Springs Rd. & South Line Rd.	P-4		4	2	2
P-A-58	Wampanoag Rd. & South Line Rd.	P-4		4	2	2
P-A-59A	Rte. 44 & Flint Locke Dr.	P-4		2	1	1
P-A-59B	Rte. 44 & Flint Locke Dr.	P-4		2	1	1
P-A-60	Rte. 44 & Montgomery Dr.	P-4		2	1	1
P-A-61	Rte. 44 & Pilgrim Hill Rd.	P-4		2	1	1
P-A-62	Rte. 44 & Seneca La.	P-4		2	1	1
P-A-63	Rte. 44 & No. Triangle Dr.	P-4		2	1	1
P-A-64	Rte. 44 & Charlotte Dr.	P-4		2	1	1
P-A-65	Rte. 44 & Esta Rd. (East of Tavern, PA)	P-4		2	1	1
P-A-66	Rte. 44 & Surrey Dr.	P-4		2	1	1
P-A-67	Rte. 44 & Esta Rd. (West of Surrey Rd.)	P-4		2	1	1
P-A-68	Rte. 44 & Algonquin Terrace	P-4		2	1	1
P-A-69	Route 3A & Cordage Park Entrance	P-1	1	5	1	2

Table I-P-2. Allocation of Access Control Points to Towns

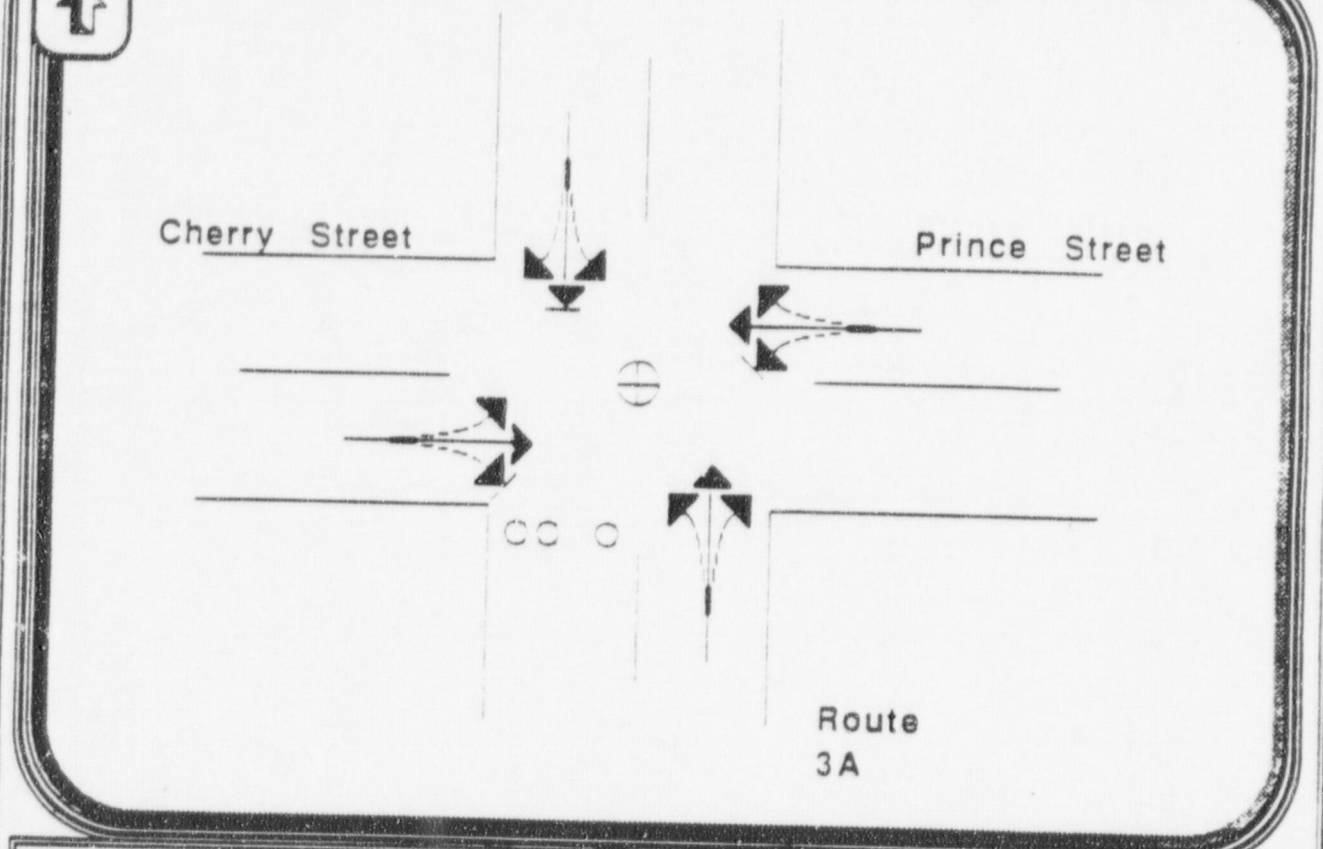
TOWN: Plymouth

ACCESS CONTROL POINT	ACTIVATED FOR FOLLOWING REGIONS:
P-AT-13A	1 through 9, 12 through 22
P-AT-13B	18, 19
P-AT-14B	15, 16, 17
P-AT-15B	8, 9
P-AT-16A	1 through 9, 12, 13, 14, 20, 21, 22
P-AT-16B	15, 16, 17, 18, 19
P-AT-17	3, 4, 5, 8, 9, 18, 21
P-AT-18	3, 4, 5, 15, 16, 17, 18, 21
P-AT-19A	1 through 9, 12 through 18, 20, 21, 22
P-AT-19B	19
P-AT-20	All regions except 10 & 11
P-AT-21A	1 through 9, 12 through 18, 20, 21, 22
P-AT-21B	19
P-AT-22A	1 through 9, 12 through 18, 20, 21, 22
P-AT-22B	19
P-AT-23A	3, 4, 5, 12 through 18, 21
P-AT-23B	2, 7
P-AT-24	1, 4, 5, 6, 12 through 18, 19, 20
P-AT-25	All regions
P-AT-26	2, 3, 10, 11, 21
P-AT-27	All regions
P-A-28	1, 4, 5, 6, 12 through 18, 19, 20
P-A-29	1, 4, 5, 6, 12 through 18, 19, 20
P-A-30	1, 4, 5, 6, 12 through 18, 19, 20
P-A-31	1, 4, 5, 6, 12 through 18, 19, 20
P-A-32	1, 4, 5, 6, 12 through 18, 19, 20
P-A-33	1, 4, 5, 6, 12 through 18, 19, 20
P-A-34	1, 4, 5, 6, 12 through 18, 19, 20
P-A-35	1, 4, 5, 6, 12 through 18, 19, 20
P-A-36A	2, 7
P-A-36B	4, 5, 12 through 18
P-A-37	1, 2, 4, 5, 6, 7, 12 through 18, 19, 20
P-A-38	1, 2, 6, 7, 19, 20
P-A-39	2, 3, 10, 11, 21
P-A-40	2, 3, 10, 11, 21
P-A-41	2, 3, 10, 11, 21
P-A-42	2, 3, 10, 11, 21
P-A-43	2, 3, 10, 11, 21
P-A-44	2, 3, 10, 11, 21
P-A-45	2, 3, 21
P-A-46	4, 5, 12 through 18
P-A-47	4, 5, 12 through 18
P-A-48	4, 5, 12 through 18

Table I-P-2. Allocation of Access Control Points to Towns (conc.)

TOWN: Plymouth

ACCESS CONTROL POINT	ACTIVATED FOR FOLLOWING REGIONS:
P-A-49	3, 4, 5, 15, 16, 17, 18, 21
P-A-50	3, 4, 5, 15, 16, 17, 18, 21
P-A-51	3, 4, 5, 15, 16, 17, 18, 21
P-A-52	3, 4, 5, 8, 9, 18, 21
P-A-53	3, 4, 5, 8, 9, 18, 21
P-A-54	3, 4, 5, 8, 9, 18, 21
P-A-55	3, 4, 5, 8, 9, 18, 21
P-A-56	7, 8, 9, 22
P-A-57	7, 8, 9, 22
P-A-58	7, 8, 9, 22
P-A-59A	8, 9
P-A-59B	15, 16, 17
P-A-60	8, 9
P-A-61	8, 9
P-A-62	15, 16, 17
P-A-63	15, 16, 17
P-A-64	15, 16, 17
P-A-65	15, 16, 17
P-A-66	15, 16, 17
P-A-67	15, 16, 17
P-A-68	15, 16, 17
P-A-69	18



Location:
Route 3A & Cherry Street (Plymouth)

Priority: 3

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

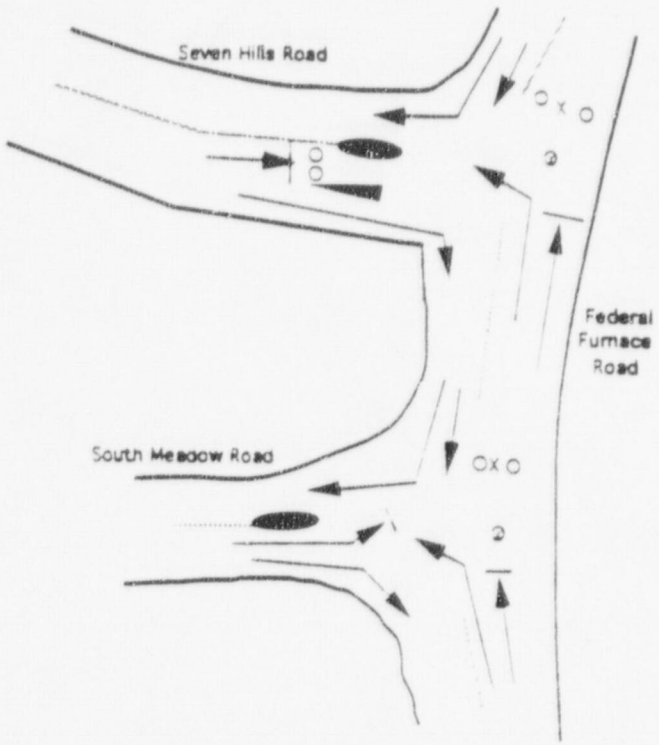
Manpower/Equipment:

1 Traffic Guide
3 Traffic Cones

Description:

Facilitate northbound traffic and traffic turning west on Cherry Street. Discourage all southbound traffic on Route 3A.

Point No. P-T-12



Location:
Federal Furnace Road, South Meadow Road and Seven Hills Rd. (Plymouth).

Priority: 3

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

2 Traffic Guides

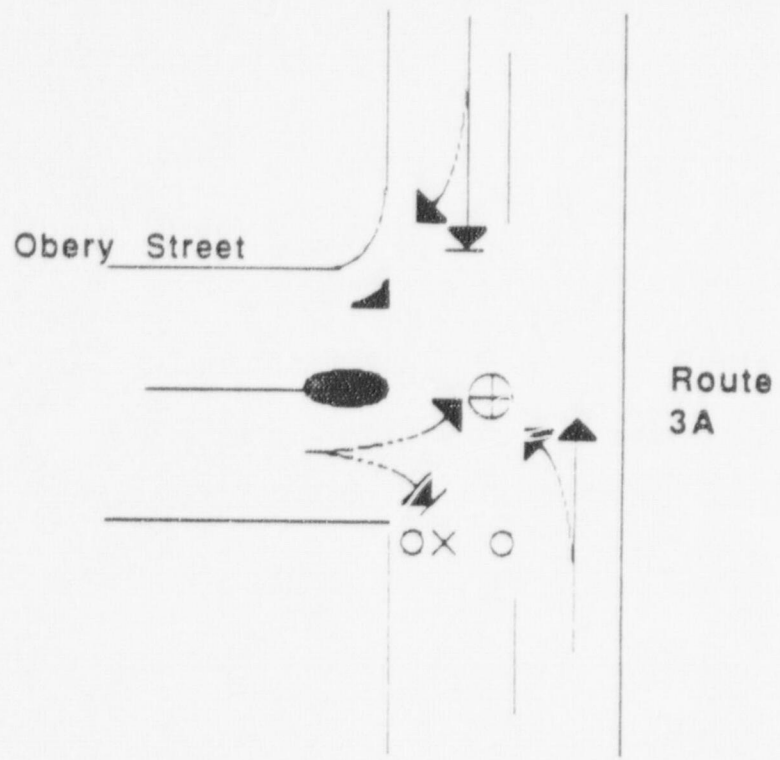
6 Traffic Cones

2 Traffic Barricades

Description:

Facilitate westbound traffic on South Meadow Rd. and Seven Hills Rd. Facilitate traffic along southbound Federal Furnace Rd. Discourage turns onto northbound Federal Furnace Rd.

Point No. P-T-03



Location:
Obery Street & Route 3A (Plymouth)

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

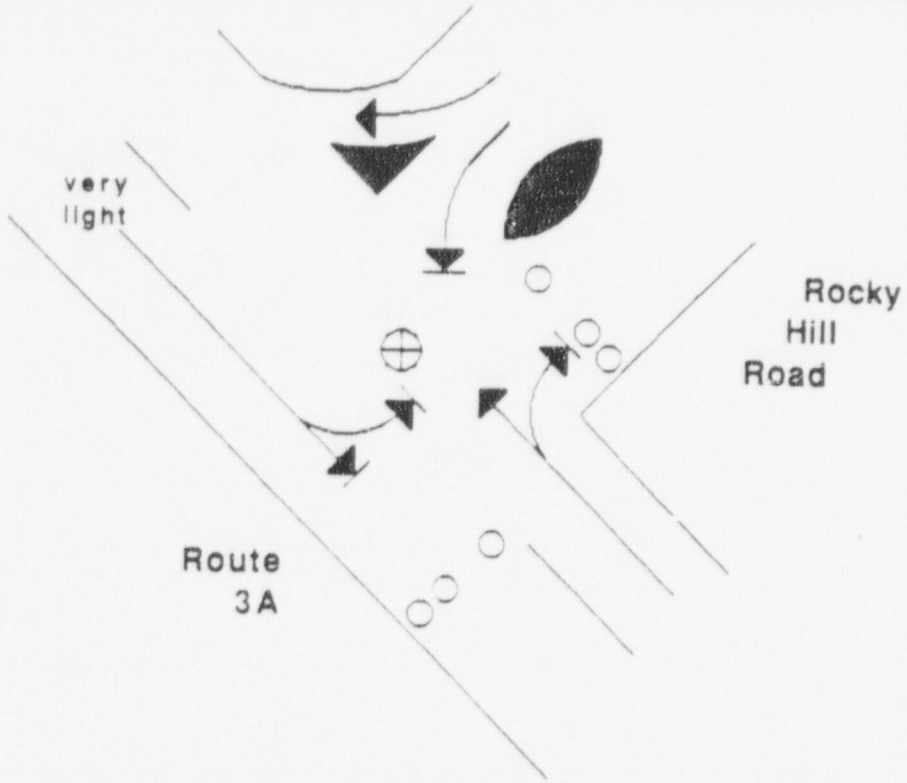
Manpower/Equipment:

1 Traffic Guide
2 Traffic Cones
1 Traffic Barricade

Description:

Facilitate westbound traffic. Discourage southbound traffic. Encourage northbound traffic on Route 3A to use westbound Obery Street.

Detail No. P-T-04



Location:
Rocky Hill Road & Route 3A (Plymouth)

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

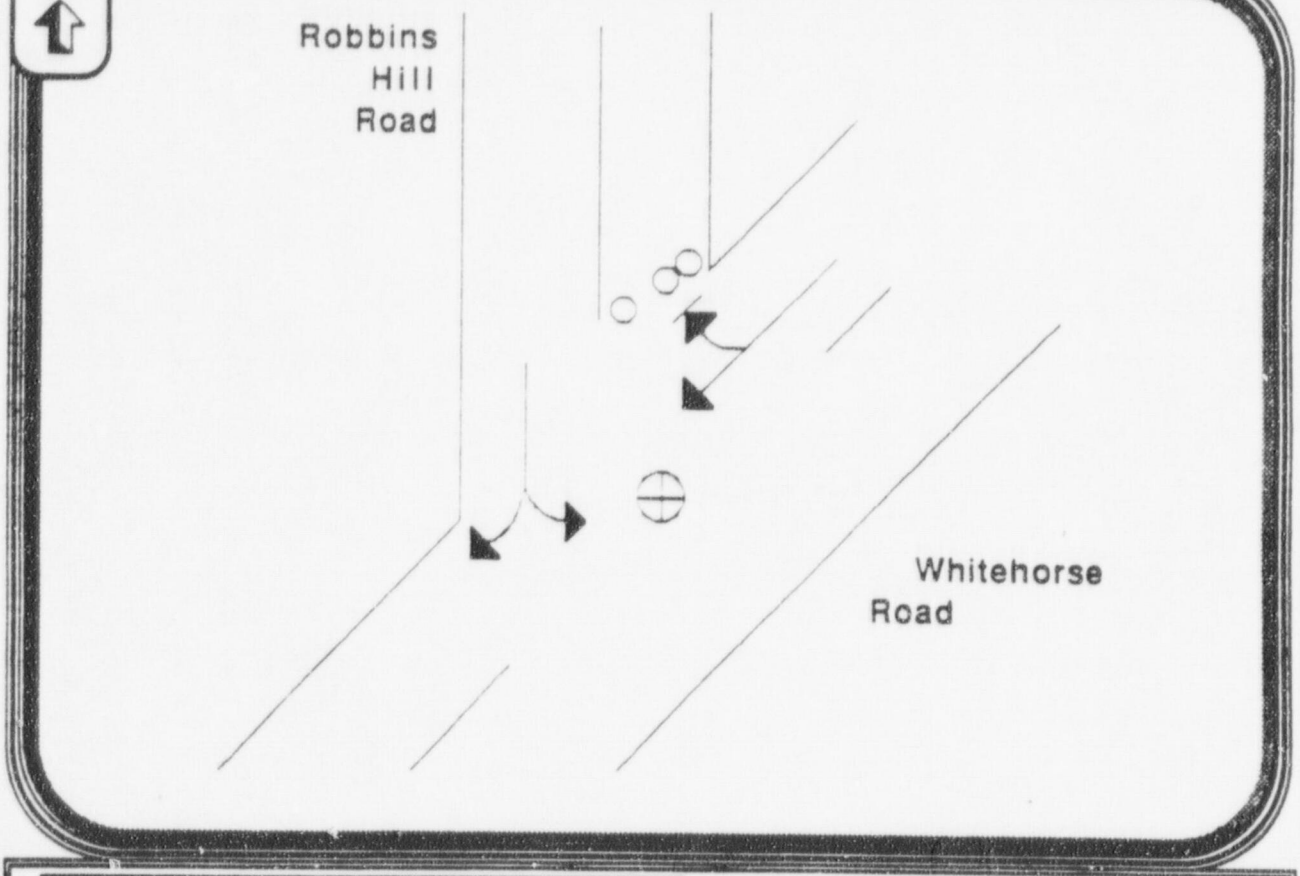
Manpower/Equipment:

1 Traffic Guide
6 Traffic Cones

Description:

Facilitate northbound traffic on Route 3A and traffic turning north onto Route 3A from Rocky Hill Road. Discourage eastbound traffic onto Rocky Hill Road and southbound traffic on Route 3A.

Point No. P-T-05



Location:
Whitehorse Road & Robbins Hill Road (Plymouth)

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

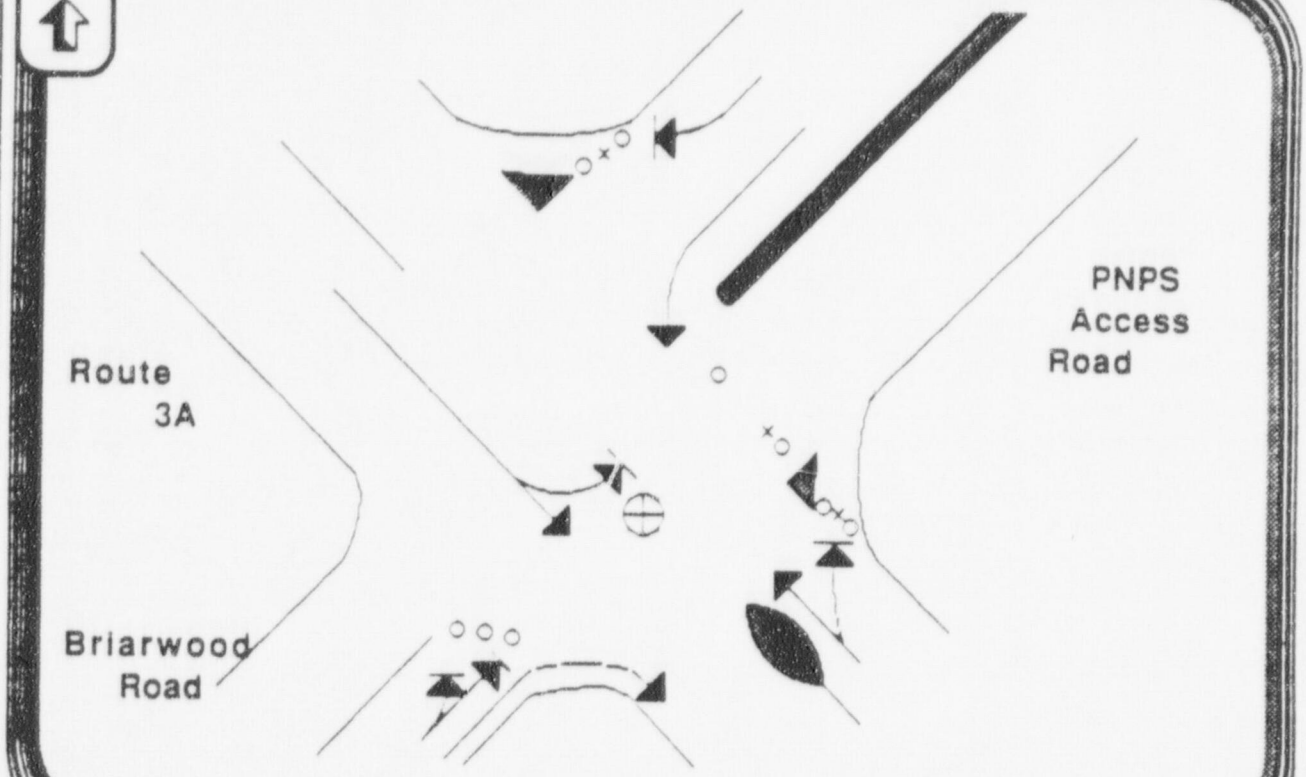
Manpower/Equipment:

1 Traffic Guide
3 Traffic Cones

Description:

Facilitate southbound traffic on Whitehorse Road. Discourage northbound traffic on Robbins Hill Road.

Point No. P-T-06



Location:
Route 3A & PNPS Access (Plymouth)

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

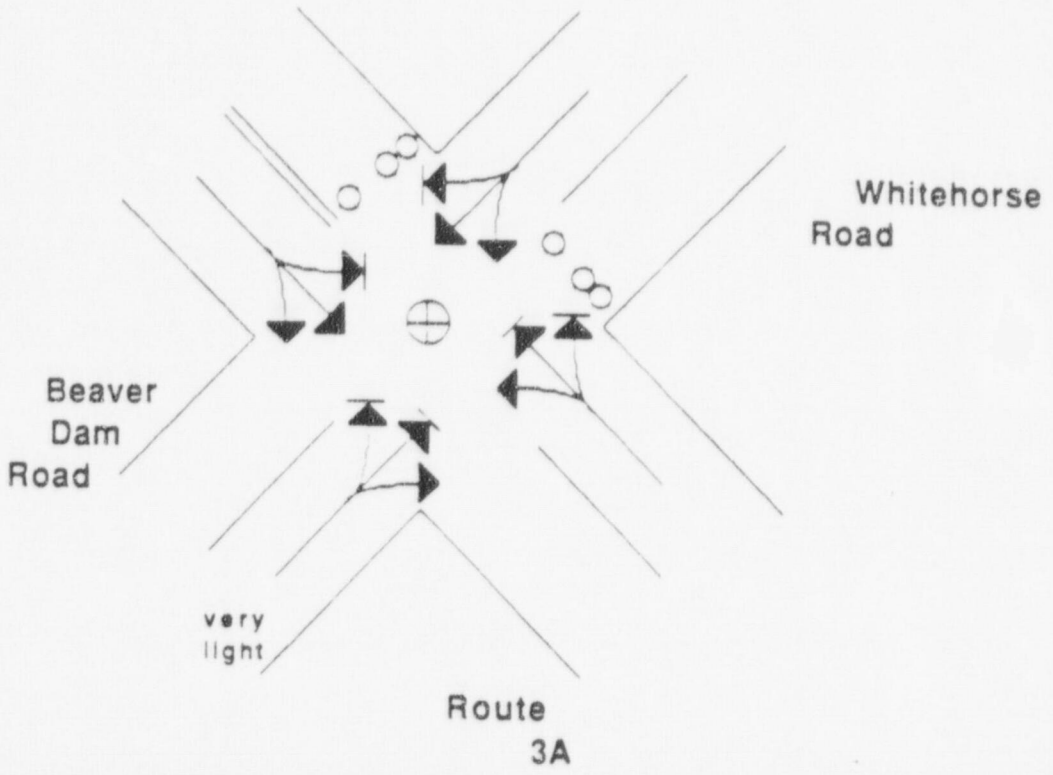
Manpower/Equipment:

1 Traffic Guide
9 Traffic Cones
3 Traffic Barricades

Description:

Discourage all turns onto PNPS Access except for emergency vehicles. Facilitate southbound traffic on Route 3A.

Point No. P-T-07



Location:
Whitehorse Road & Route 3A (Plymouth)

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

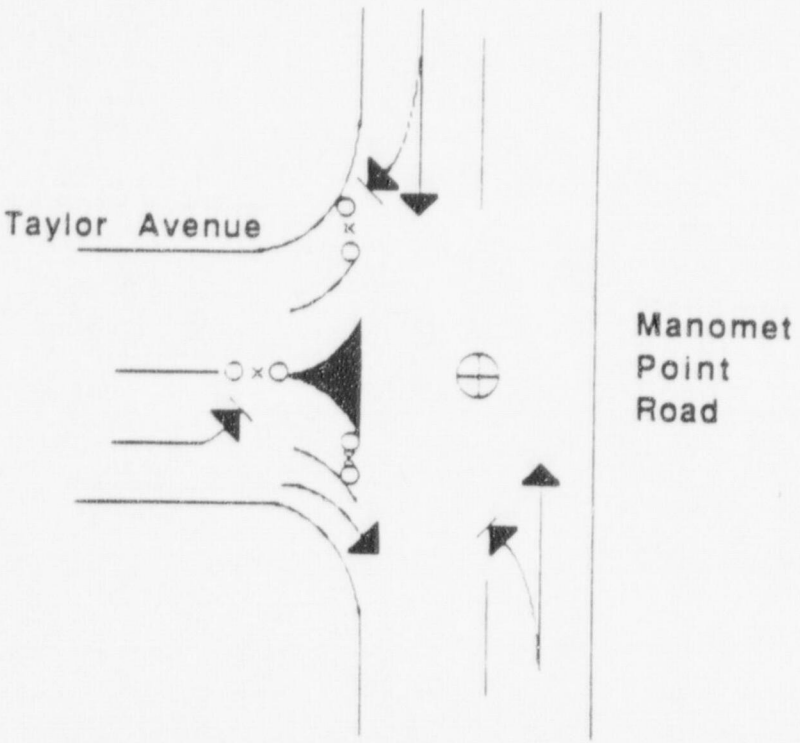
1 Traffic Guide

6 Traffic Cones

Description:

Facilitate westbound traffic on Whitehorse Road. Direct all traffic to westbound Beaver Dam Road. Discourage northbound traffic on Route 3A and eastbound traffic on Whitehorse Road.

Point No. P-T-03



Location:
Taylor Avenue & Manomet Point Road
(Plymouth)

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

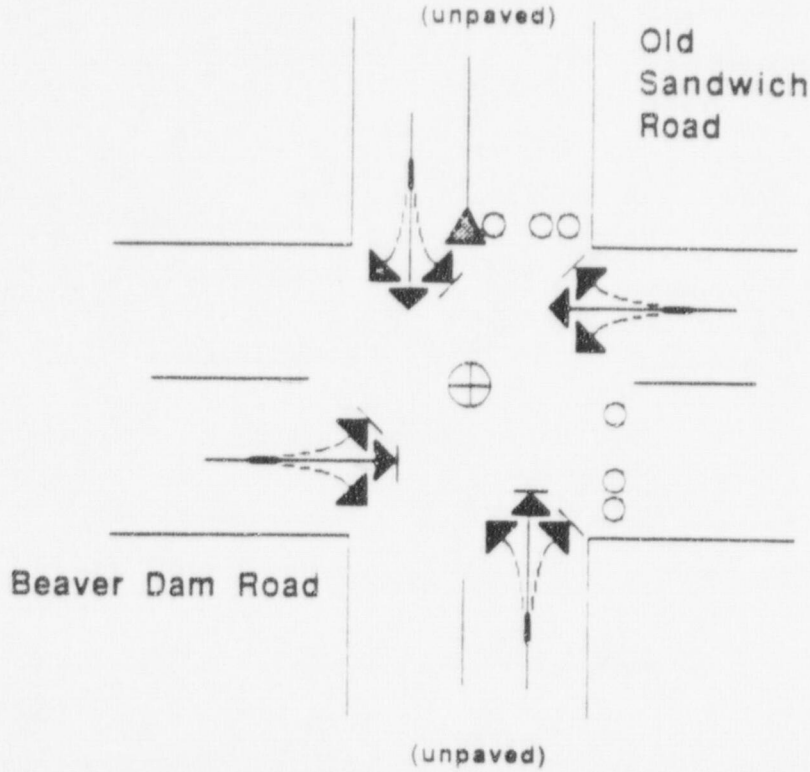
Manpower/Equipment:

1 Traffic Guide
6 Traffic Cones
3 Traffic Barricades

Description:

Facilitate southbound traffic on Manomet Point Road.
Discourage westbound traffic onto Taylor Avenue.

Point No. P-I-18



Location:
Old Sandwich Road & Beaver Dam Road
(Plymouth)

Priority: 3

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

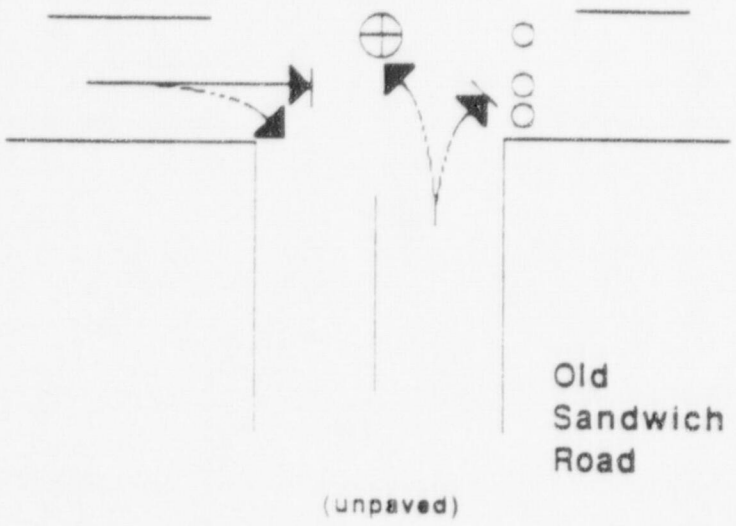
Manpower/Equipment:

1 Traffic Guide

6 Traffic Cones

Description:

Facilitate southbound and westbound traffic. Discourage northbound and eastbound traffic.



Location:
Old Sandwich Road & Ship Pond Road (Plymouth)

Priority: 3

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

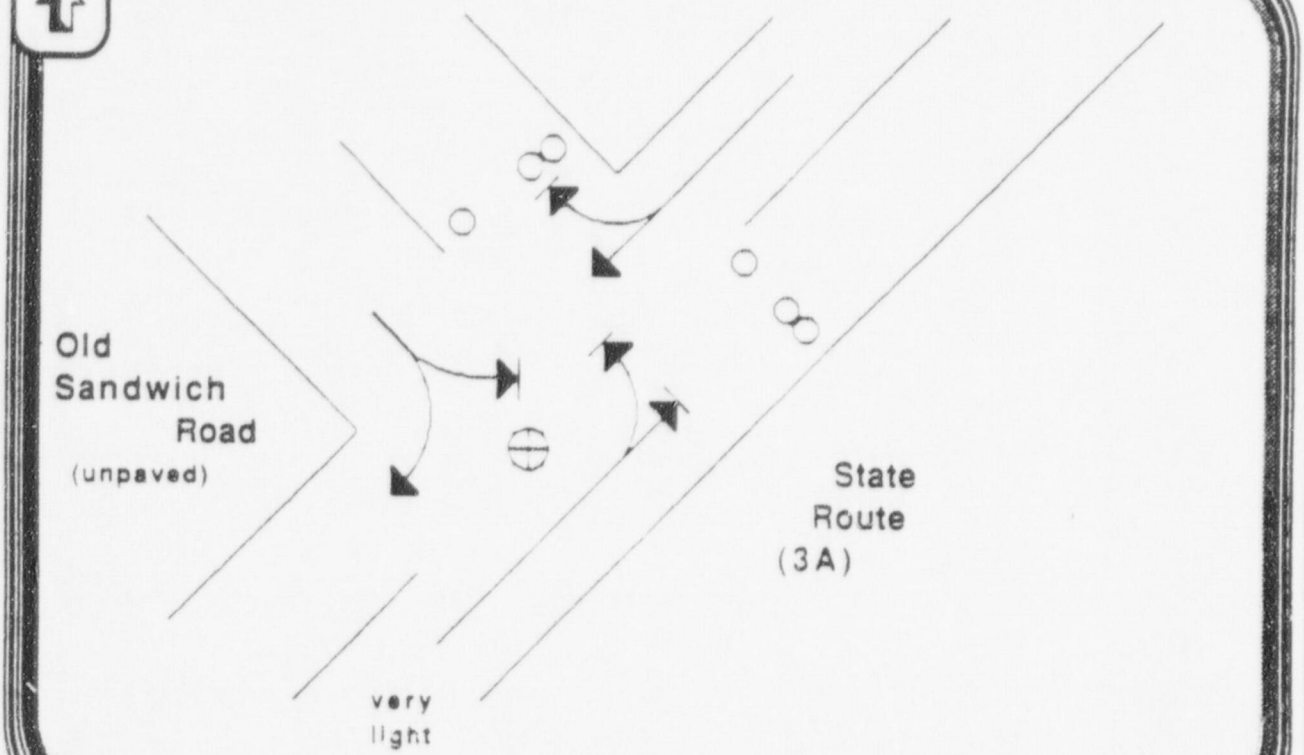
Manpower/Equipment:

1 Traffic Guide

3 Traffic Cones

Description:

Facilitate westbound traffic on Ship Pond Road. Discourage eastbound traffic on Ship Pond Road.



Location:
Old Sandwich Road & Route 3A (Plymouth)

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

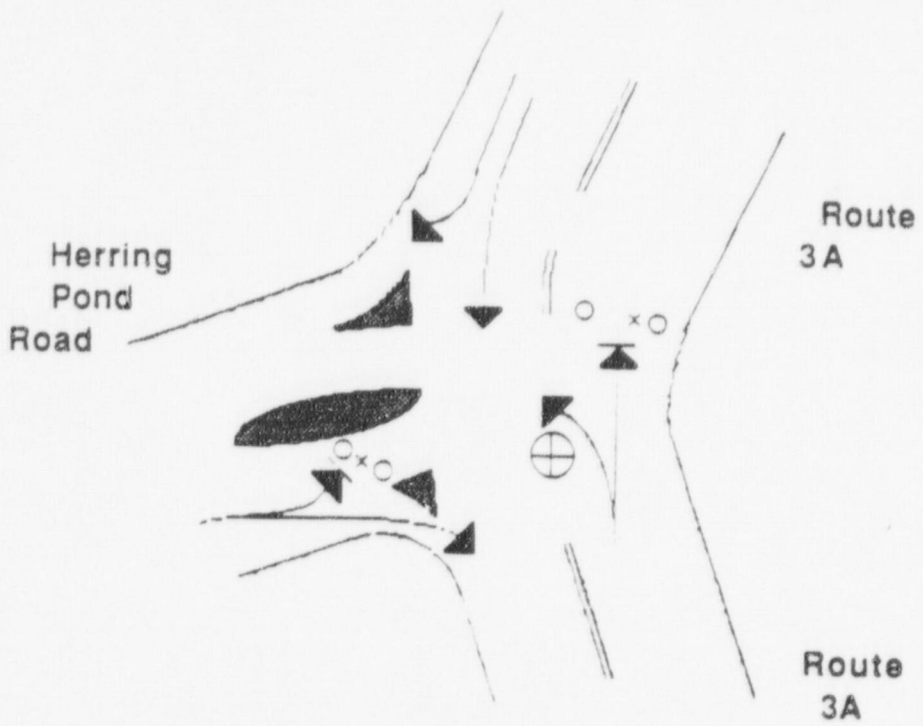
1 Traffic Guide

6 Traffic Cones

Description:

Facilitate southbound traffic. Discourage northbound traffic on Route 3A and westbound traffic on Old Sandwich Road.

Point No. P-T-12



Location:
Route 3A & Herring Pond Road (Plymouth)

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- ⊕ Traffic guide
- ○ Traffic cone
- × Traffic barricade

Manpower/Equipment:

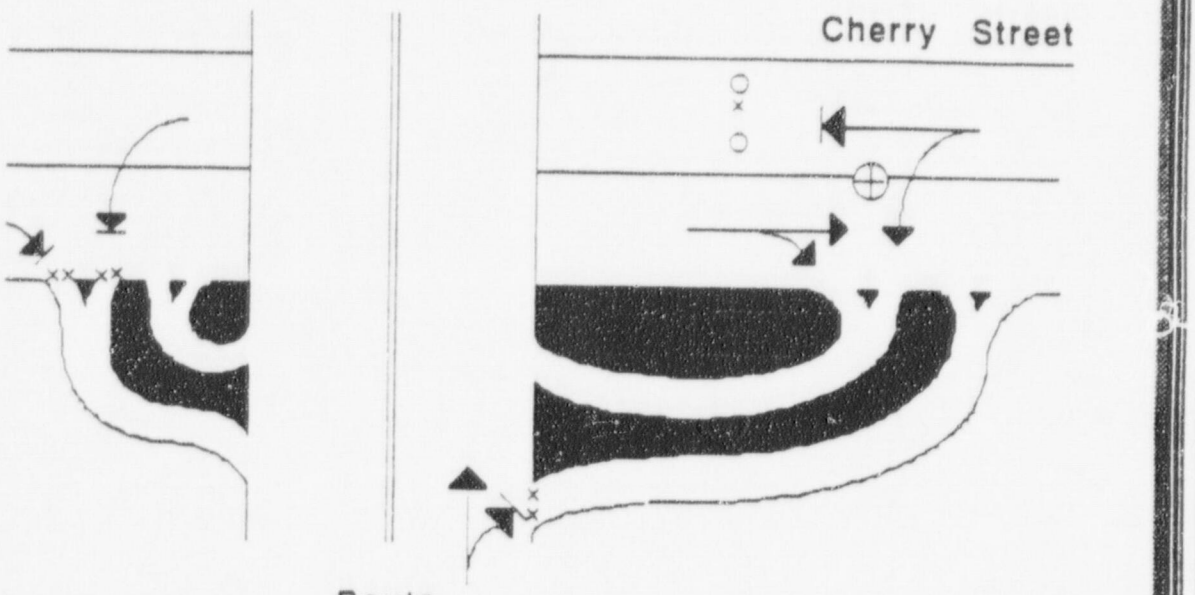
1 Traffic Guide
4 Traffic Cones
2 Traffic Barricades

Description:

Facilitate southbound traffic on Route 3A and turns onto westbound Herring Pond Road. Discourage northbound traffic on Route 3A.

PLY ACP.P.T.12 | [illegible]

Point No. P-AT-13a



Location:
Route 3 & Cherry Street (Plymouth), Exit 7

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

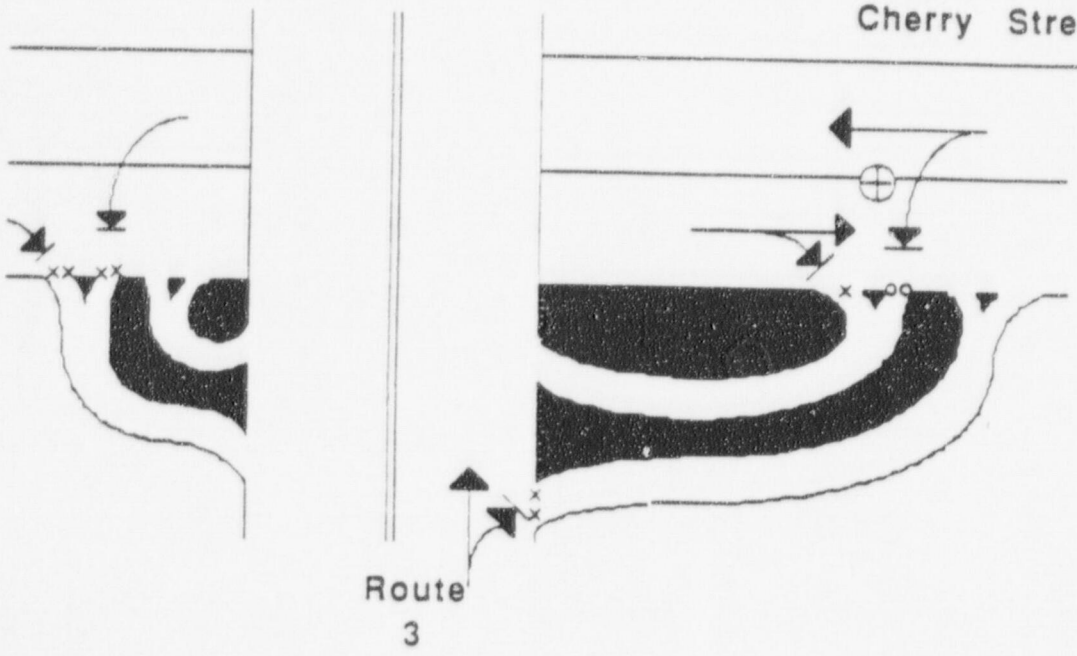
Manpower/Equipment:

1 Traffic Guide
2 Traffic Cones
7 Traffic Barricades

Description:

Facilitate entry onto northbound Route 3. Discourage entry onto southbound Route 3.

Plan No. PLY-13b



Location:
Route 3 & Cherry Street (Plymouth), Exit 7

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

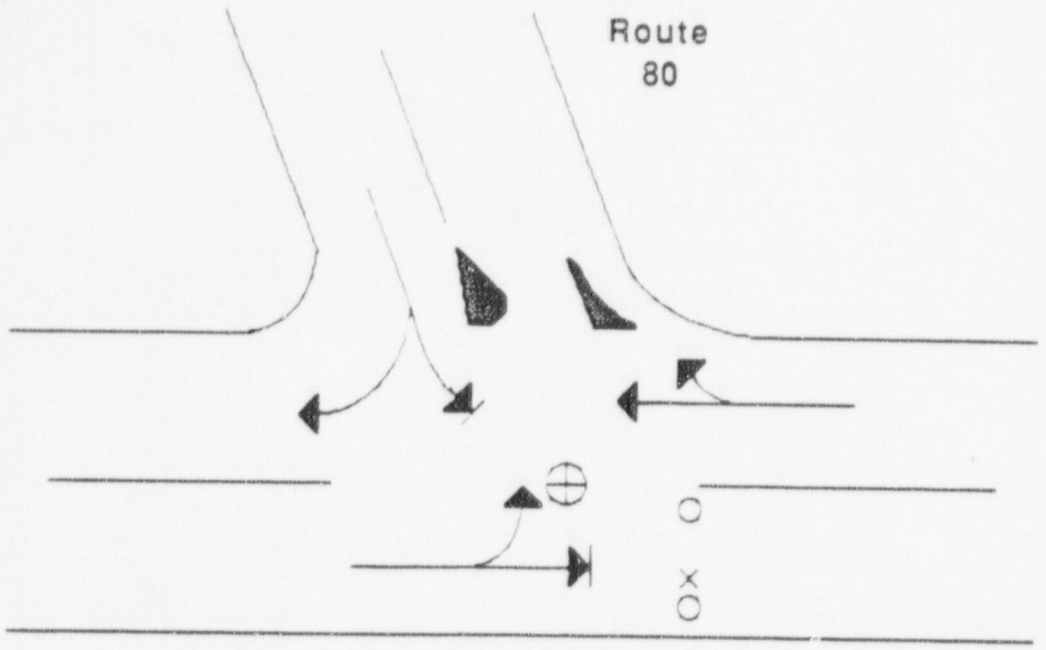
Manpower/Equipment:

1 Traffic Guide
2 Traffic Cones
7 Traffic Barricades

Description:

Discourage entry onto southbound and northbound Route 3.

Point No. P-AT-148



Location:
Route 44 & Route 80 (Plymouth)

Priority: 3

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

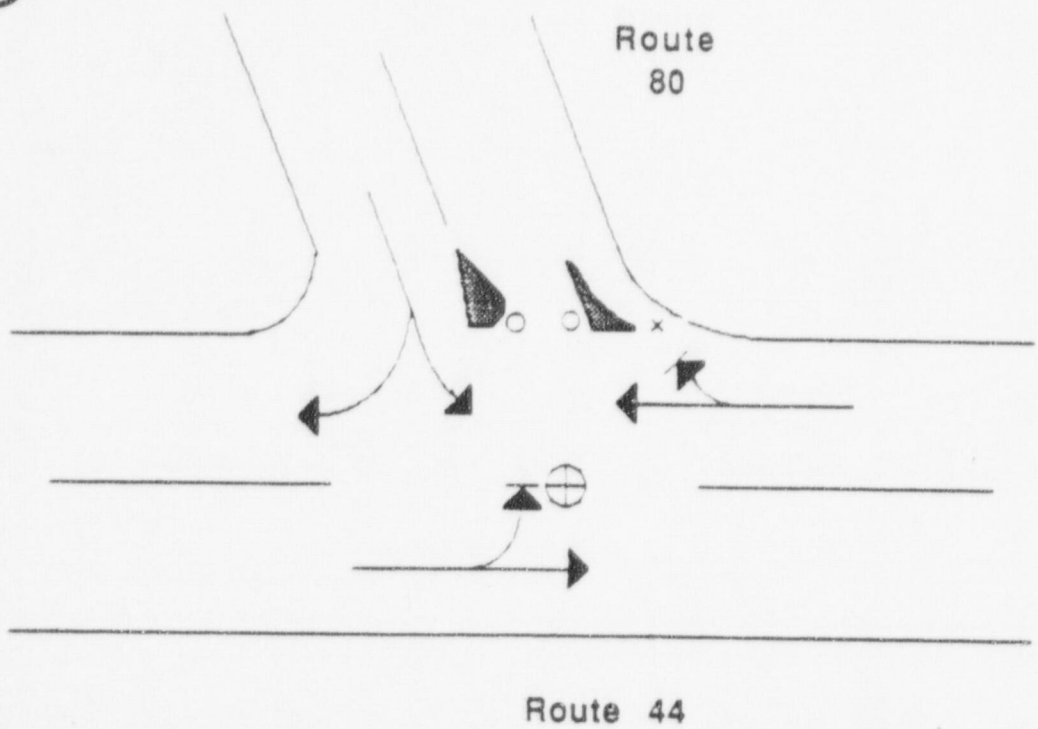
Manpower/Equipment:

1 Traffic Guide
2 Traffic Cones
1 Traffic Barricade

Description:

Facilitate westbound traffic on Route 44 and northbound traffic on Route 80. Discourage eastbound traffic on Route 44.

Point No. P-AT-14b



Location:
Route 44 & Route 80 (Plymouth)

Priority: 3

KEY

→	Movement facilitated
→	Movement discouraged
⊕	Traffic guide
○	Traffic cone
×	Traffic barricade

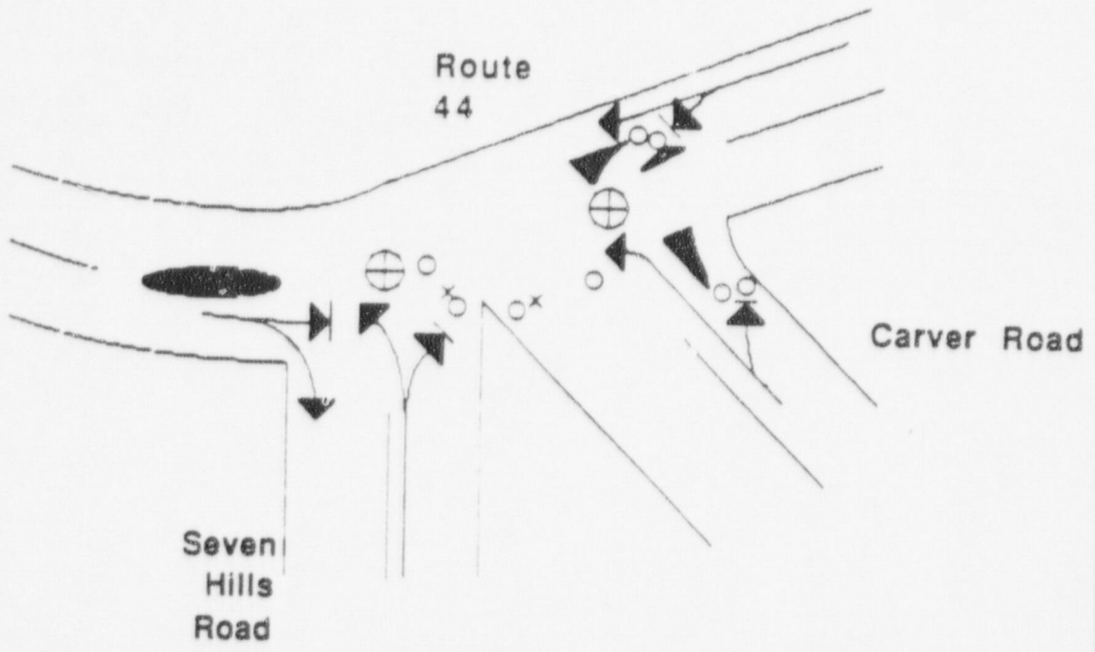
Manpower/Equipment:

1 Traffic Guide
2 Traffic Cones
1 Traffic Barricade

Description:

Facilitate westbound traffic on Route 44. Discourage northbound traffic on Route 80.

Plan No. P-AT-15a



Location:
Route 44 & Seven Hills Road (Plymouth)

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- ⊕ Traffic guide
- ○ Traffic cone
- × Traffic barricade

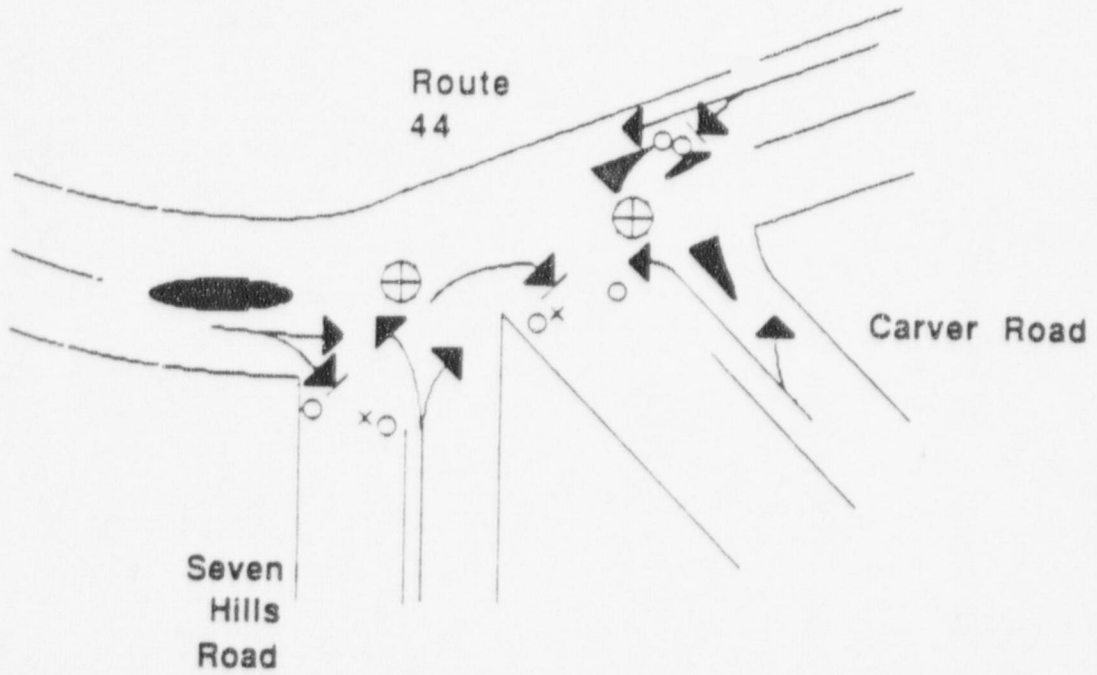
Manpower/Equipment:

2 Traffic Guides
8 Traffic Cones
2 Traffic Barricades

Description:

Facilitate westbound traffic on Route 44 and movements onto westbound Route 44 from Seven Hills Roads and Carver Road. Discourage eastbound movement on Route 44 and Carver Road.

Plan No. P-AT-15b



Location:
Route 44 & Seven Hills Road (Plymouth)

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

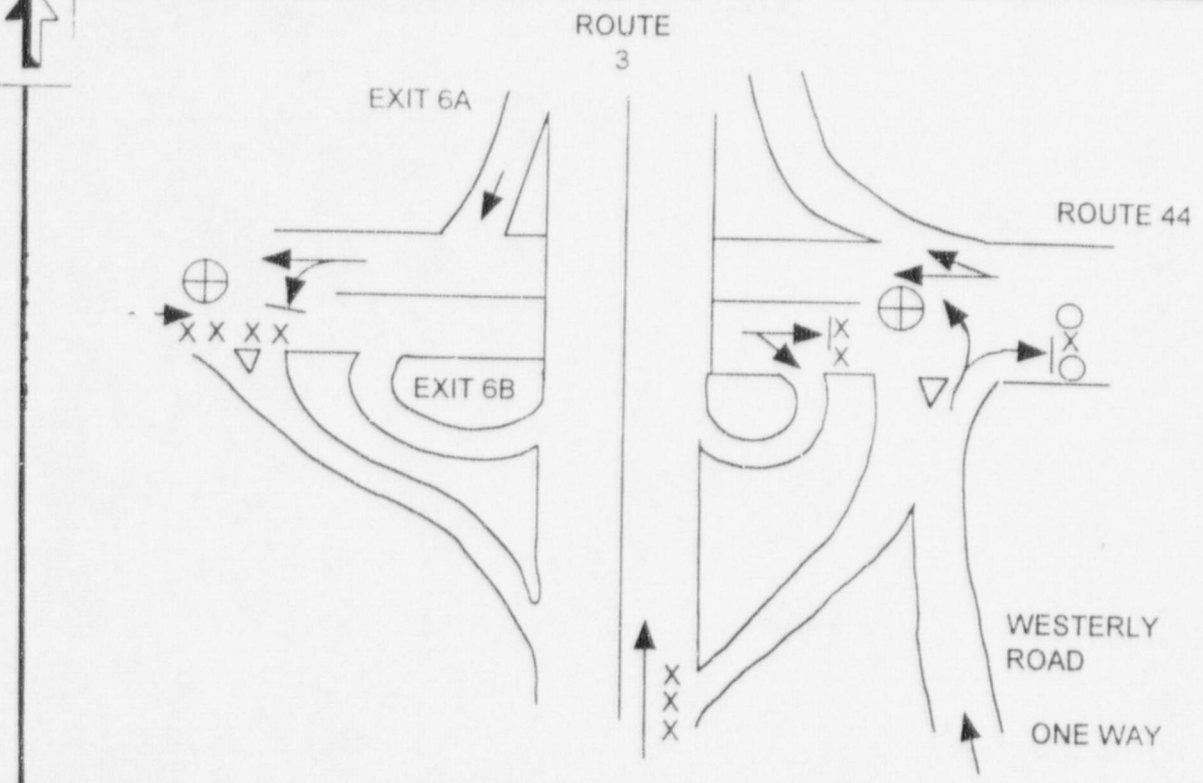
Manpower/Equipment:

2 Traffic Guides
6 Traffic Cones
2 Traffic Barricades

Description:

Facilitate westbound traffic on Route 44 and movements onto westbound Route 44 from Seven Hills Roads and Carver Road. Discourage eastbound movement on Carver Road, and southbound movement on Seven Hills Road.

Point No. P-AT-16a



Location:
Route 3 and Route 44 (Exit 6A) Plymouth

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

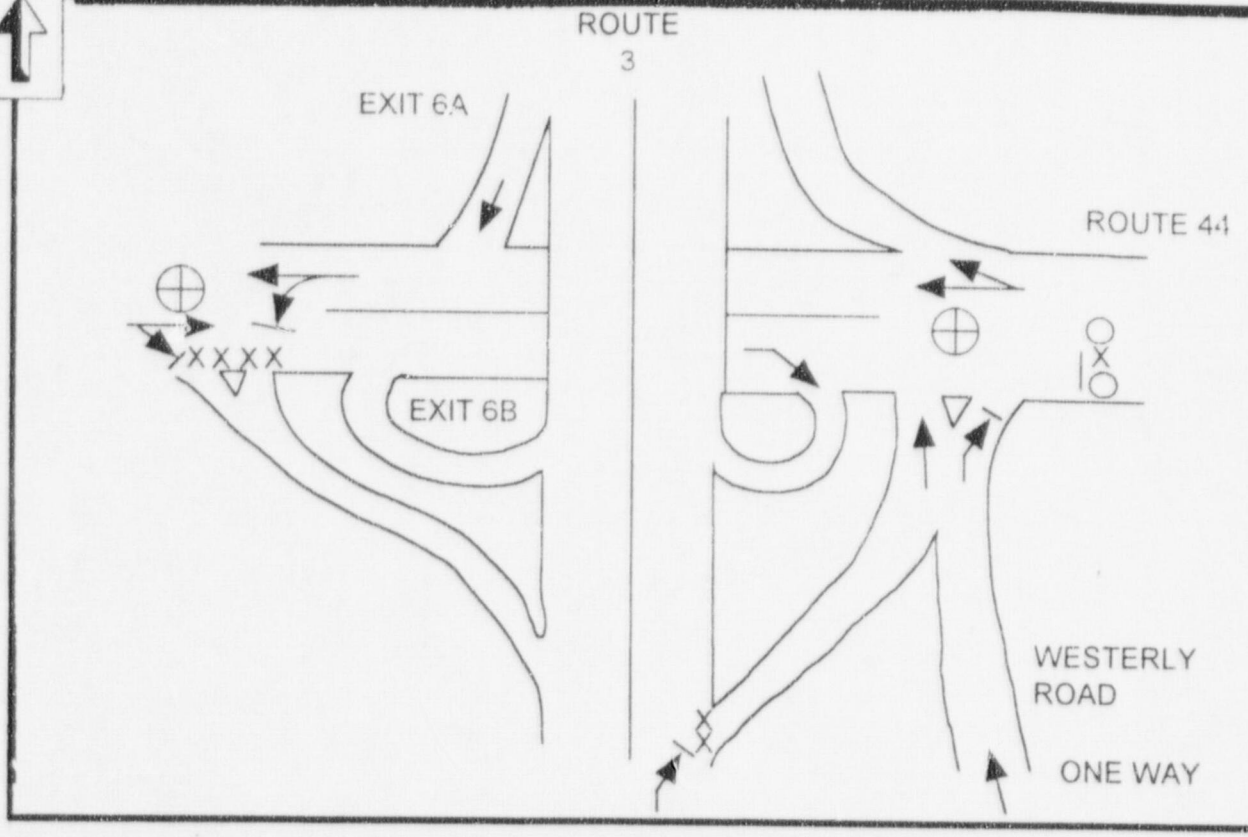
Manpower/Equipment:

2 Traffic Guide
2 Traffic Cones
10 Traffic Barricade

Description:

Facilitate entry onto northbound Route 3. Discourage entry onto southbound Route 3

Point No. P-AT-16b



Location:
Route 3 and Route 44 (Exit 6A) Plymouth

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

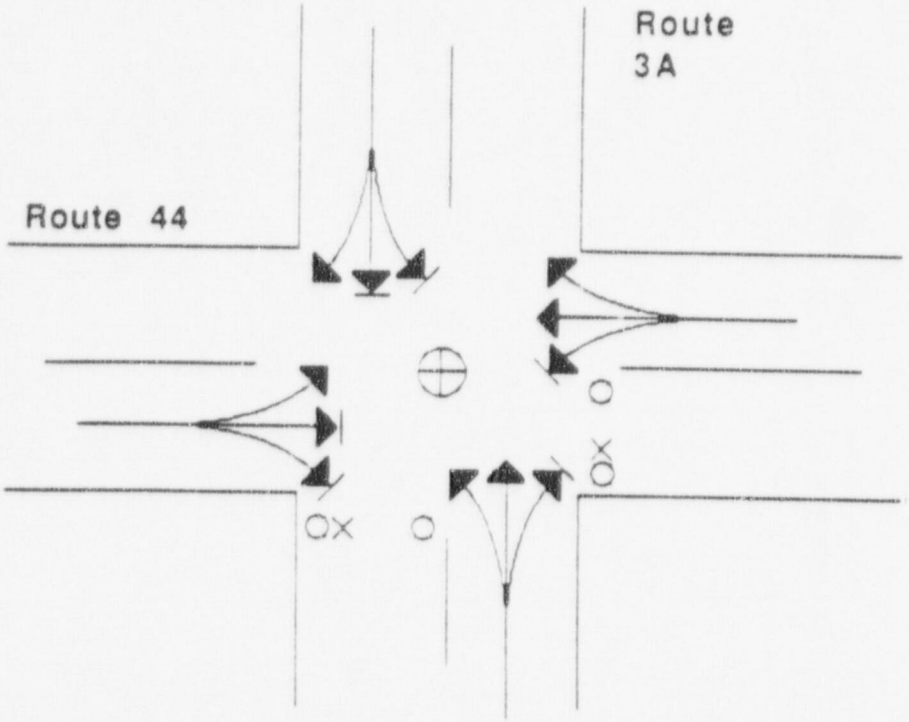
Manpower/Equipment:

2 Traffic Guide
2 Traffic Cones
9 Traffic Barricade

Description:

Facilitate entry onto northbound Route 3. Discourage entry onto eastbound Route 44

Point No. P-AT-17



Location:
Route 3A & Route 44 (Plymouth)

Priority: 2

KEY

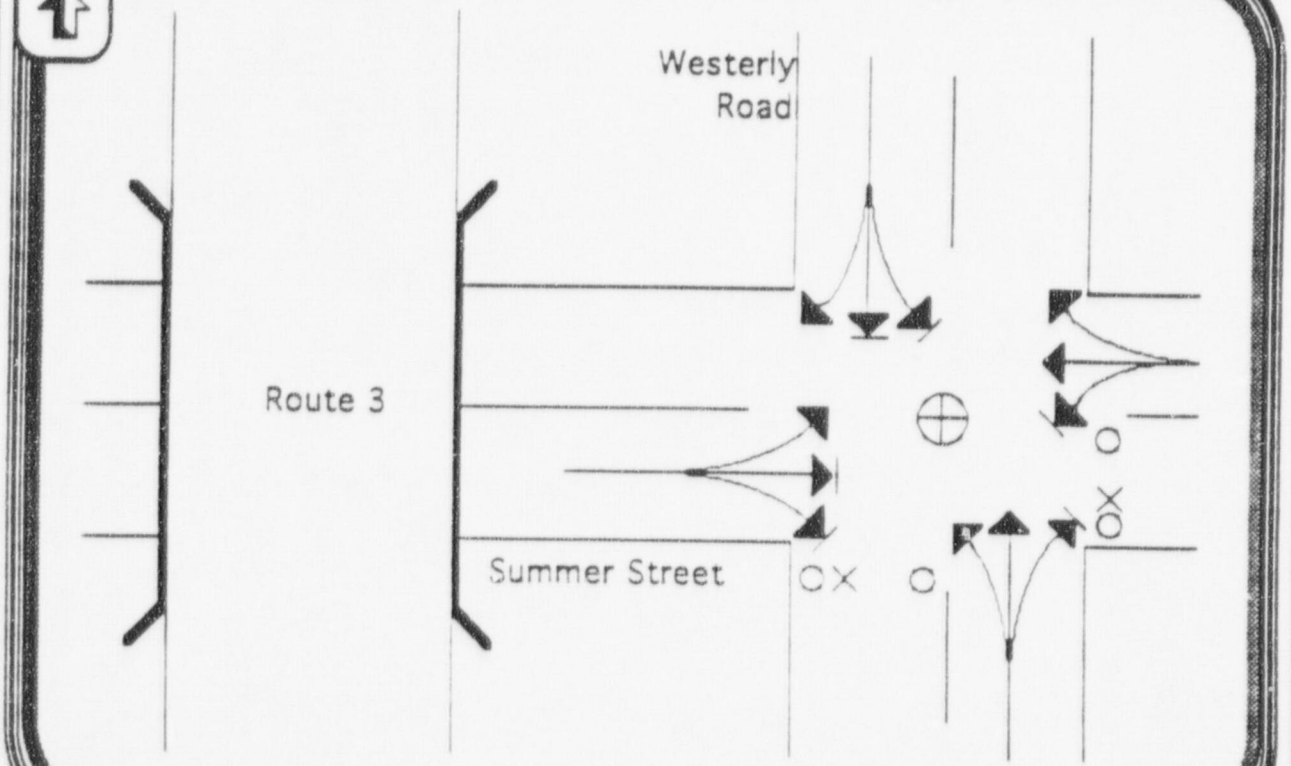
- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

1 Traffic Guide
4 Traffic Cones
2 Traffic Barricades

Description:

Facilitate northbound traffic turning west on Route 44. Discourage all southbound and eastbound traffic.



Location:
Summer Street & Westerly Road (Plymouth)

Priority: 3

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

1 Traffic Guide

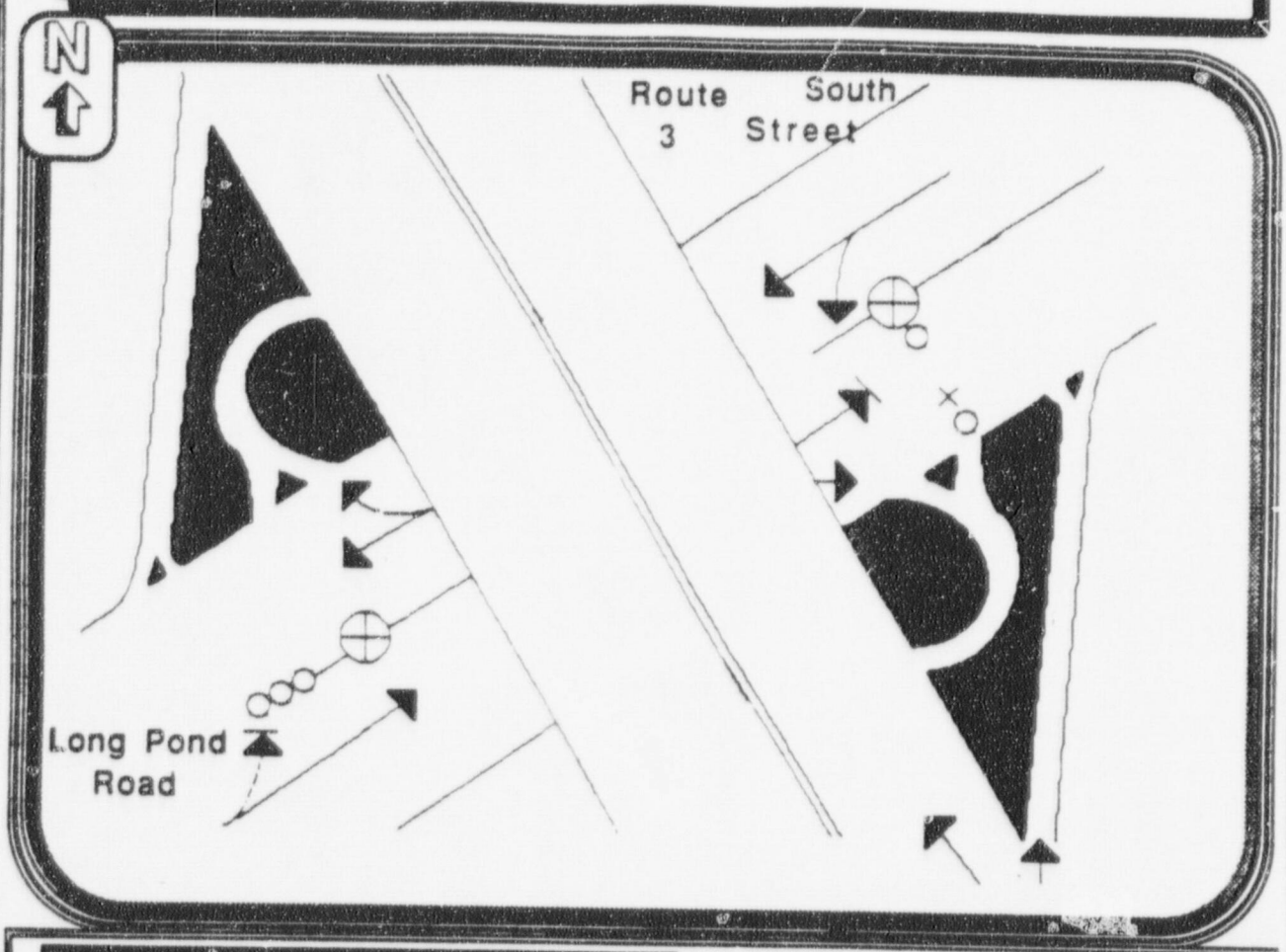
4 Traffic Cones

2 Traffic Barricades

Description:

Facilitate westbound traffic and traffic turning onto northbound Westerly Road. Discourage eastbound and southbound traffic.

Point No. P-AT-13a



Location:
Route 3 & Long Pond Road (Plymouth), Exit 5

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

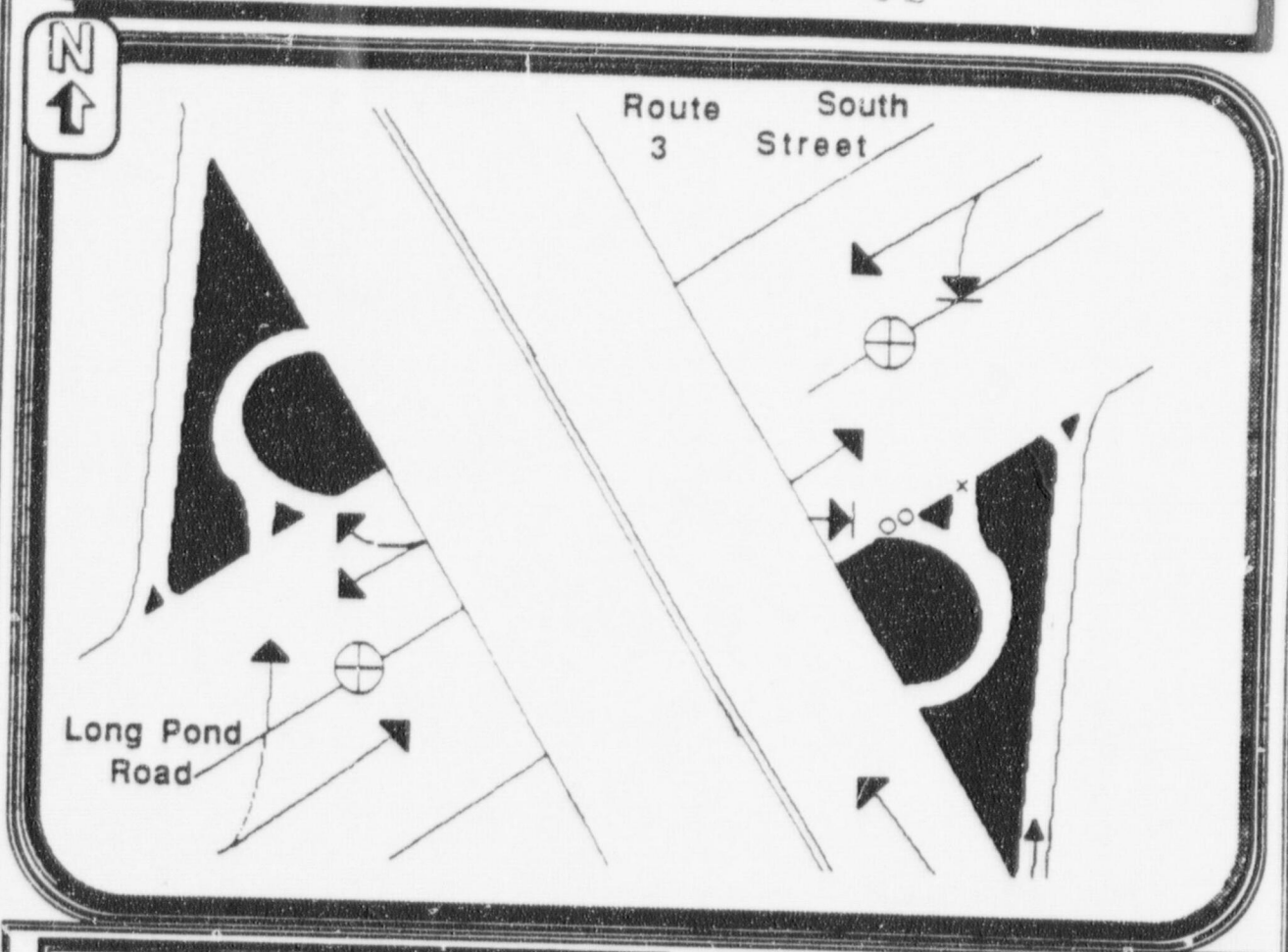
Manpower/Equipment:

2 Traffic Guides
5 Traffic Cones
1 Traffic Barricade

Description:

Facilitate traffic entering southbound and northbound Route 3. Discourage eastbound traffic on South Street.

Point No. P-AT-18D



Location:
Route 3 & Long Pond Road (Plymouth), Exit 5

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

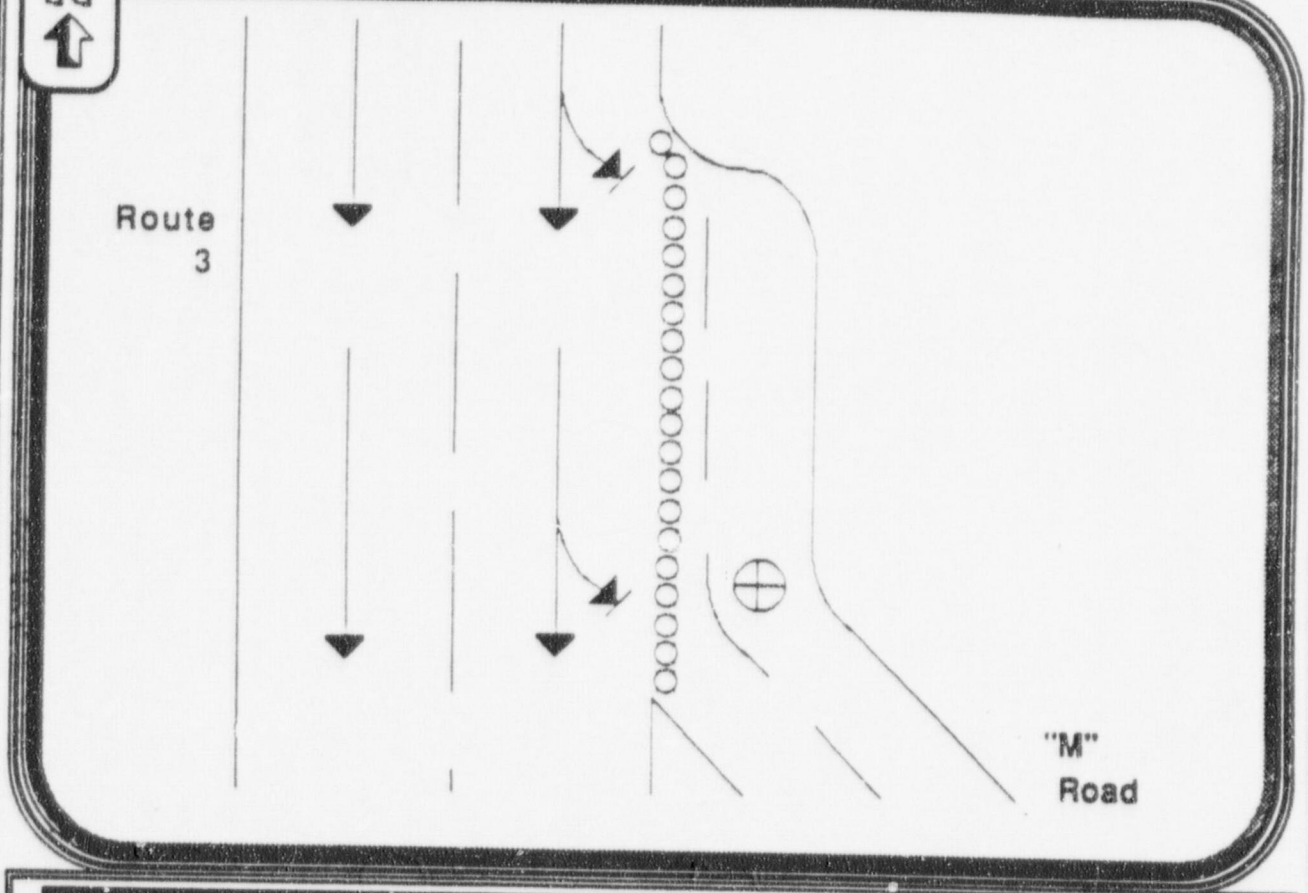
Manpower/Equipment:

2 Traffic Guides
2 Traffic Cones
1 Traffic Barricade

Description:

Facilitate traffic entering southbound Route 3. Discourage traffic entering northbound Route 3.

Point No. P-AT-20



Location:
Route 3 & "M" Road (Plymouth)

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

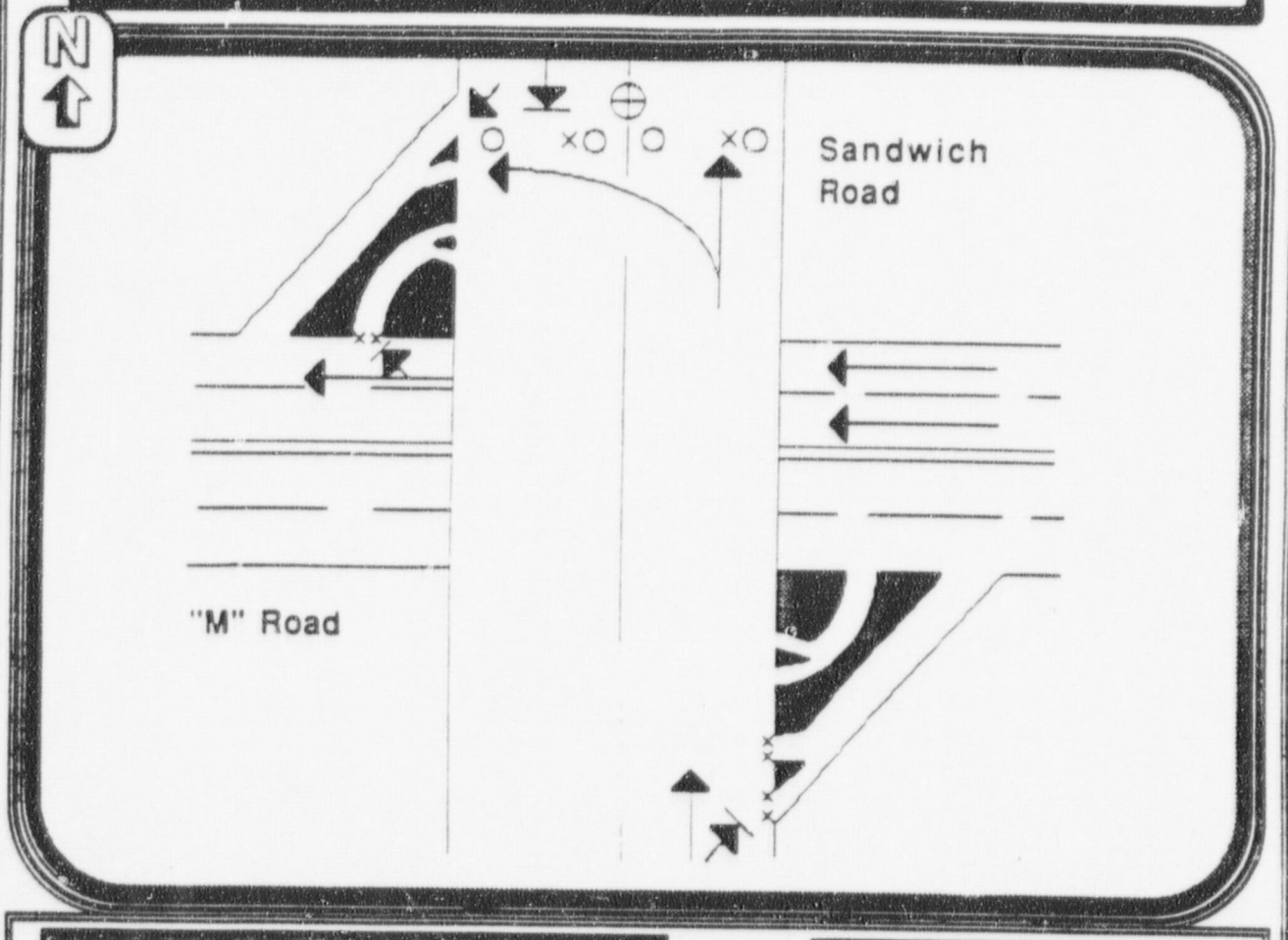
1 Traffic Guide

20 Traffic Cones

Description:

Discourage traffic from exiting Route 3 southbound onto "M" Road

Point No. P-AT-21a



Location:
"M" Road & Sandwich Road (Plymouth)

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

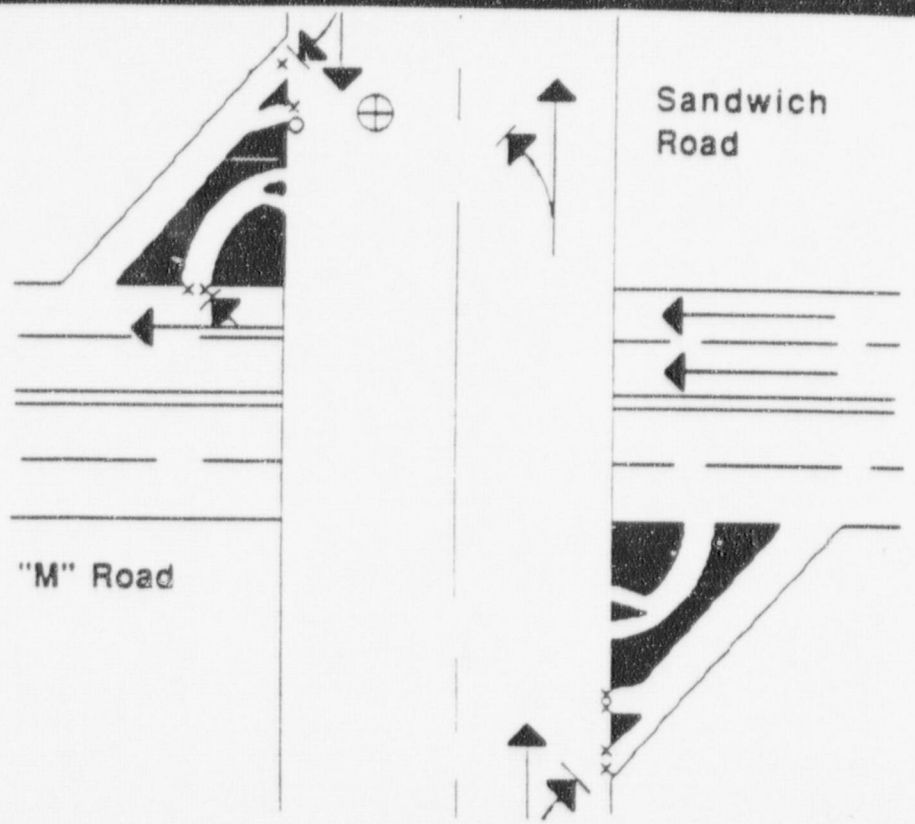
Manpower/Equipment:

1 Traffic Guide
4 Traffic Cones
8 Traffic Barricades

Description:

Facilitate westbound traffic on "M" Road and traffic turning west onto "M" Road from Sandwich Road. Discourage eastbound traffic onto "M" Road and traffic on Sandwich Road.

Plan No. P-AT-21b



Location:
"M" Road & Sandwich Road (Plymouth)

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

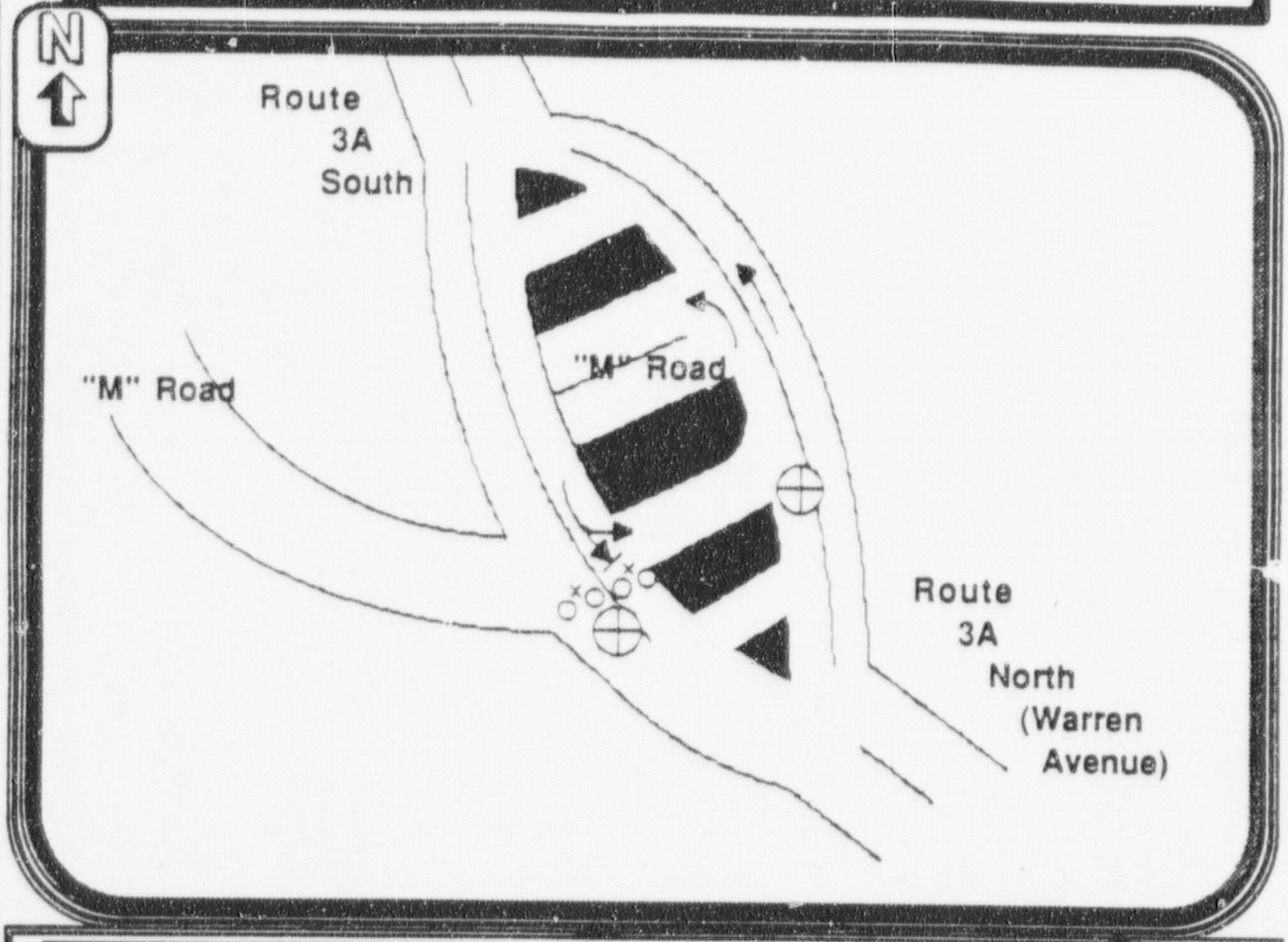
1 Traffic Guide
1 Traffic Cone
8 Traffic Barricades

Description:

Discourage eastbound and westbound traffic on "M" Road.

PLY ACP AT 21b | 272788

Plan No. P-AT-22a



Location:
"M" Road & Route 3A (Plymouth)

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

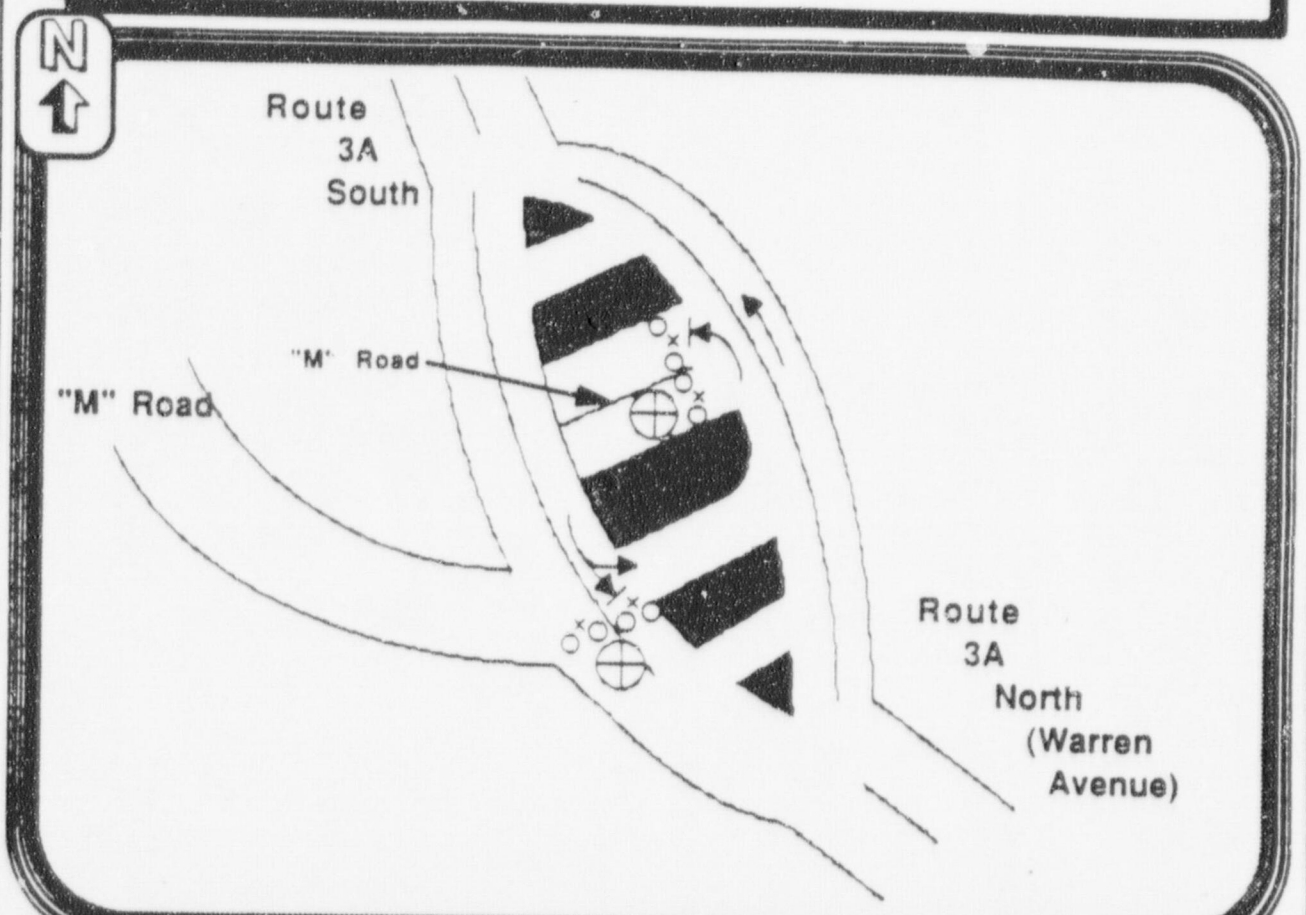
Manpower/Equipment:

2 Traffic Guides
4 Traffic Cones
2 Traffic Barricades

Description:

Facilitate westbound traffic on "M" Road. Discourage southbound traffic on Route 3A.

Point No. P-AT-22b



Location:
"M" Road & Route 3A (Plymouth)

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

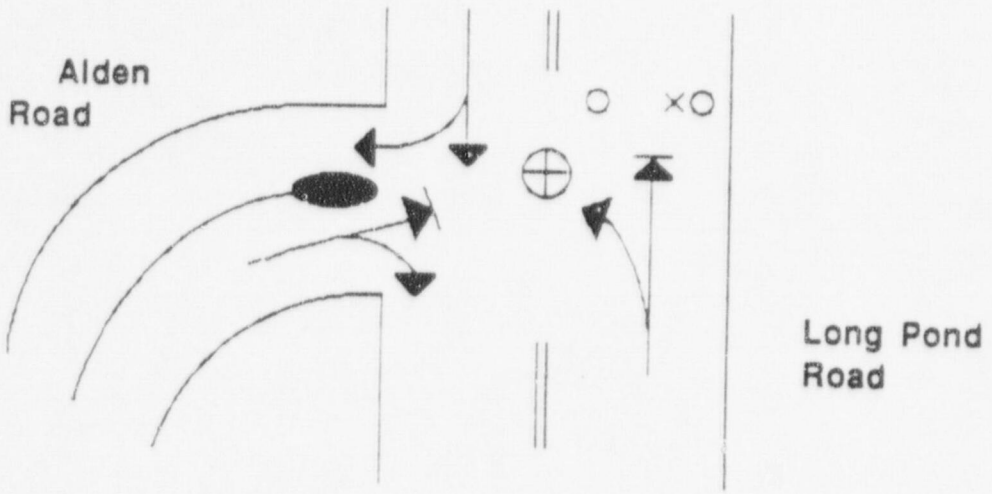
Manpower/Equipment:

2 Traffic Guides
8 Traffic Cones
4 Traffic Barricades

Description:

Discourage southbound traffic on Route 3A and westbound traffic on "M" Road.

Point No. P-AT-23a



Location:
Alden Road & Long Pond Road (Plymouth)

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

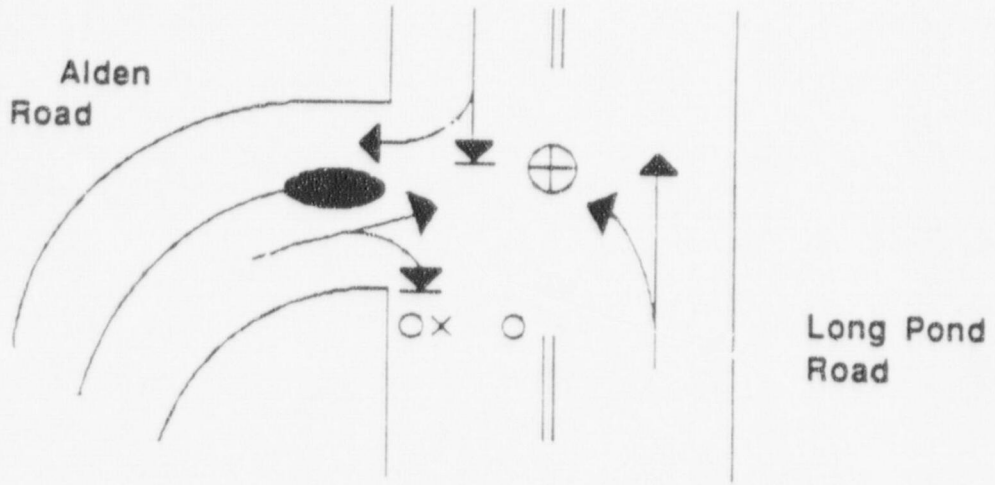
Manpower/Equipment:

1 Traffic Guide
2 Traffic Cones
1 Traffic Barricade

Description:

Facilitate southbound traffic on Long Pond Road turning onto Alden Road. Discourage northbound traffic on Long Pond Road.

Point No. P-AT-23b



Location:
Alden Road & Long Pond Road (Plymouth)

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- ⊕ Traffic guide
- ○ Traffic cone
- × Traffic barricade

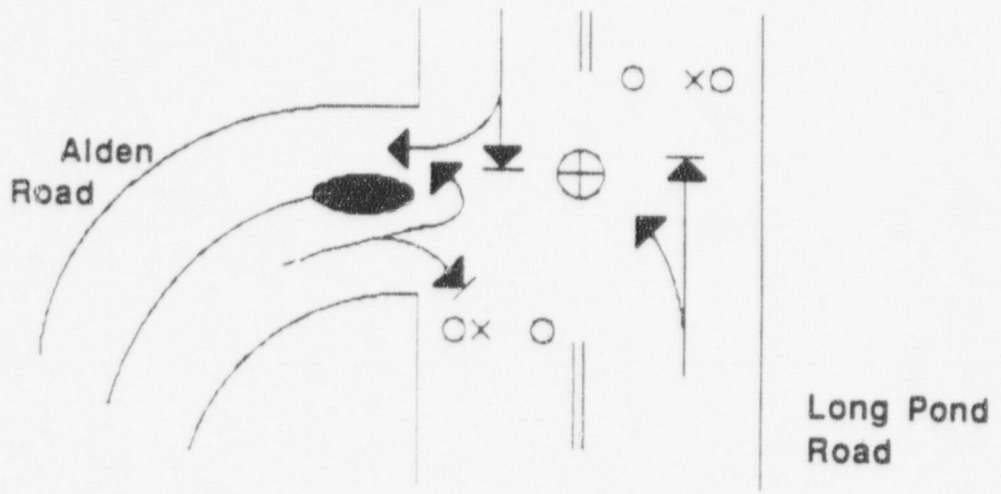
Manpower/Equipment:

1 Traffic Guide
2 Traffic Cones
1 Traffic Barricade

Description:

Discourage southbound traffic on Long Pond Road.

Point No. P-AT-23c



Location:
Alden Road & Long Pond Road (Plymouth)

Priority: 2

KEY

——►	Movement facilitated
——►|	Movement discouraged
⊕	Traffic guide
○	Traffic cone
×	Traffic barricade

Manpower/Equipment:

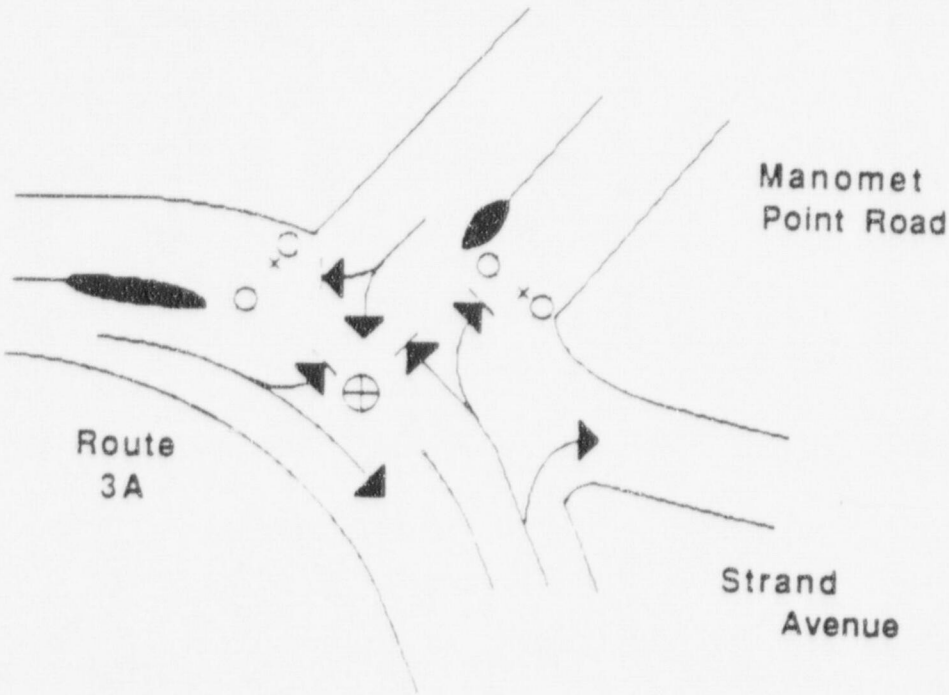
1 Traffic Guide
4 Traffic Cones
2 Traffic Barricades

Description:

Discourage southbound and northbound traffic on Long Pond Road.

PLY ACP-P-AT-23c	072788	
Plymouth Access Control Point #23c	1 of 1	37

Point No. P-A-T-24



Location:
Route 3A & Manomet Point Road (Plymouth)

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

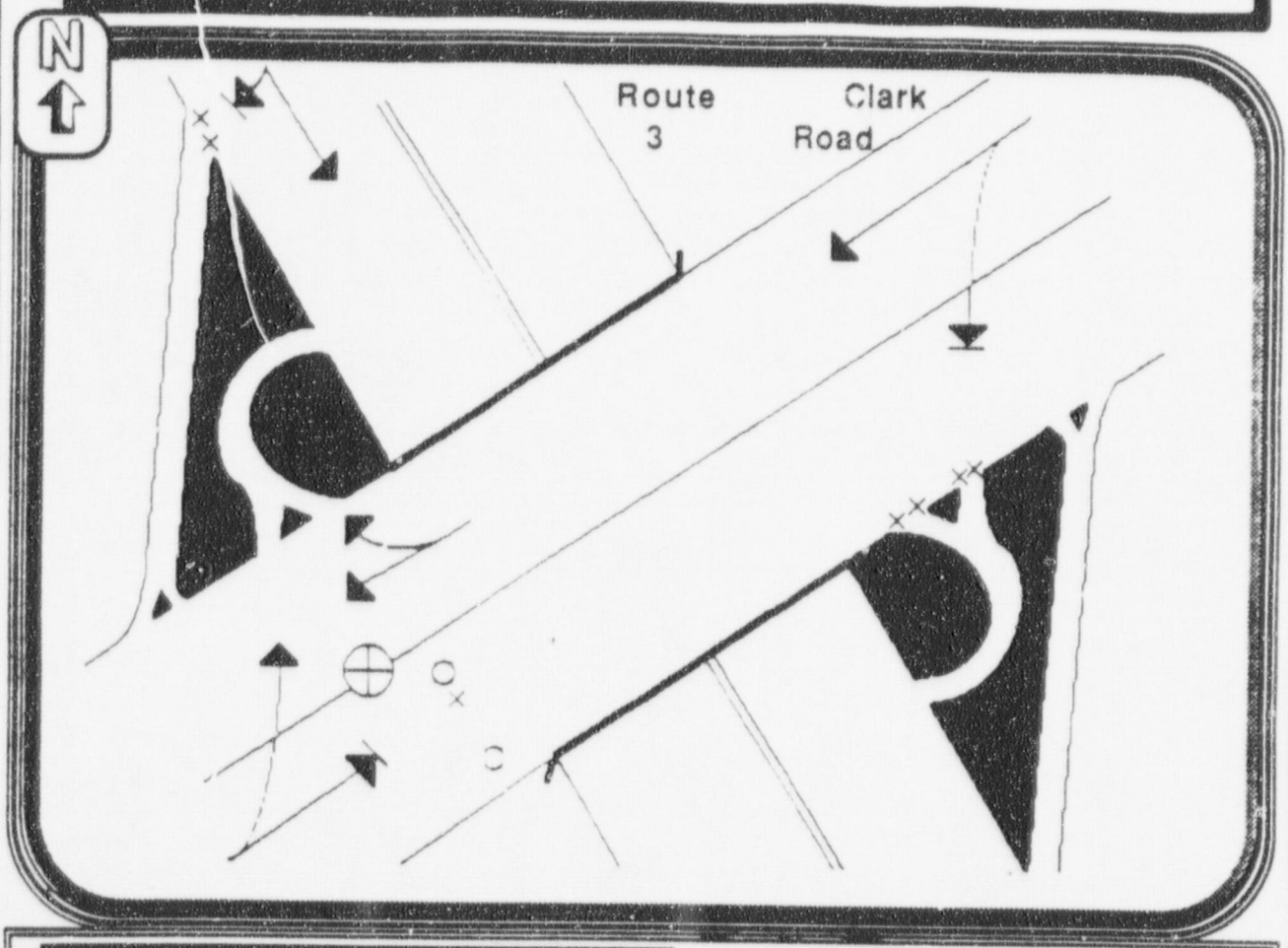
Manpower/Equipment:

1 Traffic Guide
4 Traffic Cones
2 Traffic Barricades

Description:

Facilitate southbound traffic on Route 3A and turns from Manomet Point Road to southbound 3A. Discourage northbound traffic on Route 3A and Manomet Point Road.

Point No. P-AT-25



Location:
Route 3 & Clark Road (Plymouth), Exit 3

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

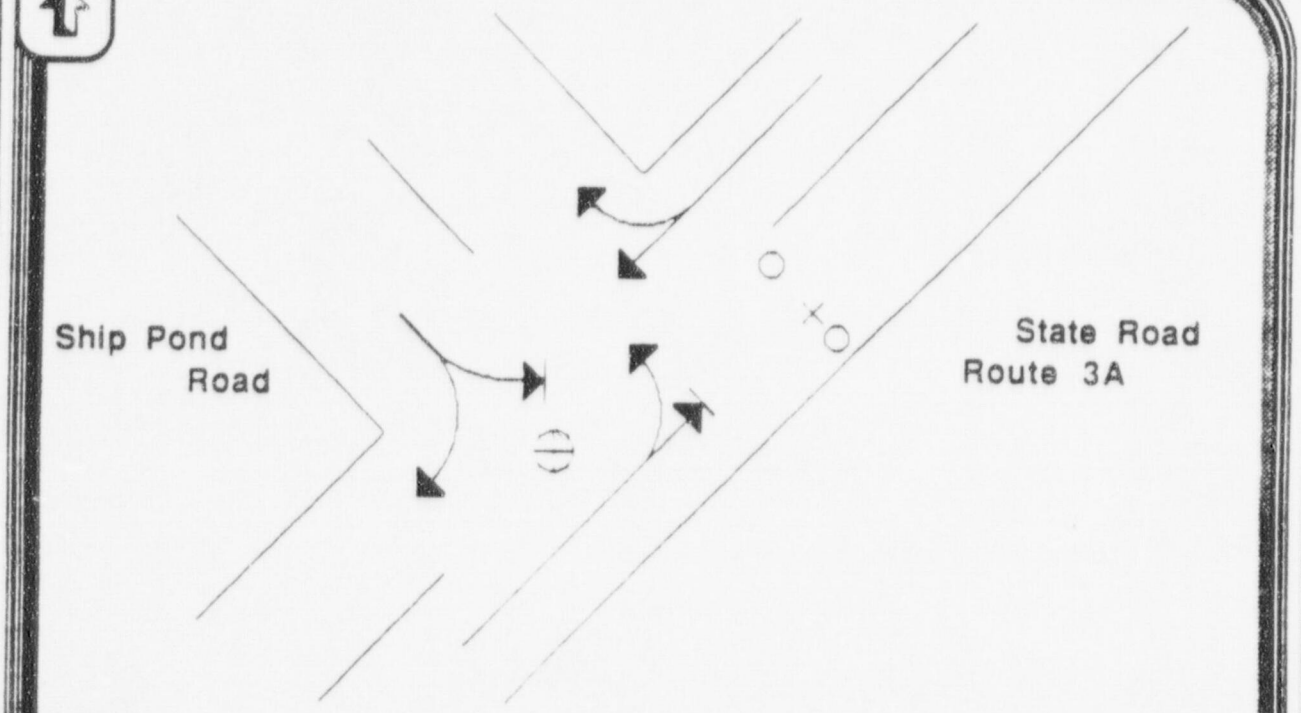
Manpower/Equipment:

1 Traffic Guide
2 Traffic Cones
7 Traffic Barricades

Description:

Facilitate traffic entering southbound Route 3. Discourage northbound traffic on Route 3 and Clark Road.

Point No: P-AT-28



Location:
State Road (Route 3A) and Ship Pond Road (Plymouth)

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- ⊕ Traffic guide
- ○ Traffic cone
- × Traffic barricade

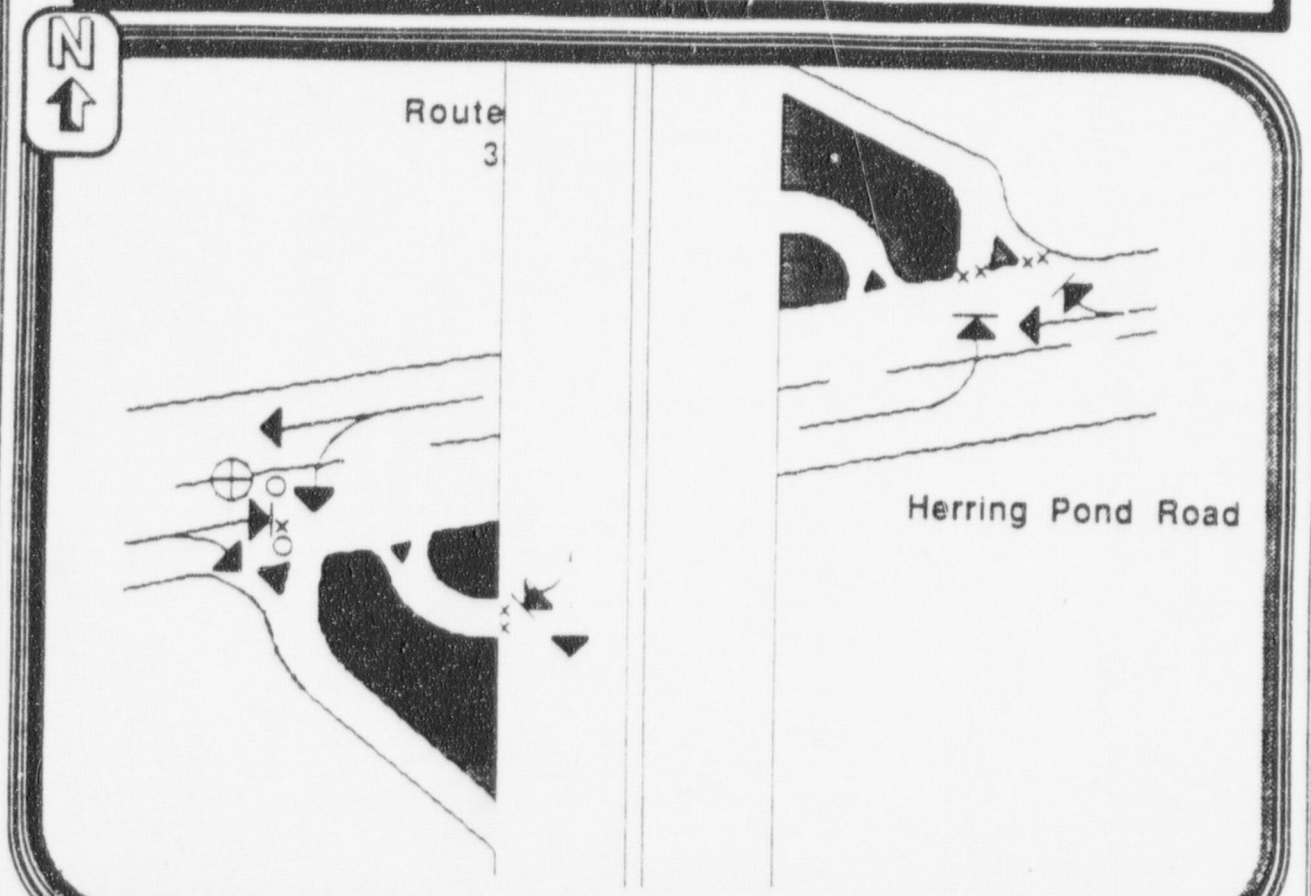
Manpower/Equipment:

1 Traffic Guide
2 Traffic Cones
1 Traffic Barricade

Description:

Facilitate southbound traffic. Discourage northbound traffic on Route 3A.

Point No. P-AT-27



Location:
Route 3 & Herring Pond Road (Plymouth), Exit 2

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

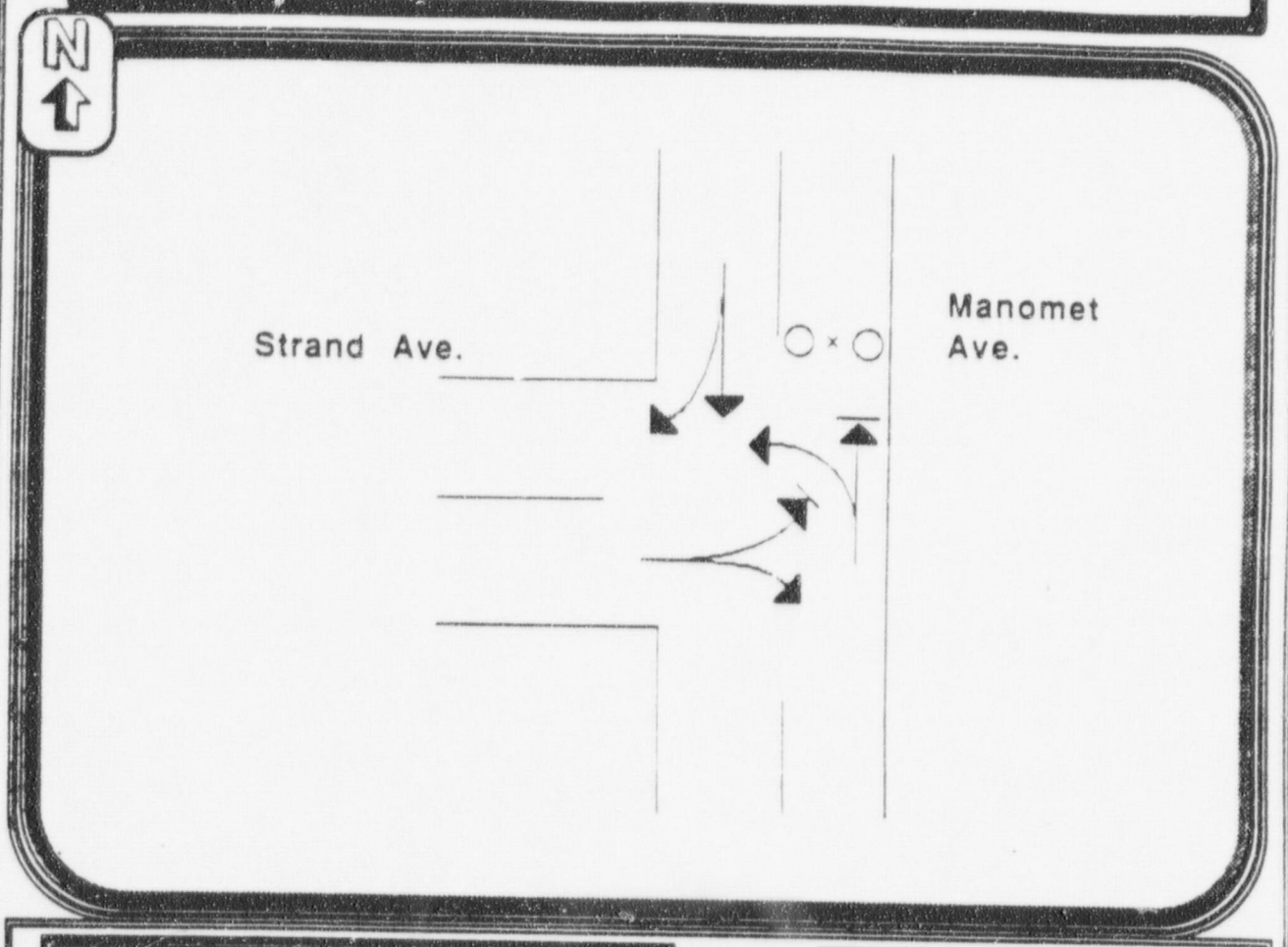
1 Traffic Guide
2 Traffic Cones
7 Traffic Barricades

Description:

Facilitate traffic entering southbound Route 3. Discourage traffic entering northbound Route 3. Discourage eastbound traffic on Herring Pond Road.

PLY ACP P-AT-27	272758
Plymouth Access Control Point #27	

Point No. P-A-28



Location:
Strand Ave. & Manomet Ave. (Plymouth)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

2 Traffic Cones

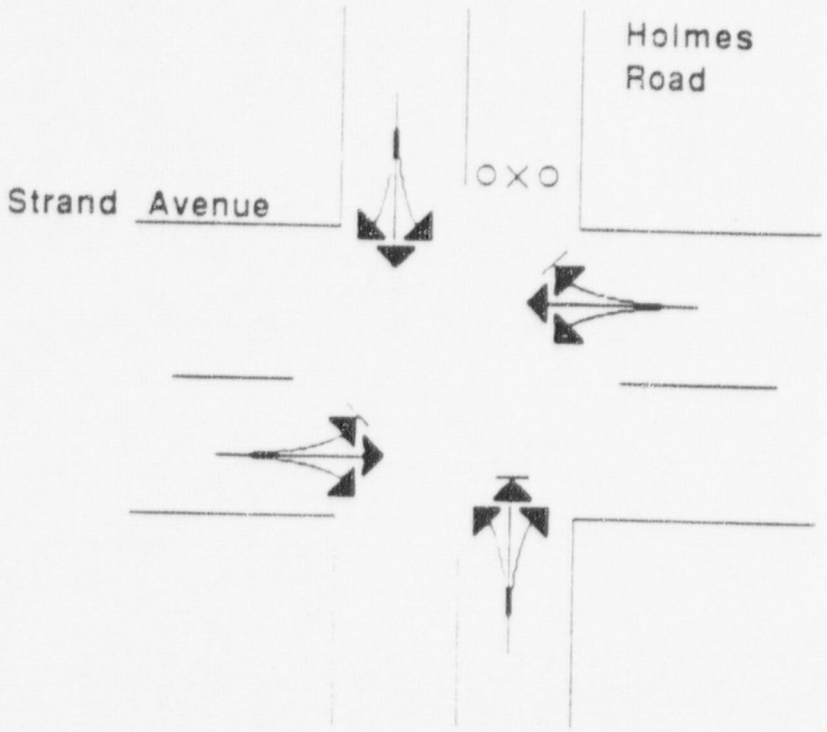
1 Traffic Barricade

Description:

Discourage northbound traffic on Manomet Ave.

PLY ACP P A 28

Pattern No. P-A-28



Location:
Strand Avenue & Holmes Road (Plymouth)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

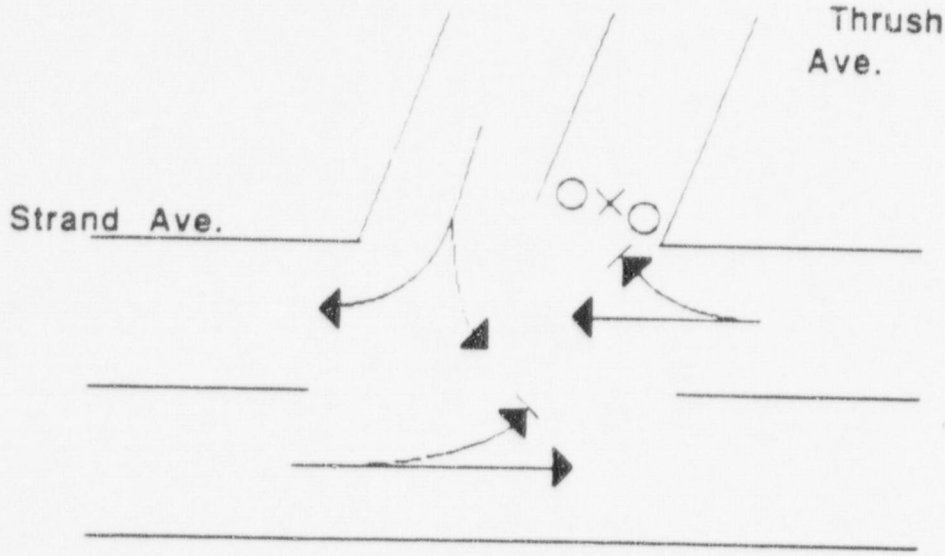
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage northbound traffic on Holmes Road.

Point No. P-A-30



Location:
Strand Ave. & Thrush Ave. (Plymouth)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

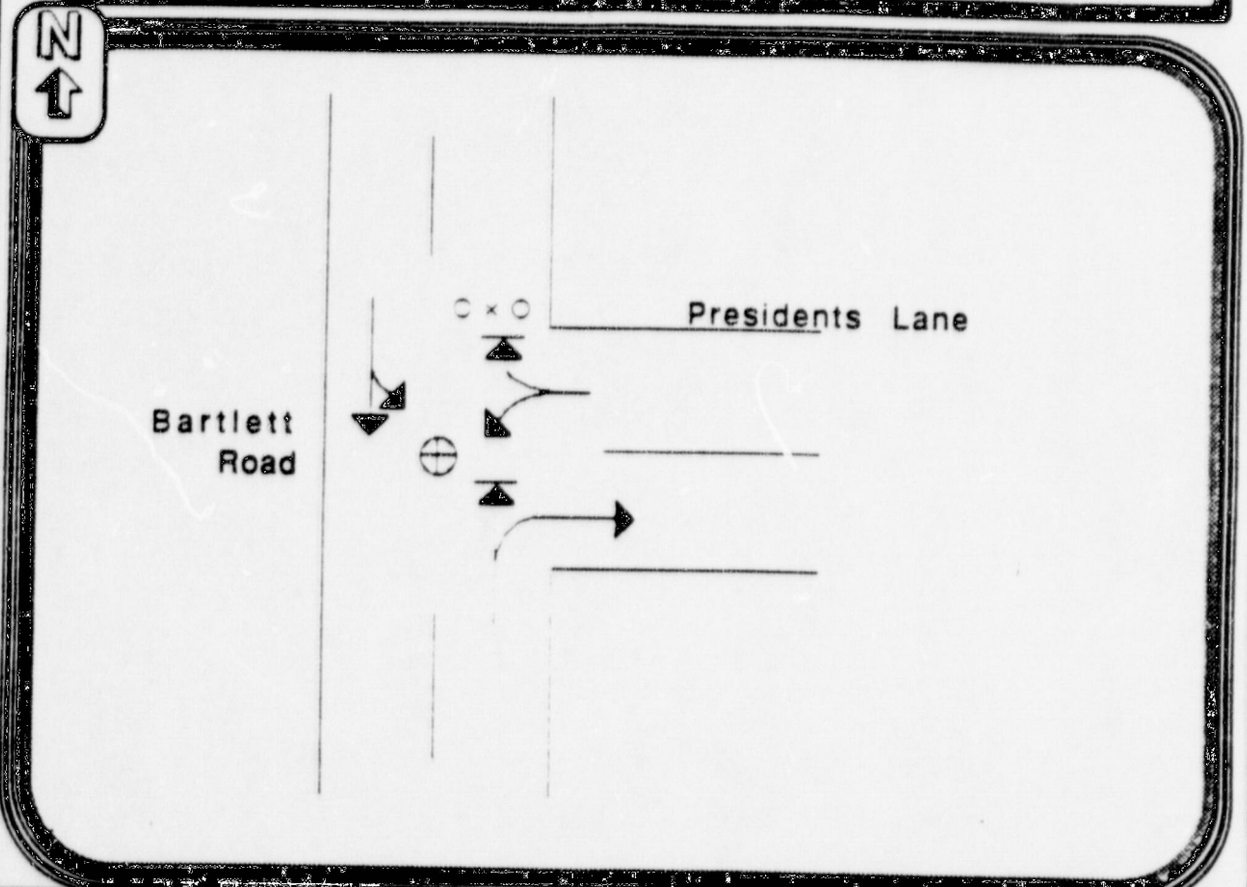
Manpower/Equipment:

2 Traffic Cones

1 Traffic Barricade

Description: Discourage northbound traffic on Thrush Ave.

Point No. P-A-31



Location:
Bartlett Road & Presidents Lane (Plymouth)

Priority: 3

KEY

——▶	Movement facilitated
——▶|	Movement discouraged
⊕	Traffic guide
○	Traffic cone
×	Traffic barricade

Manpower/Equipment:

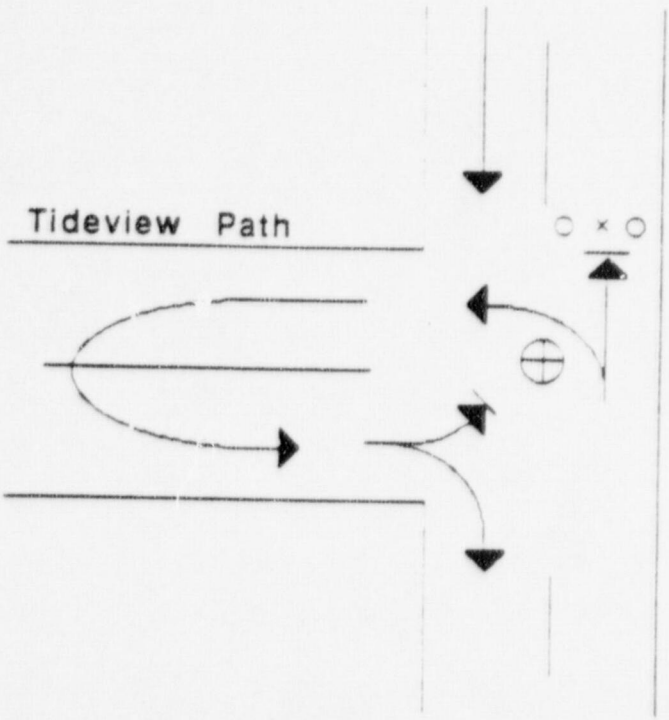
1 Traffic Guide
2 Traffic Cones
1 Traffic Barricade

Description:

Discourage northbound traffic on Bartlett Rd. Facilitate southbound traffic on Bartlett Rd. and turns from Presidents La. to southbound Bartlett Rd.

PLY ACP P-A-31

Detail No. P-A-12



Location:
Beaver Dam Rd. & Tideview Path (Plymouth)

Priority: 3

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

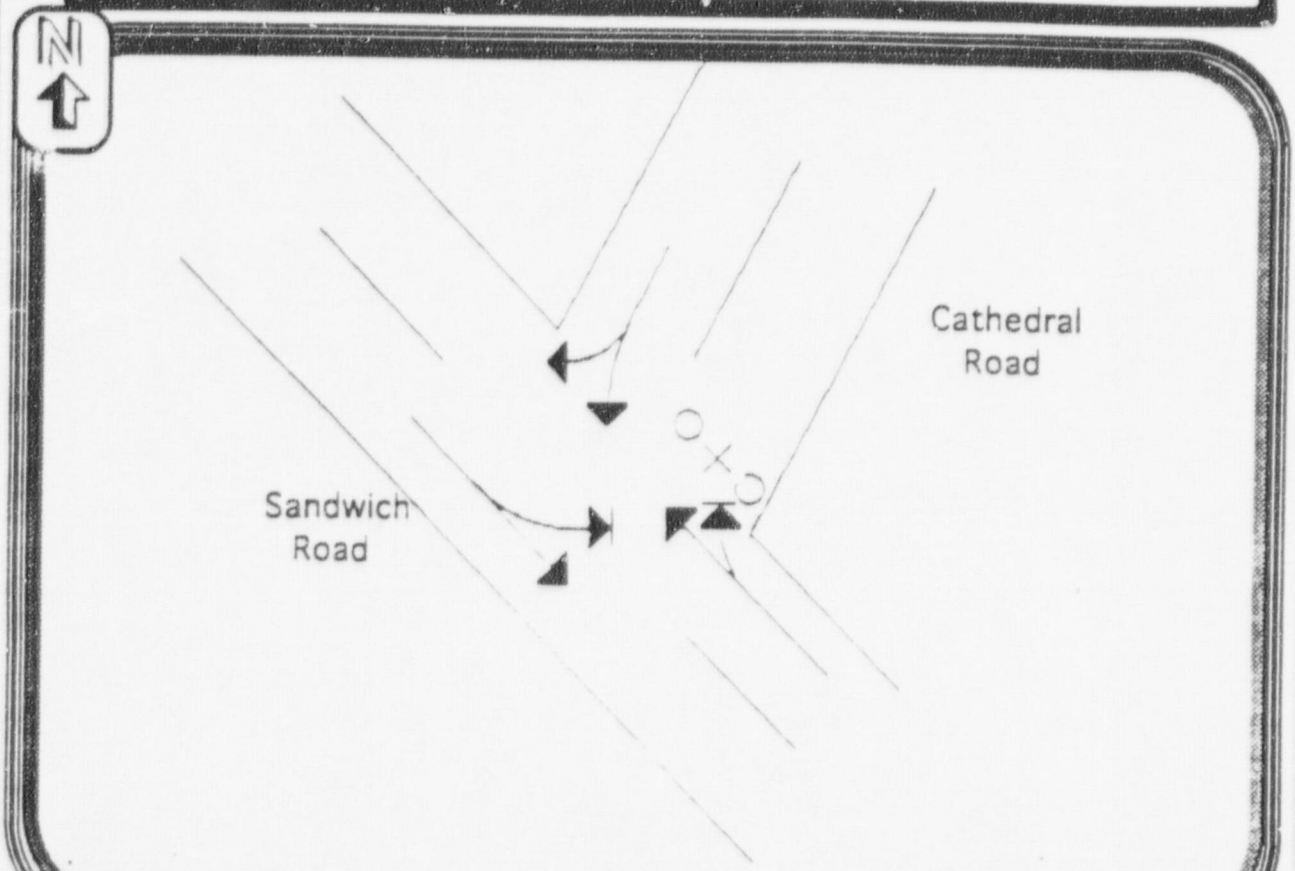
1 Traffic Guide
2 Traffic Cones
1 Traffic Barricade

Description:

Discourage northbound traffic on Beaver Dam Rd. Facilitate turns onto Tideview Path.

PLY ACP P A 12 | 3726AA

Form No. P-A-33



Location:
Sandwich Road & Cathedral Road (Plymouth)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

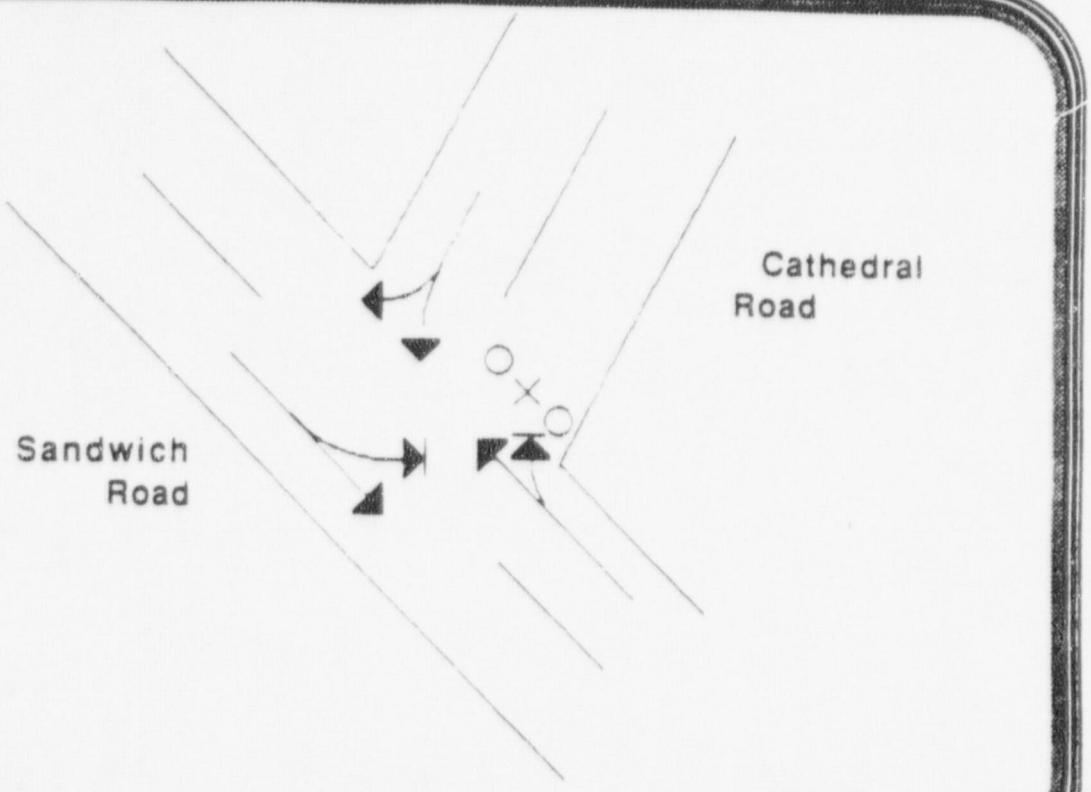
Manpower/Equipment:

2 Traffic Cones

1 Traffic Barricade

Description:
Discourage northbound traffic on Cathedral Road.

Point No. P-A-34



Location:
Sandwich Road & Cathedral Road (Plymouth)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

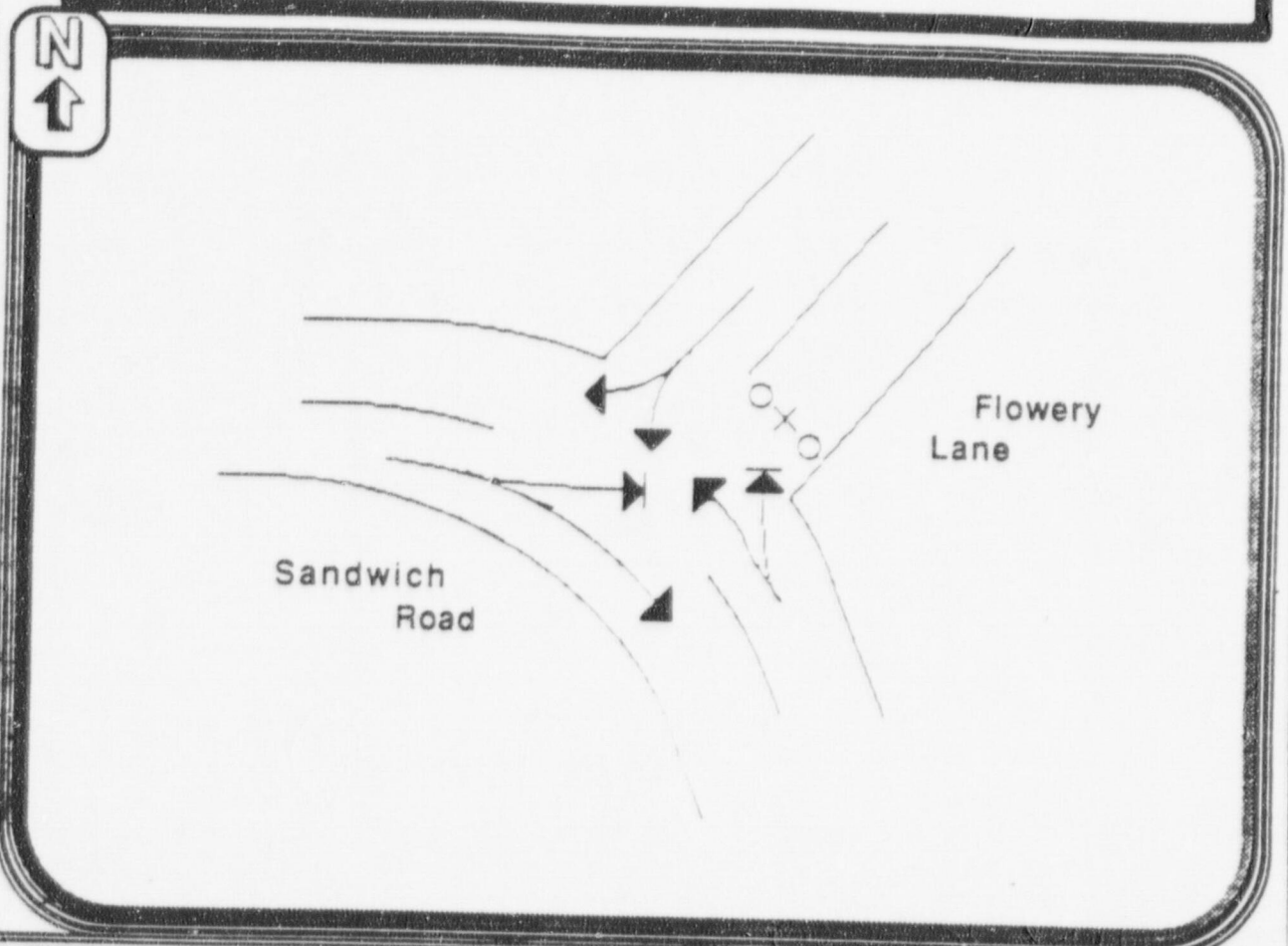
Manpower/Equipment:

2 Traffic Cones

1 Traffic Barricade

Description:
Discourage northbound traffic on Cathedral Road.

Point No. P-A-35



Location:
Sandwich Road & Flowery Lane (Plymouth)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

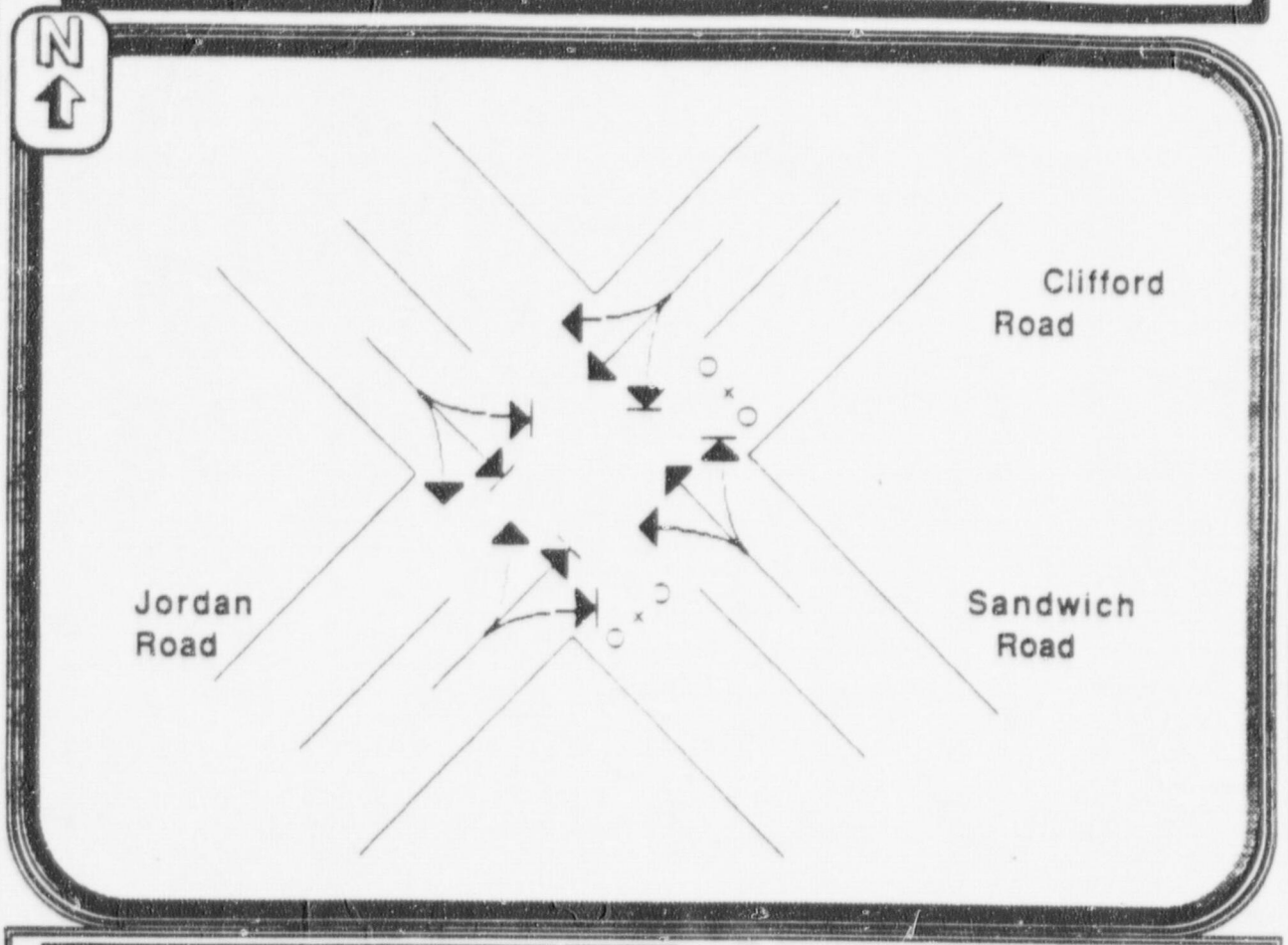
2 Traffic Cones

1 Traffic Barricade

Description: Discourage northbound traffic on Flowery Lane.

PLY ACP-P-A-35

Point No. P-A-36a



Location:
Jordan Road & Sandwich Road (Plymouth)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

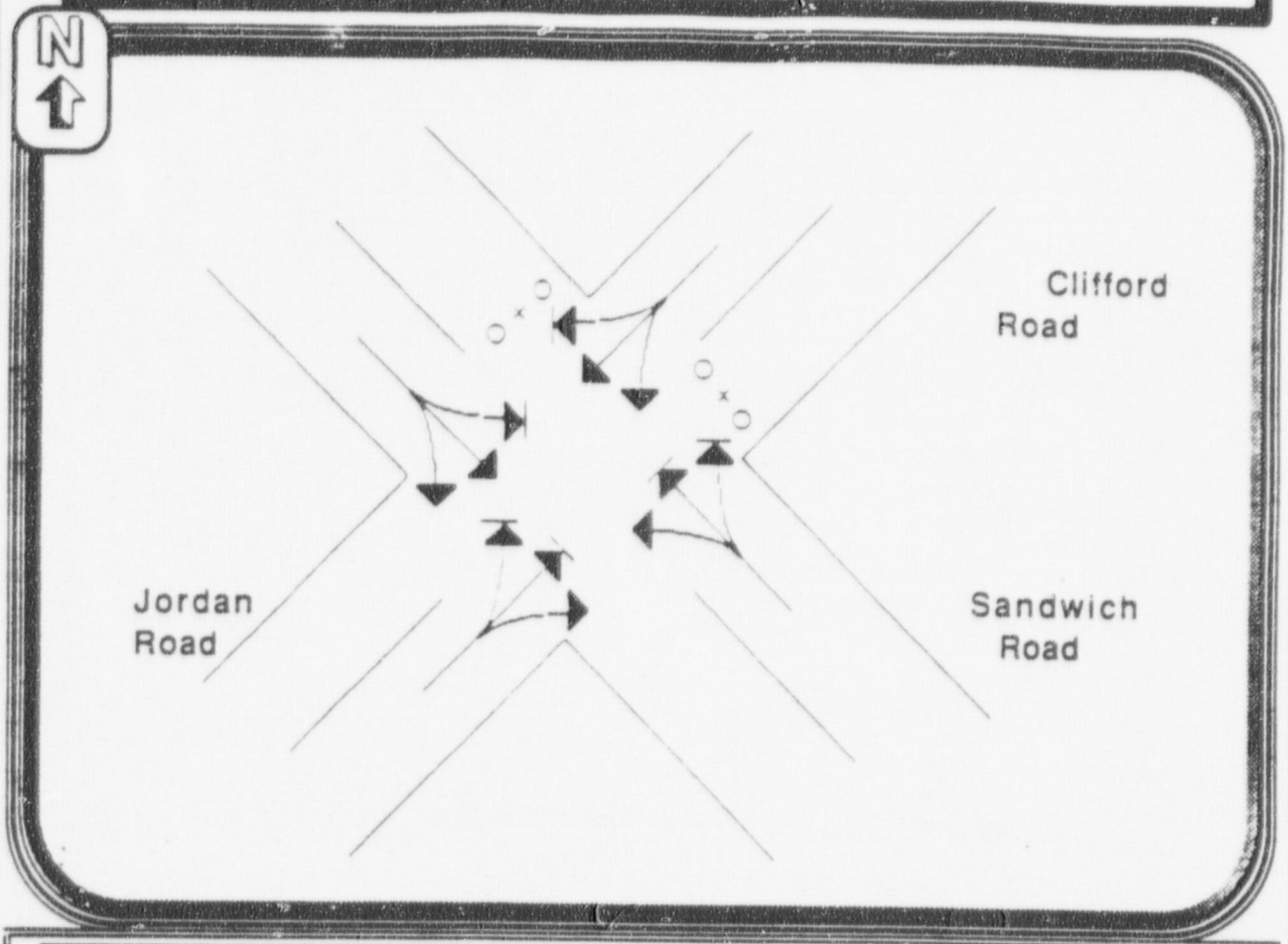
4 Traffic Cones

2 Traffic Barricades

Description:

Discourage southbound traffic on Sandwich Road and northeast bound on Clifford Road.

Point No. P-A-36b



Location:
Jordan Road & Sandwich Road (Plymouth)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

4 Traffic Cones

2 Traffic Barricades

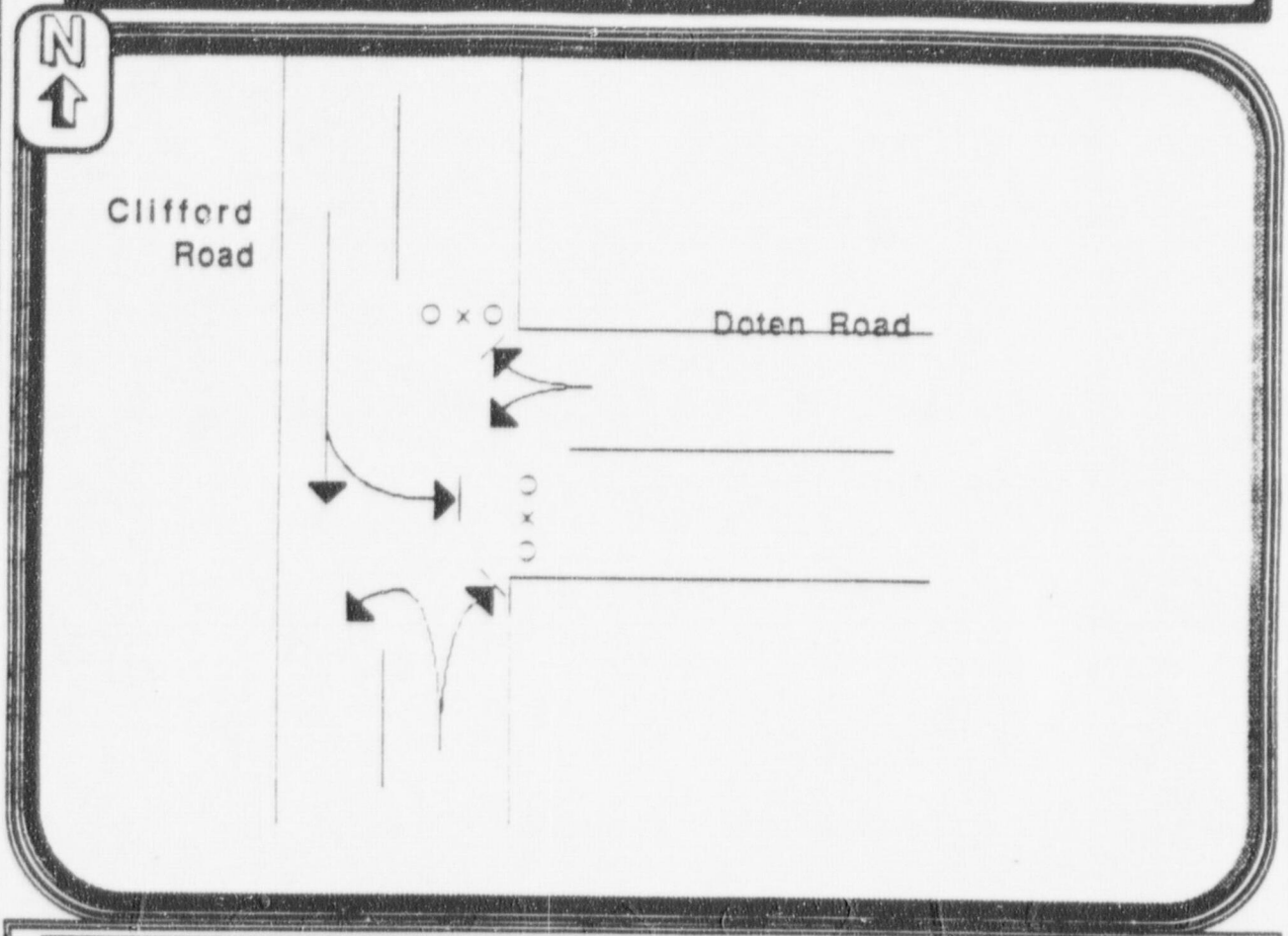
Description:

Discourage northbound traffic on Sandwich Road and northeast bound traffic on Clifford Road.

PLY ACP P A 36b

Plymouth Access Control Point #36b

Point No. P-A-37



Location:
Clifford Road & Doten Road (Plymouth)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

4 Traffic Cones

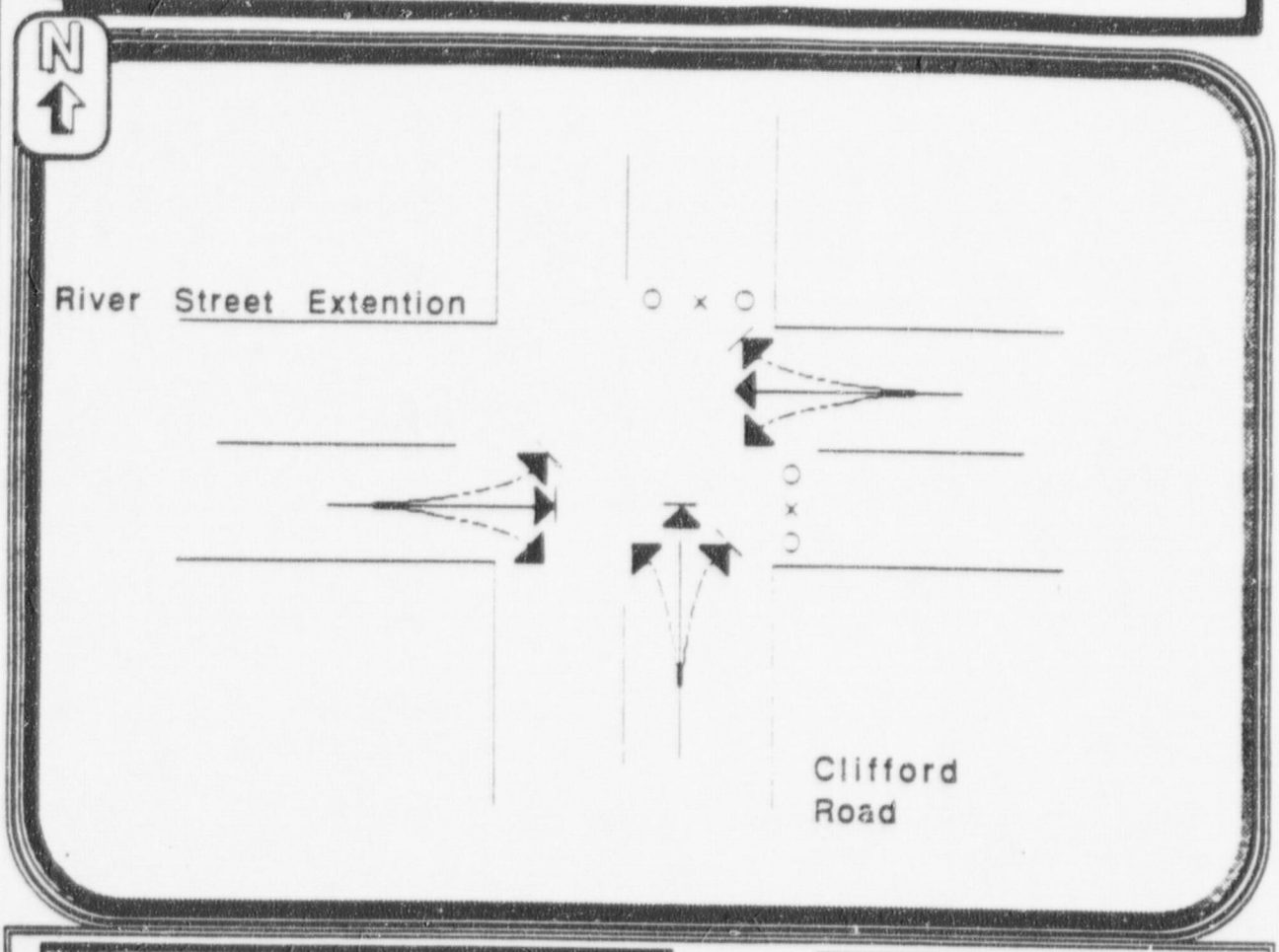
2 Traffic Barricades

Description:

Discourage eastbound traffic on Doten Road and northbound traffic on Clifford Road.

PLY ACPP A-37

Point No. P-A-08



Location:
River Street Extention & Clifford Road
(Plymouth)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

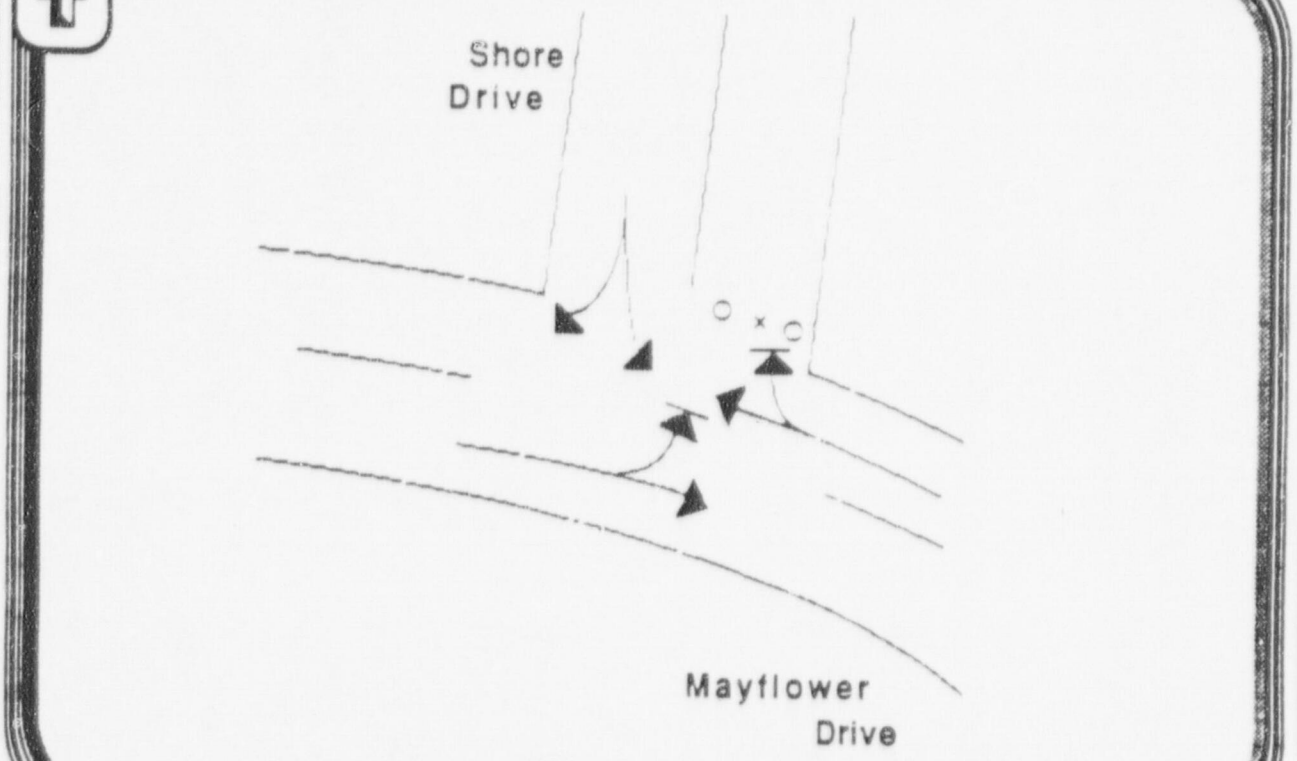
Manpower/Equipment:

4 Traffic Cones

2 Traffic Barricades

Description:

Discourage eastbound traffic on River Street Extention and northbound traffic on Clifford Road.



Location:
Mayflower Drive & Shore Drive (Plymouth)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

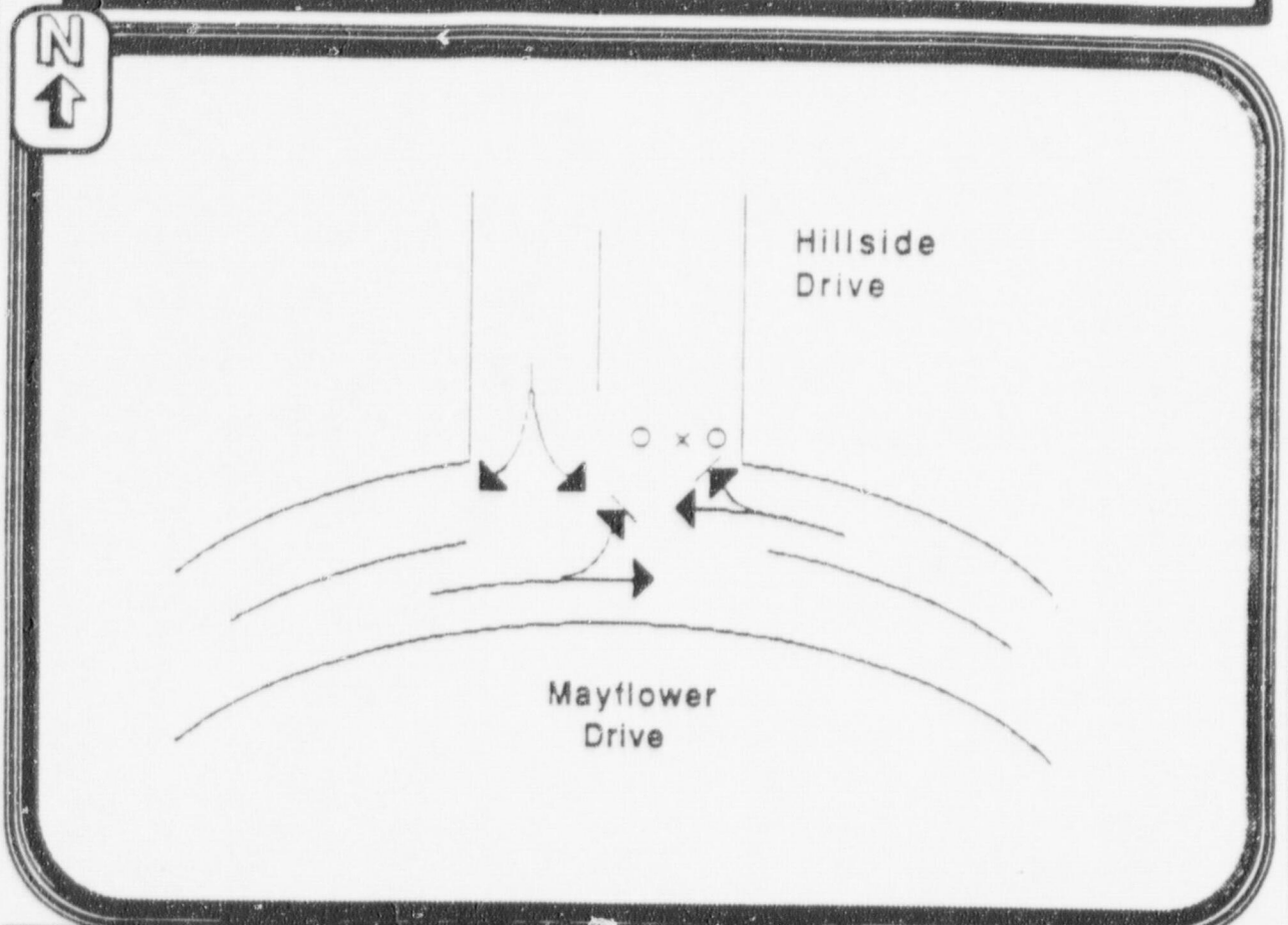
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage northbound traffic on Shore Drive.

Point No. P-A-40



Location:
Mayflower Drive & Hillside Drive (Plymouth)

Priority: 4

KEY

→	Movement facilitated
→	Movement discouraged
⊕	Traffic guide
○	Traffic cone
×	Traffic barricade

Manpower/Equipment:

2 Traffic Cones

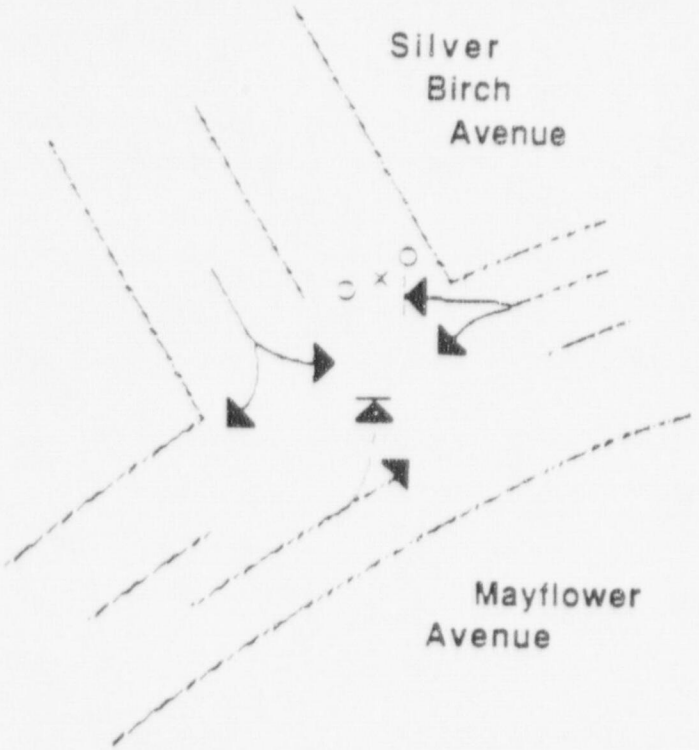
1 Traffic Barricade

Description: Discourage northbound traffic on Hillside Drive.

PLY ACP P A 40

Plymouth Access Control Point 40

Point No. P-A-41



Location:
Mayflower Avenue & Silver Birch Avenue
(Plymouth)

Priority: 4

KEY

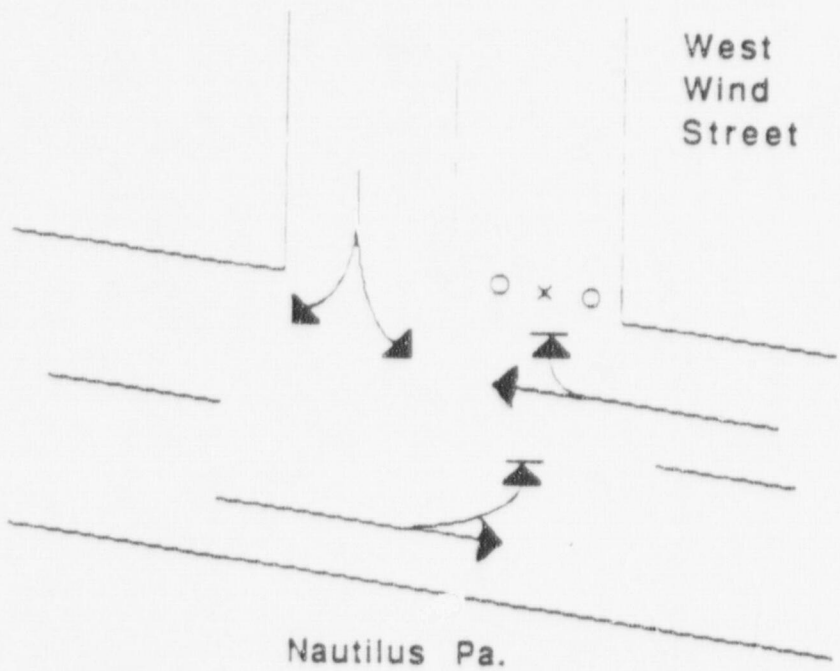
- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

2 Traffic Cones
1 Traffic Barricade

Description:

Discourage northbound traffic on Silver Birch Avenue.



Location:
Nautilus Pa. & West Wind Street (Plymouth)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

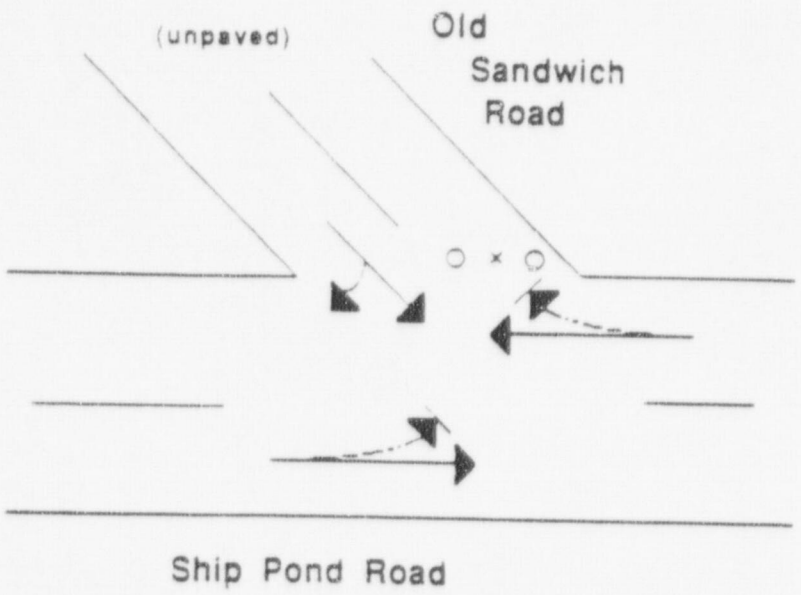
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage northbound traffic on West Wind Street.

Point No. P-A-43



Location:
Old Sandwich Road & Ship Pond Road (Plymouth)

Priority: 4

KEY

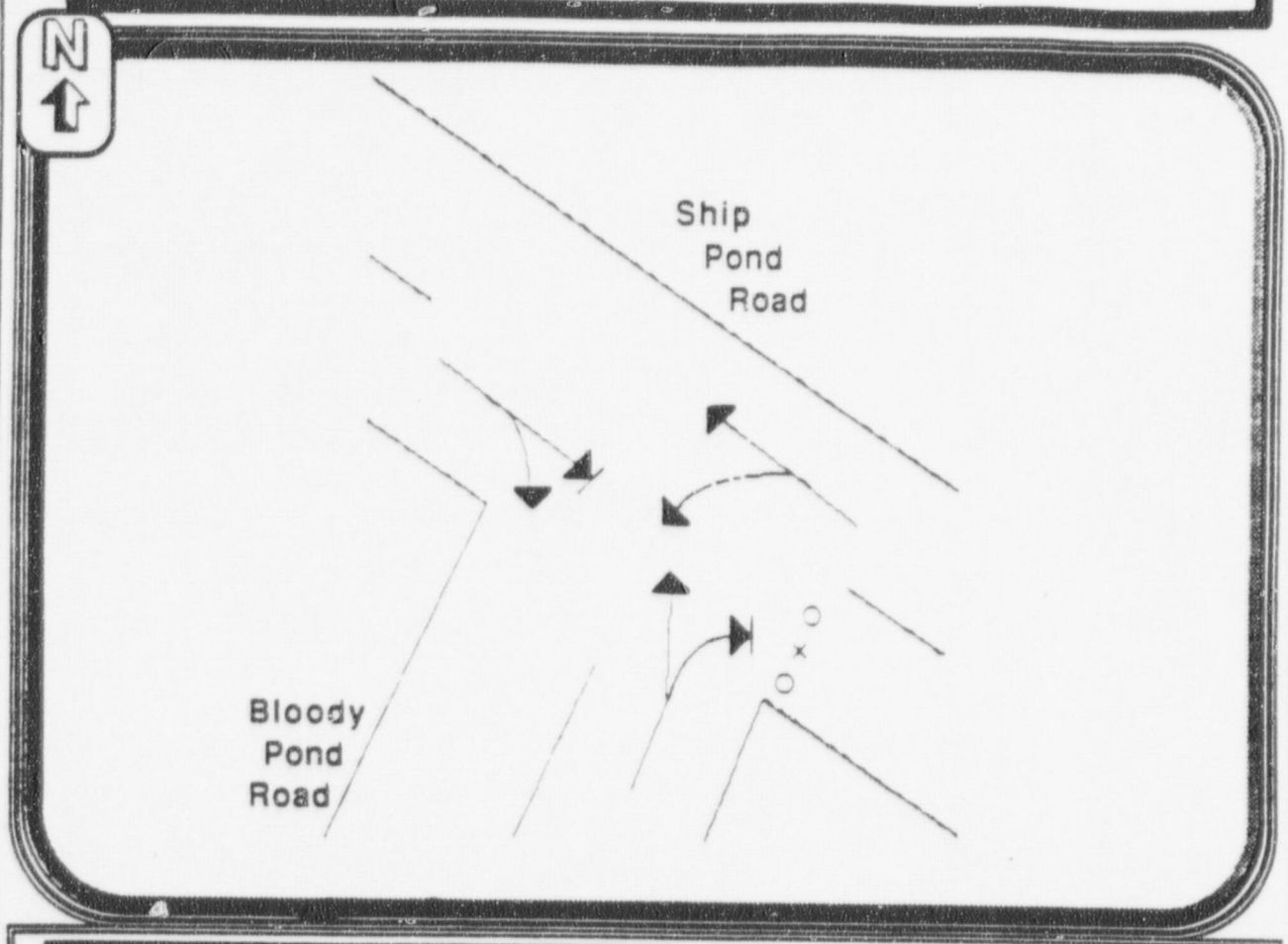
- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

2 Traffic Cones
1 Traffic Barricade

Description:
Discourage northbound traffic on Old Sandwich Road.

Point No. P-A-4-4



Location:
Ship Pond Road & Bloody Pond Road (Plymouth)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

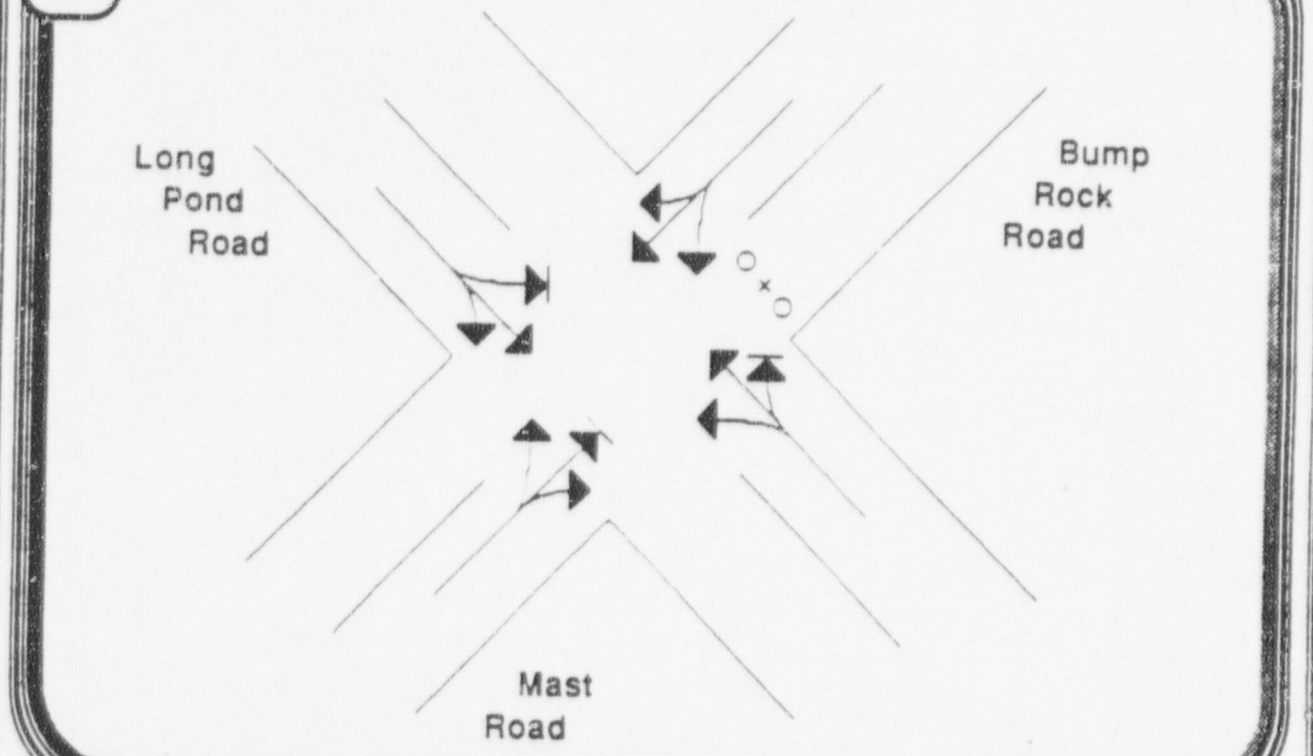
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage eastbound traffic on Ship Pond Road.

Point No. P-A-45



Location:
Long Pond Road & Bump Rock Road (Plymouth)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- ⊕ Traffic guide
- ○ Traffic cone
- × Traffic barricade

Manpower/Equipment:

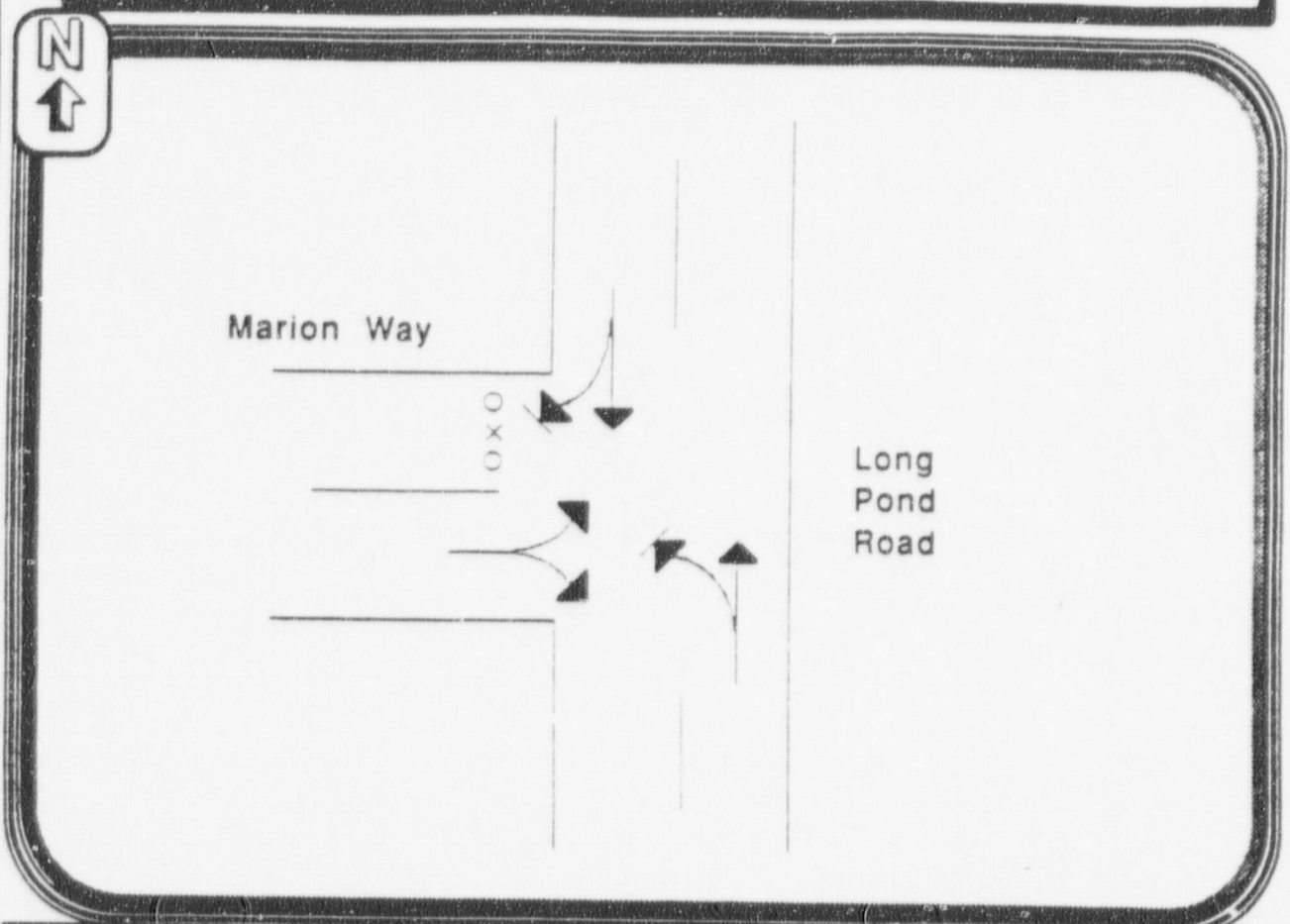
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage northbound traffic on Bump Rock Road.

Point No. P-A-46



Location:
Long Pond Road & Marion Way (Plymouth)

Priority: 4

KEY

→	Movement facilitated
→	Movement discouraged
⊕	Traffic guide
○	Traffic cone
×	Traffic barricade

Manpower/Equipment:

2 Traffic Cones

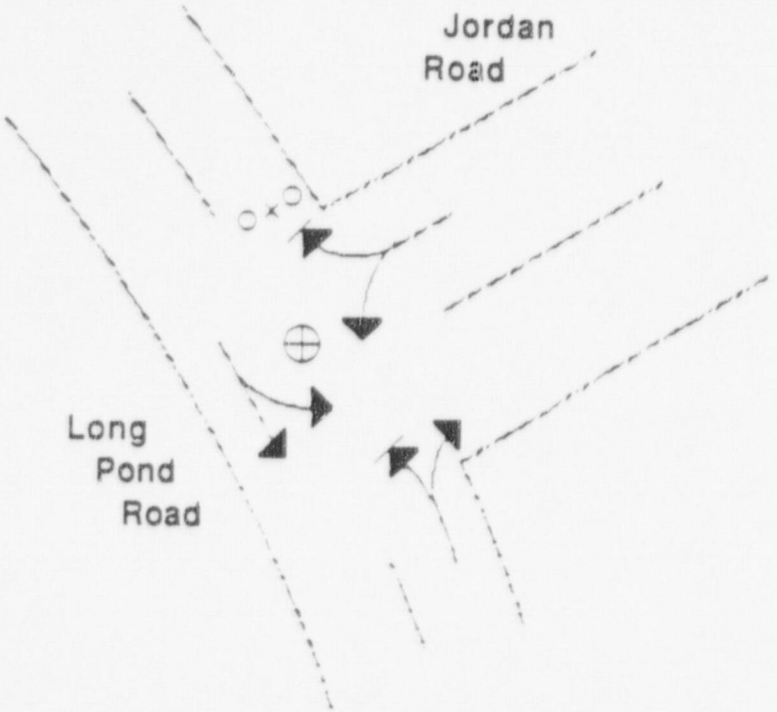
1 Traffic Barricade

Description: Discourage westbound traffic on Marion Way.

PLY ACP P-A-46

Plymouth Access Control Point #46

Point No. P-A-47



Location:
Long Pond Road & Jordan Road (Plymouth)

Priority: 3

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

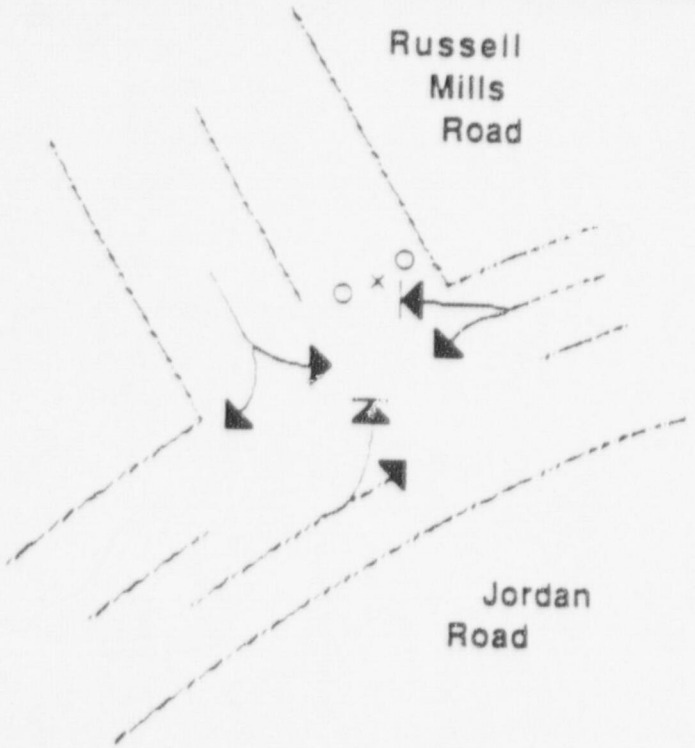
Manpower/Equipment:

1 Traffic Guide
2 Traffic Cones
1 Traffic Barricade

Description:

Discourage westbound traffic on Long Pond Road.

Detail No. P-A-4 B



Location:
Jordan Road & Russell Mills Road (Plymouth)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

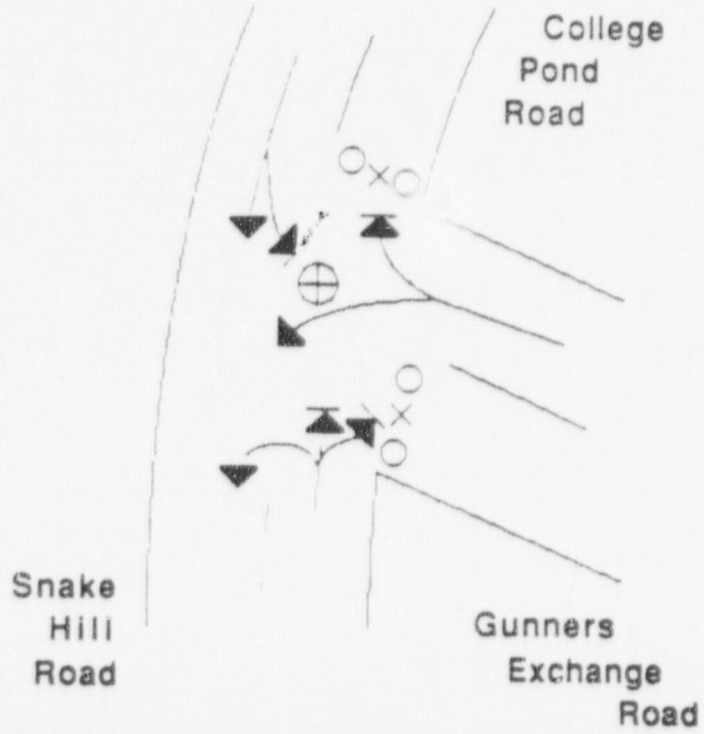
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage northbound traffic on Russell Mills Road.

Point No. P-A-48



Location:
College Pond Road & Gunners Exchange Road
(Plymouth)

Priority: 3

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

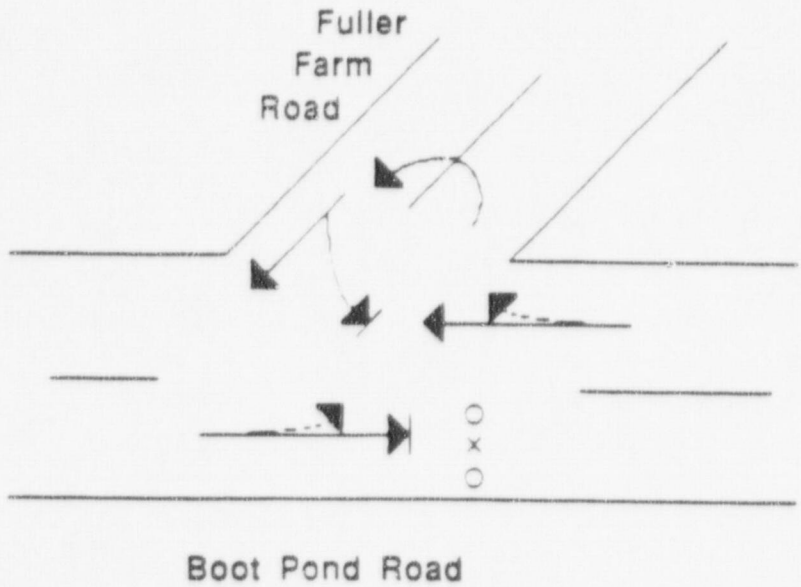
Manpower/Equipment:

1 Traffic Guide
4 Traffic Cones
2 Traffic Barricades

Description:

Discourage northbound traffic on College Pond Road and eastbound traffic on Gunners Exchange Road.

Point No. P-A-50



Location:
Boot Pond Road & Fuller Farm Road (east side of Boot Pond) (Plymouth)

Priority: 4

KEY

——▶	Movement facilitated
——▶|	Movement discouraged
⊕	Traffic guide
○	Traffic cone
×	Traffic barricade

Manpower/Equipment:

2 Traffic Cones

1 Traffic Barricade

Description:

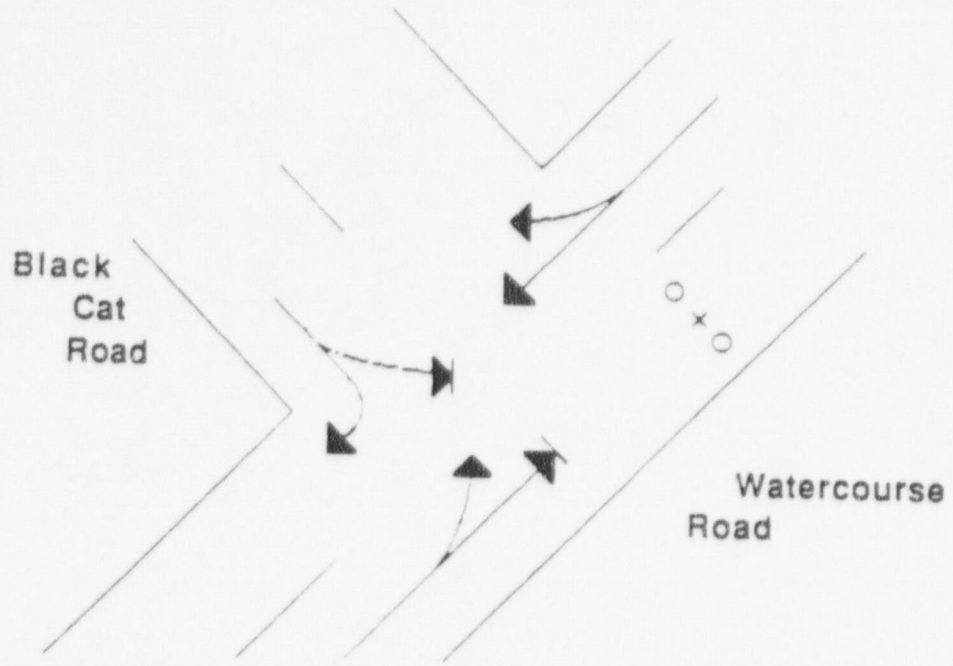
Discourage eastbound traffic on Boot Pond Road.

PLY ACP P A 50 | 272888

Plymouth Access Control Point #50

Rev. 5

Point No. P-A-51



Location:
Black Cat Road & Watercourse Road (Plymouth)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

2 Traffic Cones

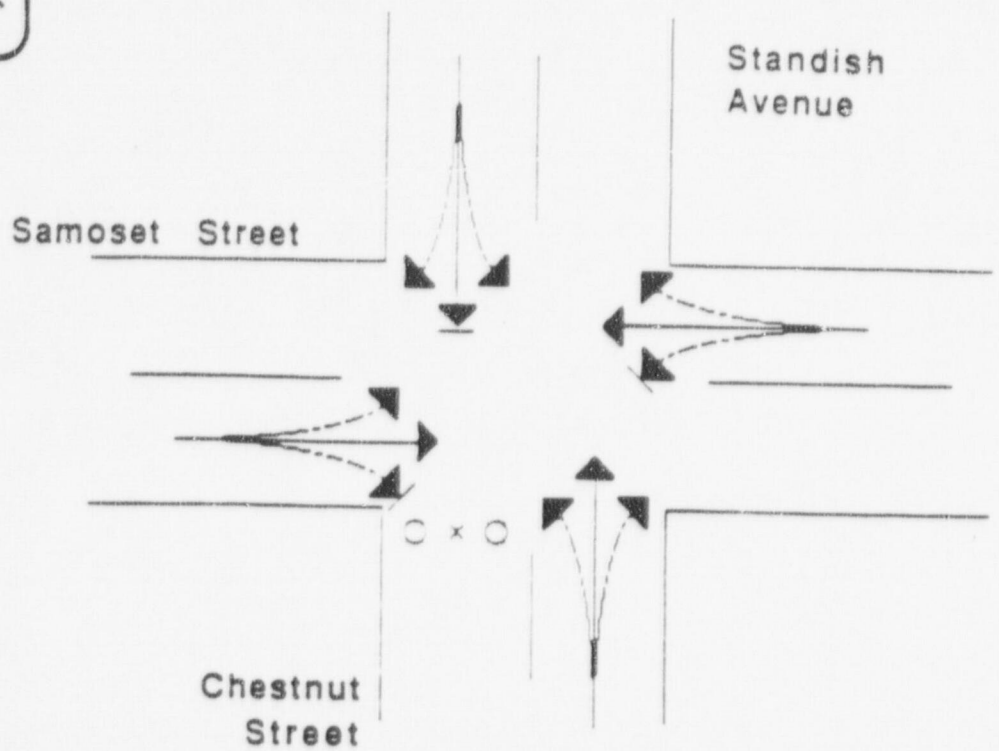
1 Traffic Barricade

Description:

Discourage northbound traffic on Watercourse Road.

PLY ACPP A-51

Plan No. P-A-52



Location:
Samoset Street & Chestnut Street (Plymouth)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

2 Traffic Cones

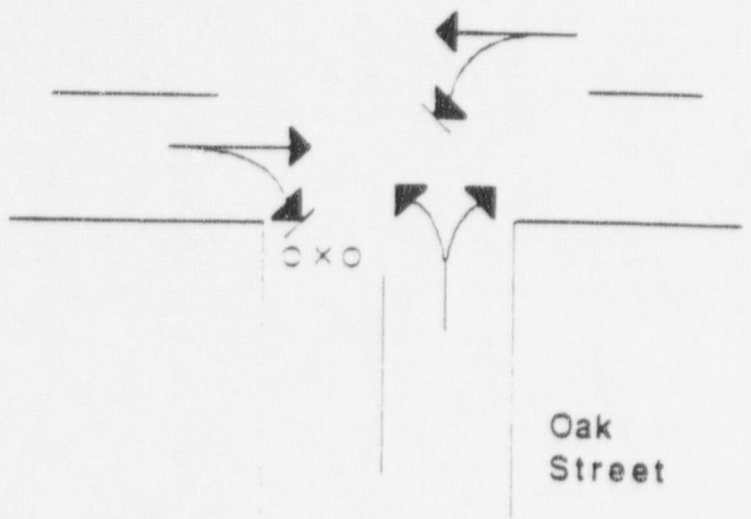
1 Traffic Barricade

Description:

Discourage southbound traffic on Chestnut Street.

PLY ACP P A-52

Point No. P-A-33



Location:
Samoset Street & Oak Street (Plymouth)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

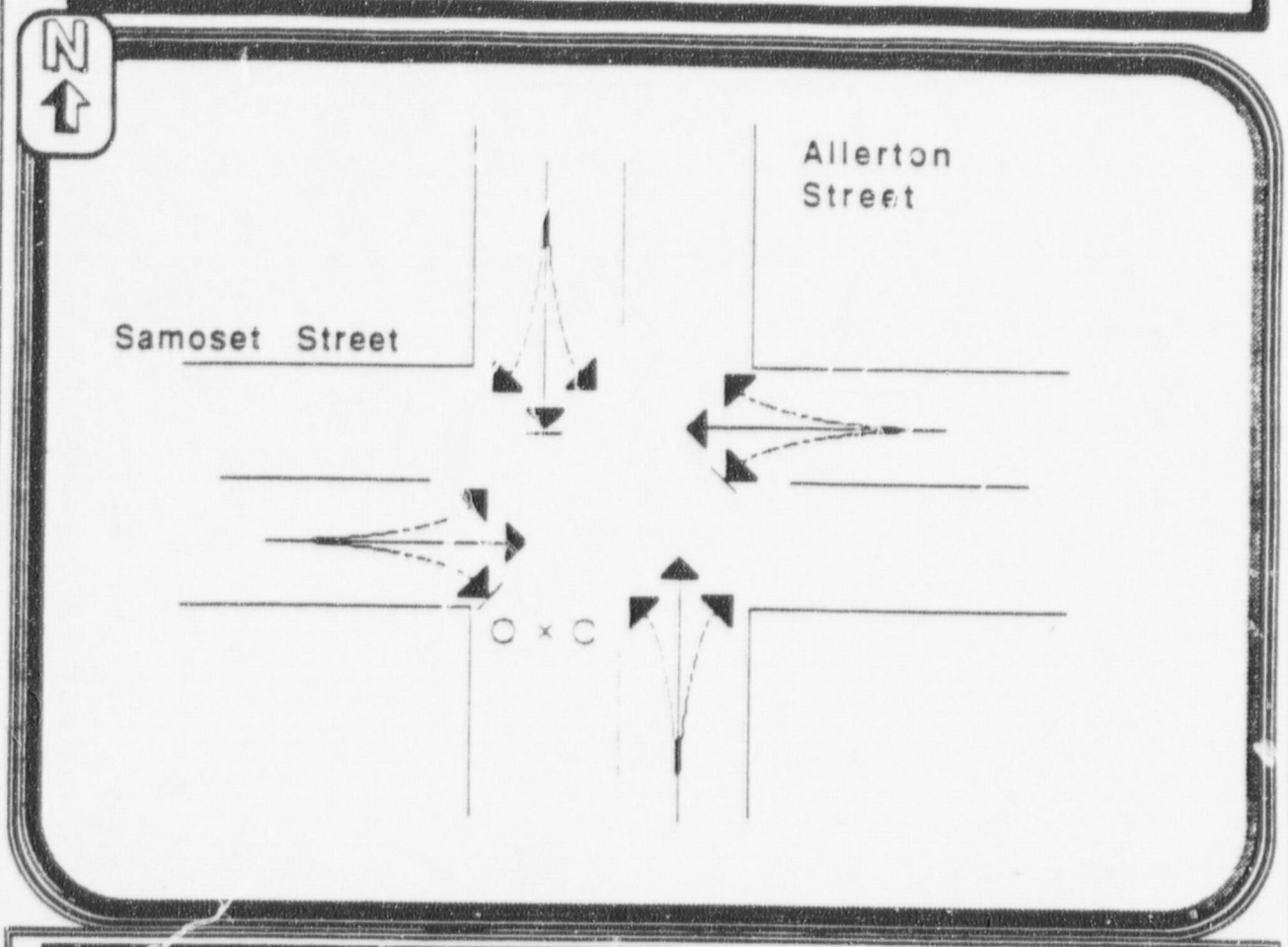
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage southbound traffic on Oak Street.

Point No. P-A-54



Location:
Samoset Street & Allerton Street (Plymouth)

Priority: 4

KEY

——►	Movement facilitated
——►|	Movement discouraged
⊕	Traffic guide
○	Traffic cone
×	Traffic barricade

Manpower/Equipment:

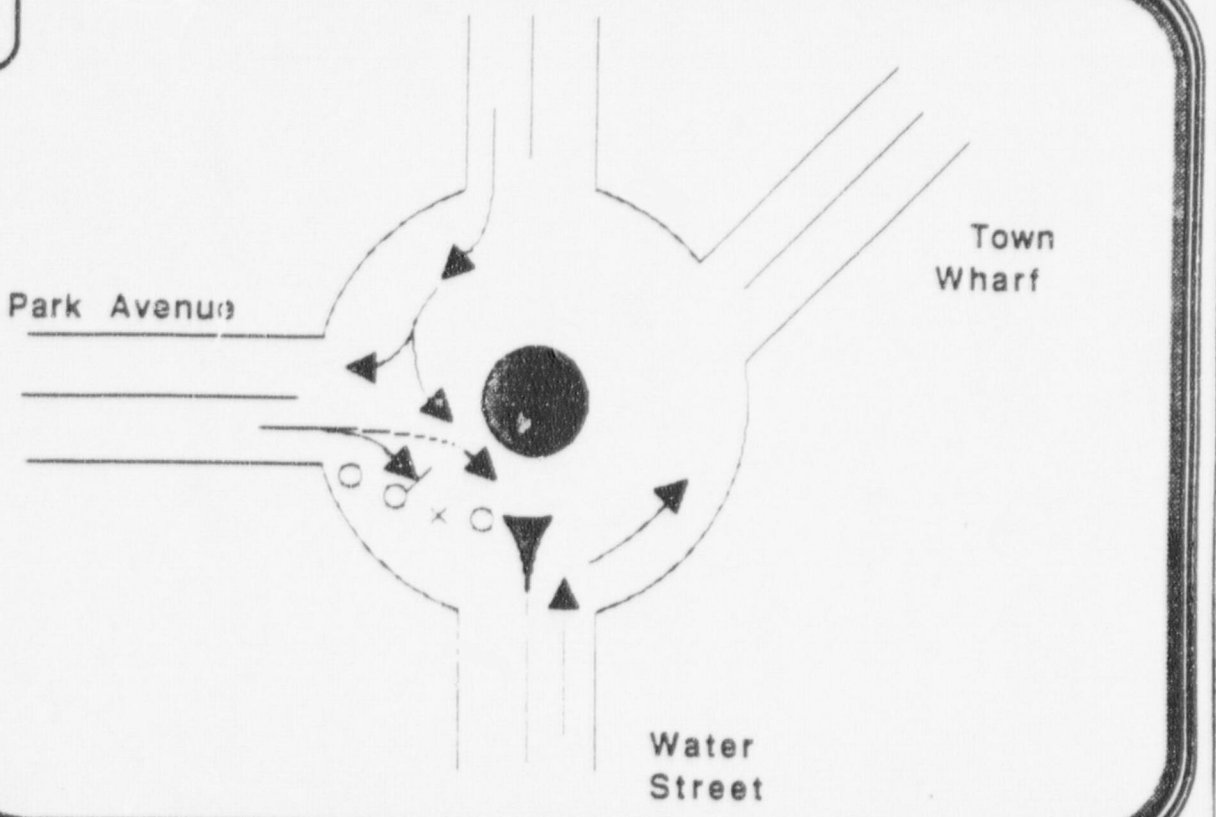
2 Traffic Cones

1 Traffic Barricade

Description: Discourage southbound traffic on Allerton Street.

PLY-ACP-P-A-54 | 072888
Plymouth Access Control Point #54

Point No. P-A-55



Location:
Park Avenue & Water Street (Plymouth)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

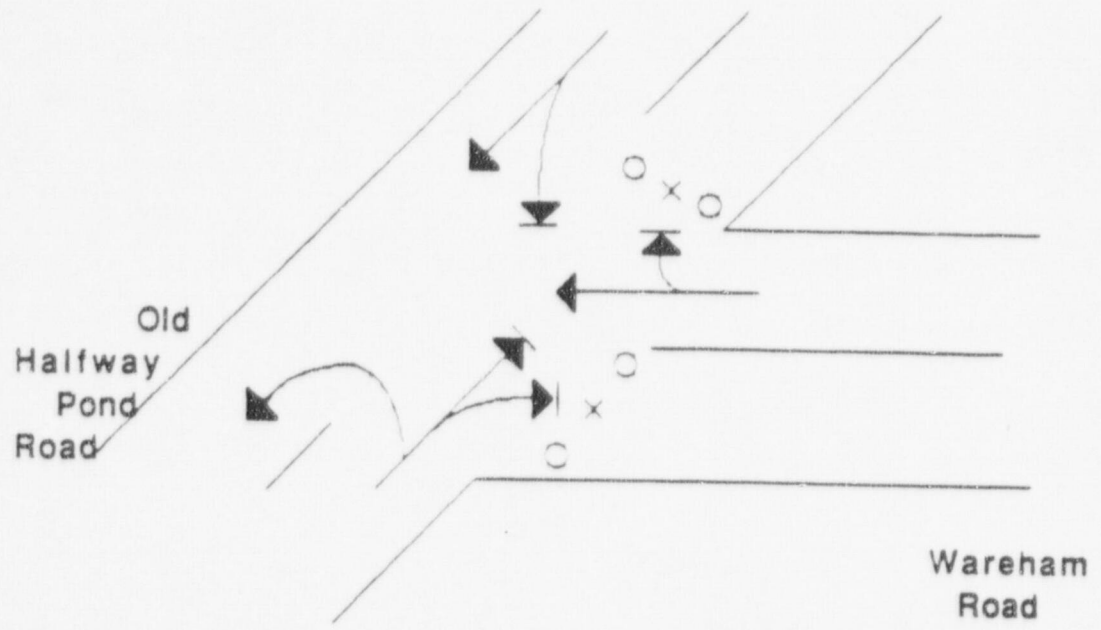
3 Traffic Cones

1 Traffic Barricade

Description:

Discourage southbound traffic on Water Street.

Point No. P-A-58



Location:
Old Halfway Pond Road & Wareham Road
(Plymouth)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

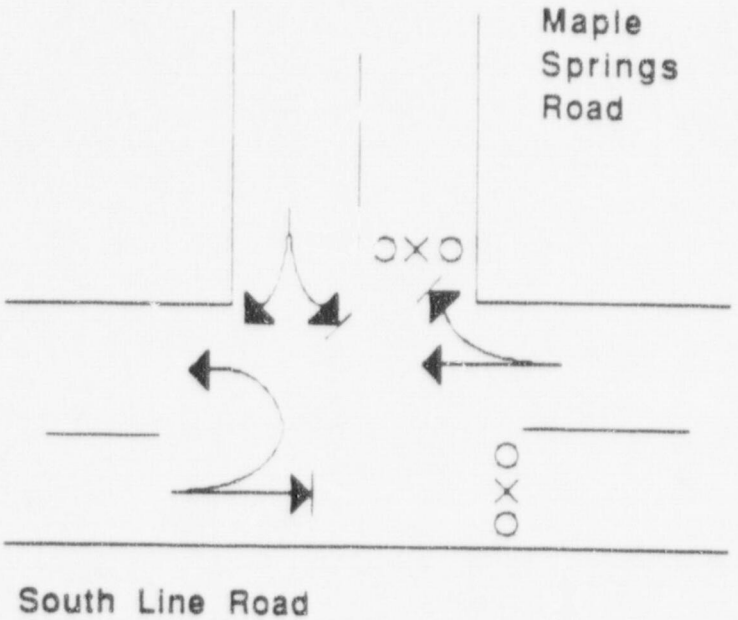
4 Traffic Cones

2 Traffic Barricades

Description:

Discourage northbound traffic on Wareham Road and Old Halfway Pond Road.

Point No. P-A-57



Location:
Maple Springs Road & South Line Road
(Plymouth)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

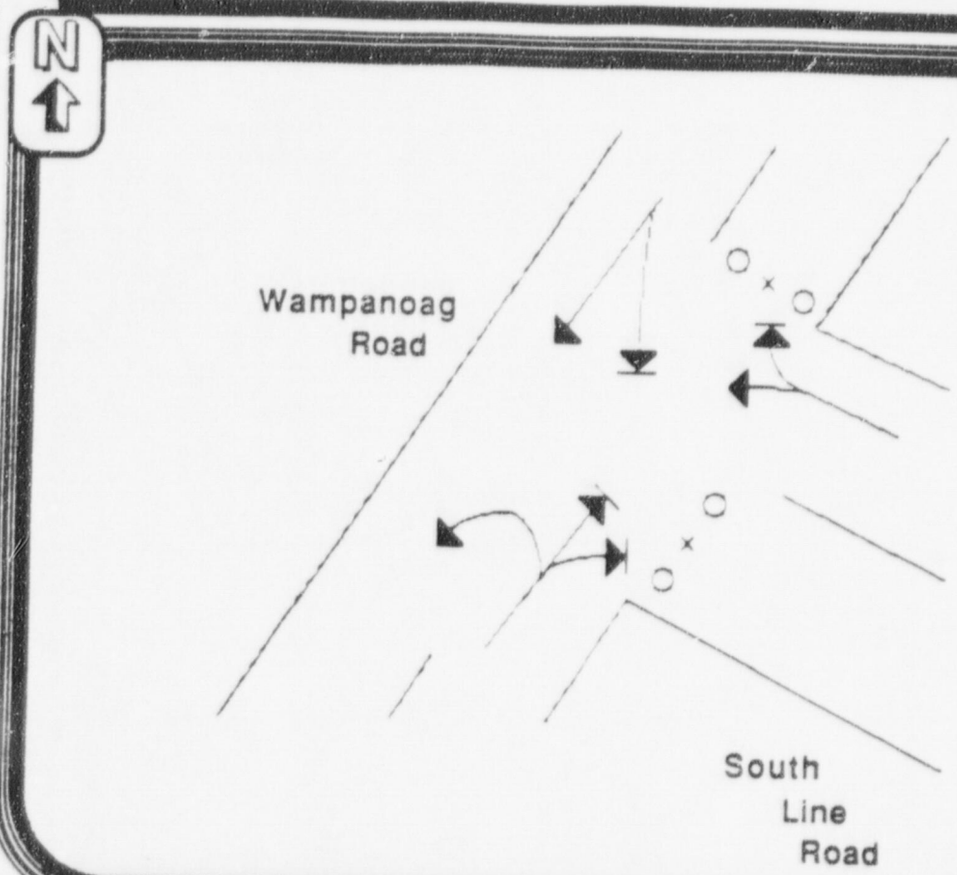
4 Traffic Cones

2 Traffic Barricades

Description:

Discourage northbound traffic on Maple Springs Road and eastbound traffic on South Line Road.

Point No. P-A-58



Location:
Wampanoag Road & South Line Road (Plymouth)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

4 Traffic Cones

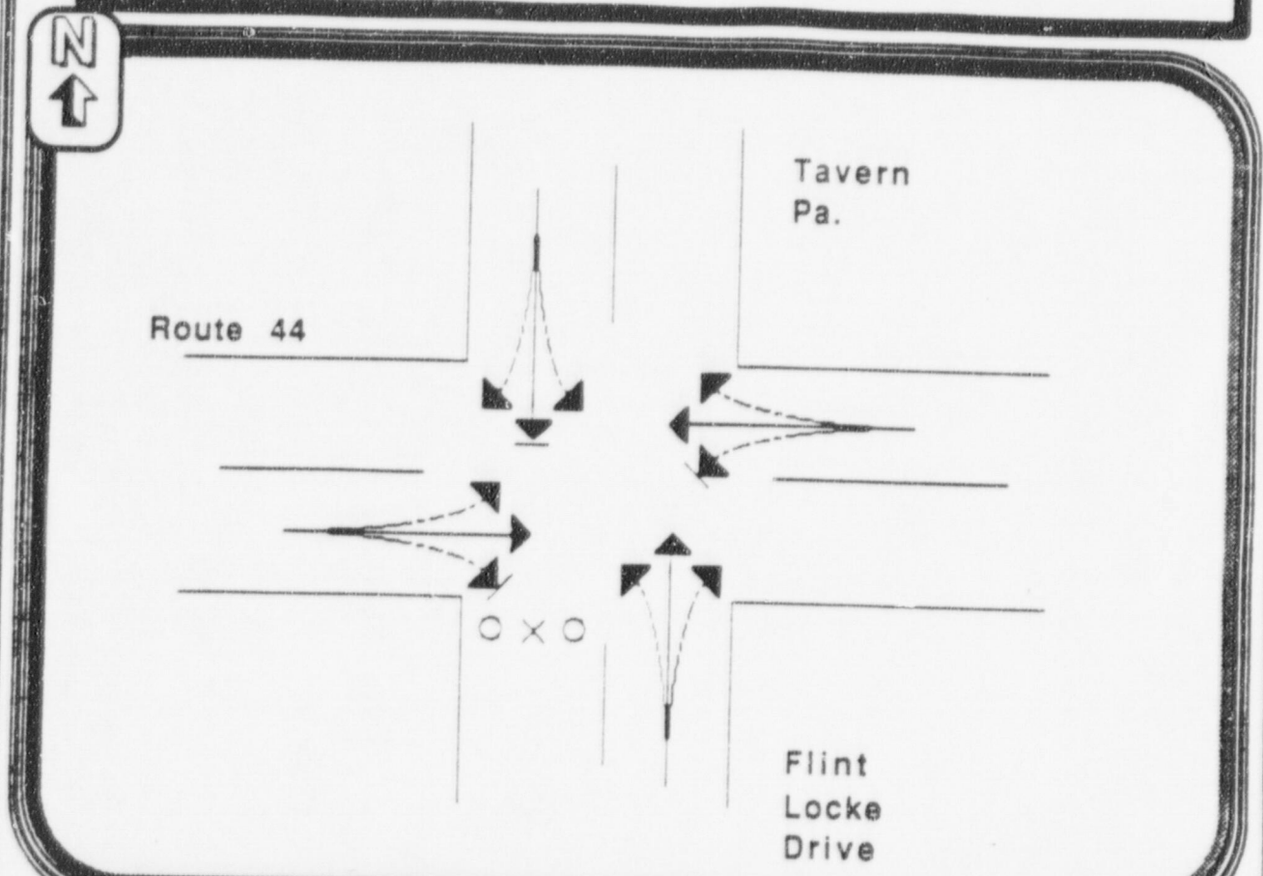
2 Traffic Barricades

Description:

Discourage northbound traffic on Wampanoag Road and eastbound traffic on South Line Road.

PLY ACP P-A-58 | 072888

Point No. P-A-598



Location:
Route 44 & Flint Locke Drive (Plymouth)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

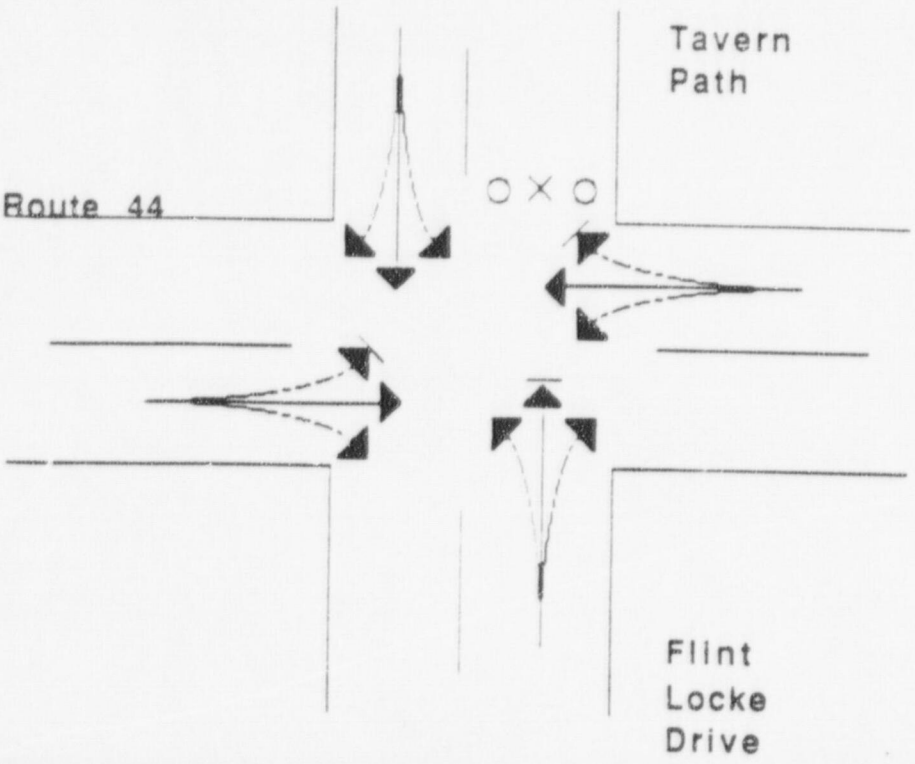
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage southbound traffic on Flint Locke Drive.

Plan No. P-A-681



Location:
Route 44 & Flint Locke Drive (Plymouth)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

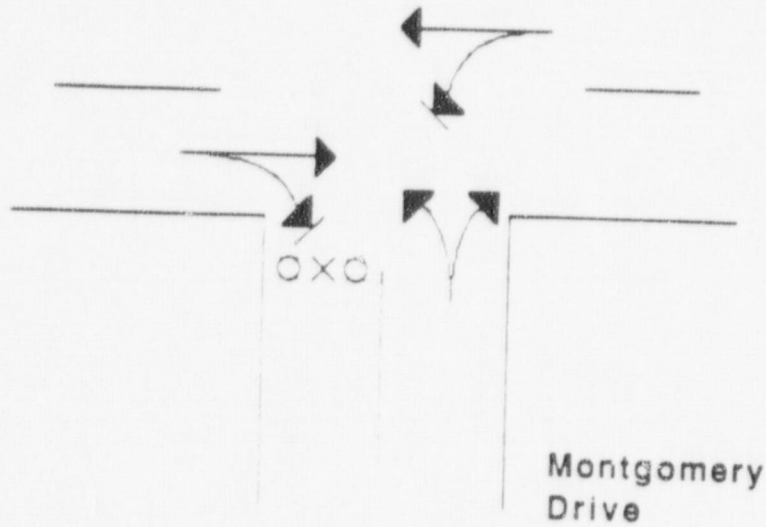
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage northbound traffic on Tavern Path.

Plan No. P-A-80



Location:
Route 44 & Montgomery Drive (Plymouth)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

2 Traffic Cones

1 Traffic Barricade

Description:

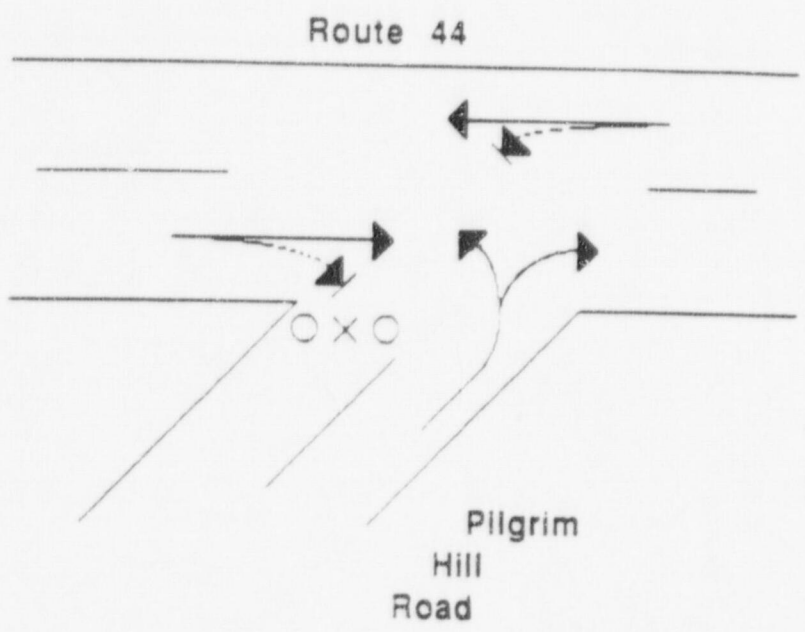
Discourage southbound traffic on Montgomery Drive.

PLY ACP P A 80

P-A-80

Rev. 5

Plan No. P-A-81



Location:
Route 44 & Pilgrim Hill Road (Plymouth)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

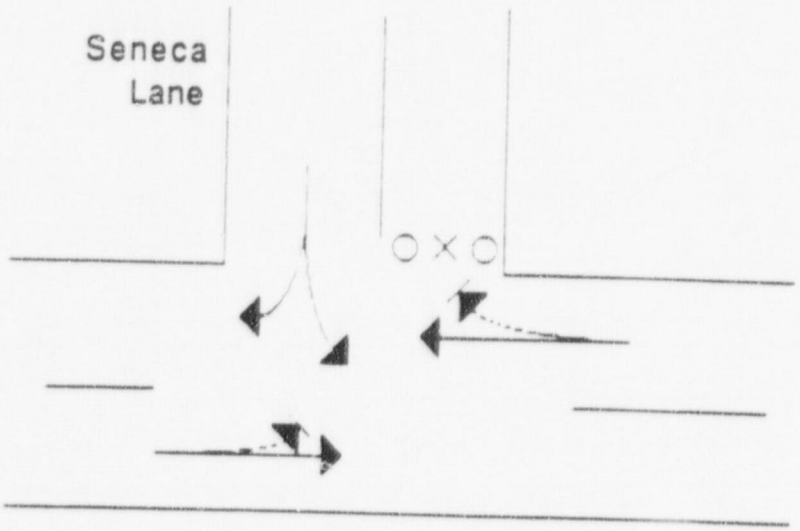
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage southbound traffic on Pilgrim Hill Road.

Point No. E-A-82



Location:
Route 44 & Seneca Lane (Plymouth)

Priority: 4

KEY

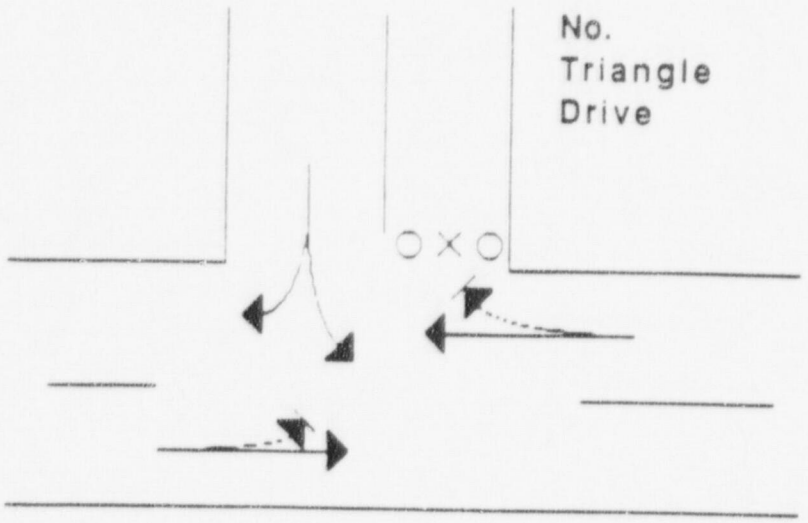
- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

2 Traffic Cones
1 Traffic Barricade

Description:
Discourage northbound traffic on Seneca Lane.

Point No. P-A-83



Location:
Route 44 & No. Triangle Drive (Plymouth)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

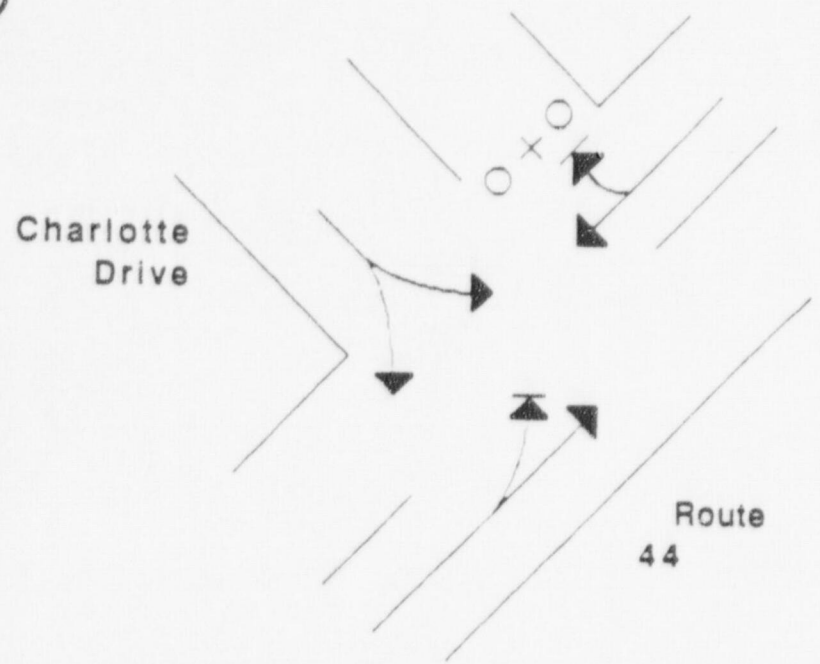
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage northbound traffic on No. Triangle Drive.

Point No: P-A-84



Location:
Route 44 & Charlotte Drive (Plymouth)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

2 Traffic Cones

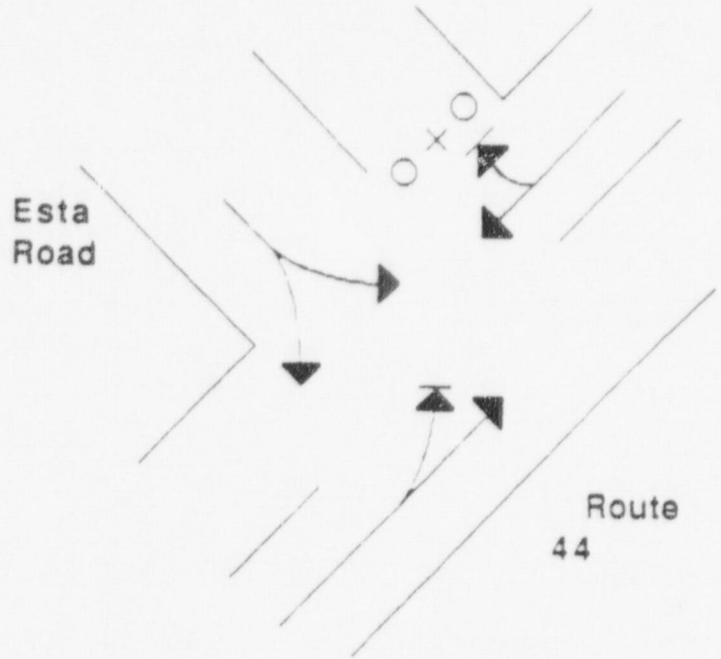
1 Traffic Barricade

Description:

Discourage northbound traffic on Charlotte Drive.

PLY ACP P A 84

Plan No. P-A-85



Location:
Route 44 & Esta Road (east of Tavern Path)
(Plymouth)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

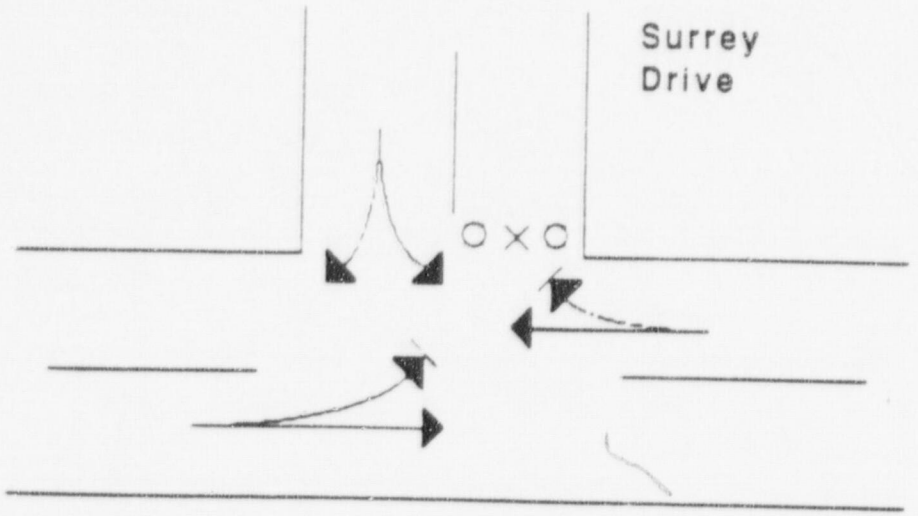
Manpower/Equipment:

2 Traffic Cones
1 Traffic Barricade

Description:

Discourage northbound traffic on Esta Road.

Point No. P-A-86



Location:
Route 44 & Surrey Drive. (Plymouth)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

2 Traffic Cones

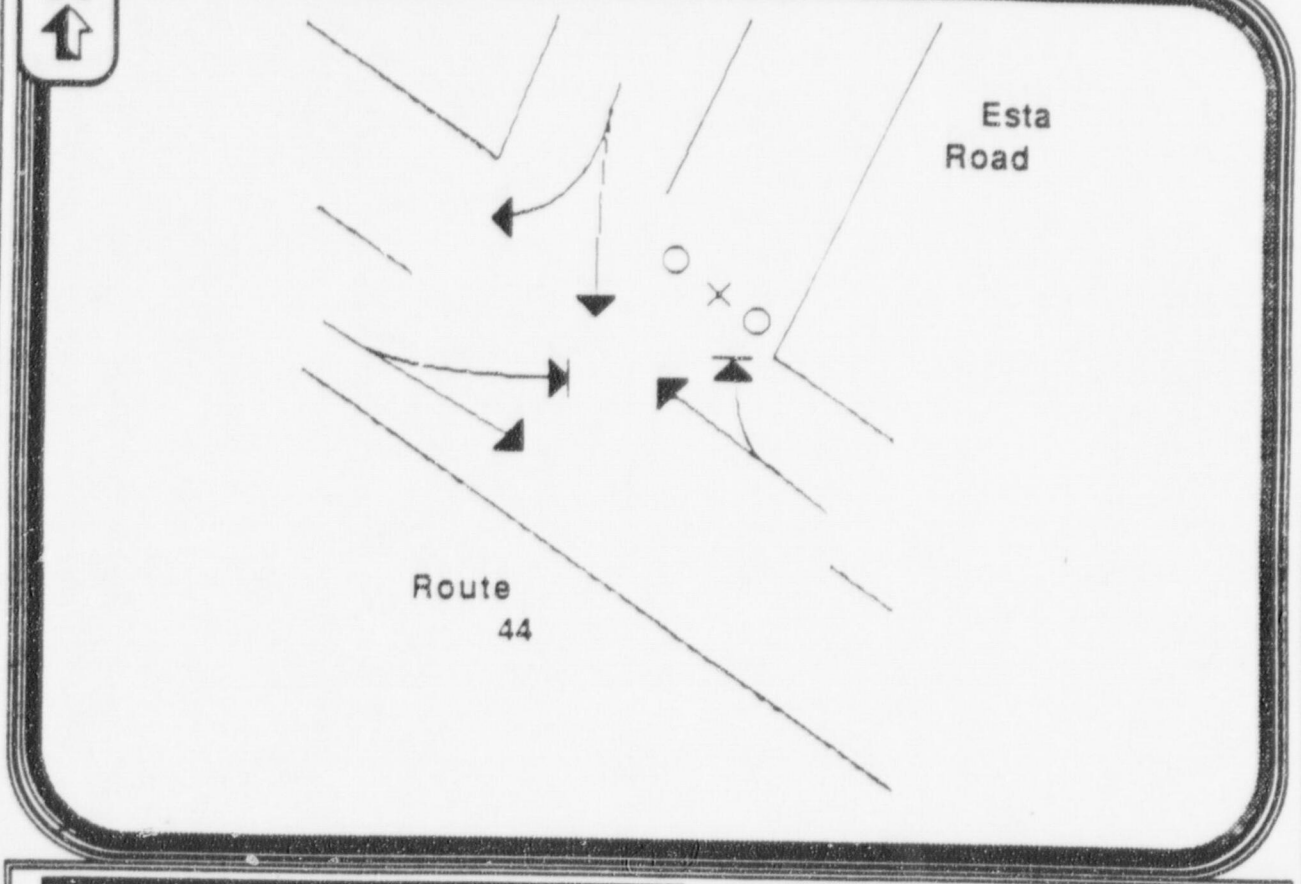
1 Traffic Barricade

Description:

Discourage northbound traffic on Surrey Drive.

PLY ACP P A 86 | 072888

Point No. P-A-87



Location:
Route 44 & Esta Road (west of Surrey Drive)
(Plymouth)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

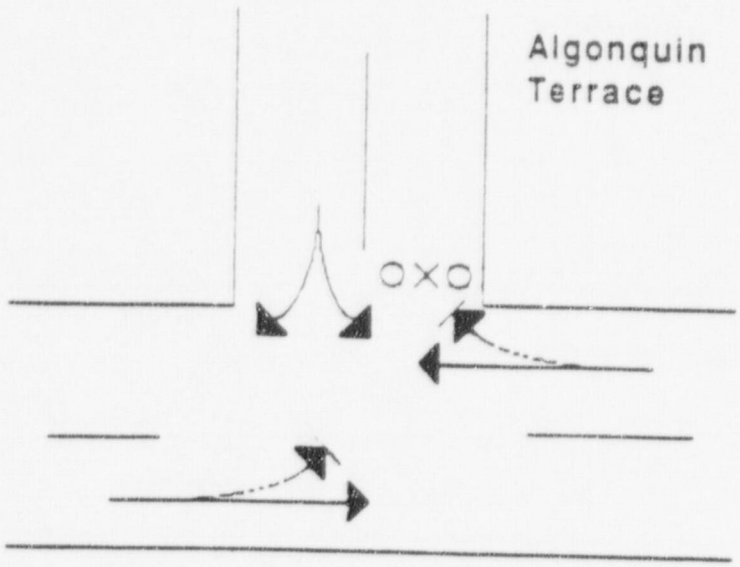
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage northbound traffic on Esta Road.

Point No. P-A-38



Route 44

Location:
Route 44 & Algonquin Terrace (Plymouth)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

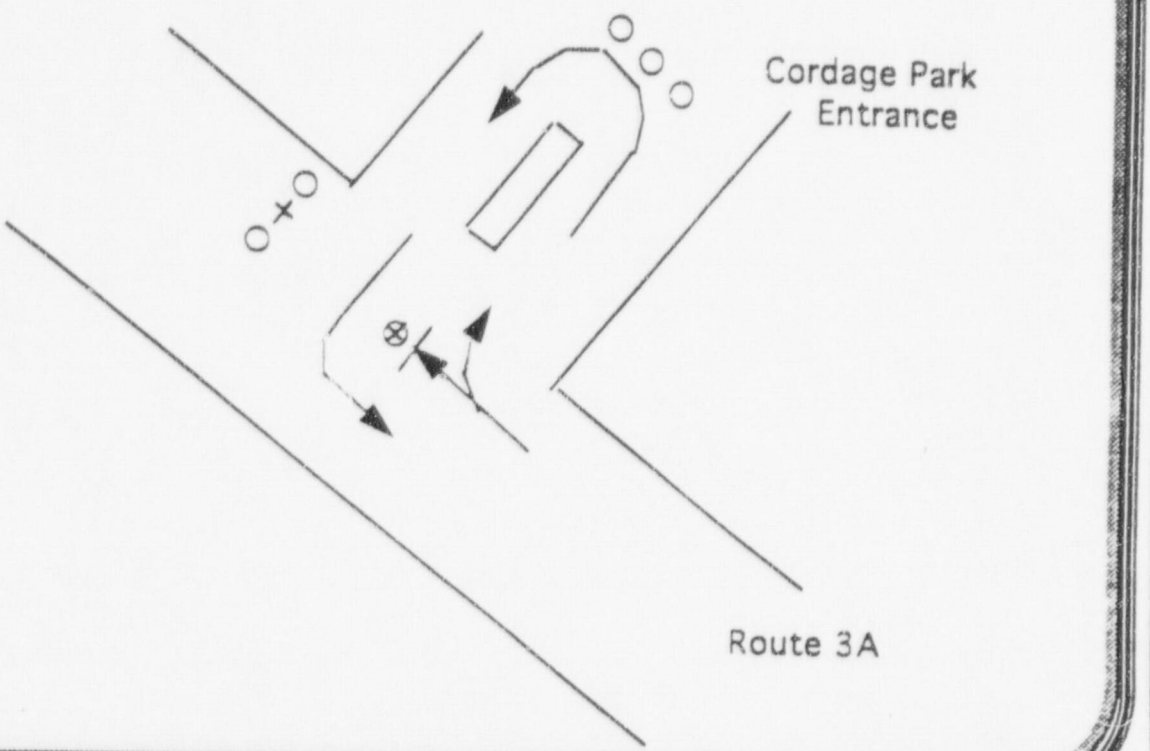
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage northbound traffic on Algonquin Terrace.

Point No. P-A-89



Location: Route 3A and entrance to Cordage Park (Plymouth).

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

1 Traffic Guide
5 Traffic Cones
1 Traffic Barricade

Description: Discourage northbound traffic on Route 3A.

Plymouth Access Control Point #P-89

MYLES STANDISH STATE FOREST

Figure I-MS-1
Traffic and Access Control Points
Myles Standish State Forest

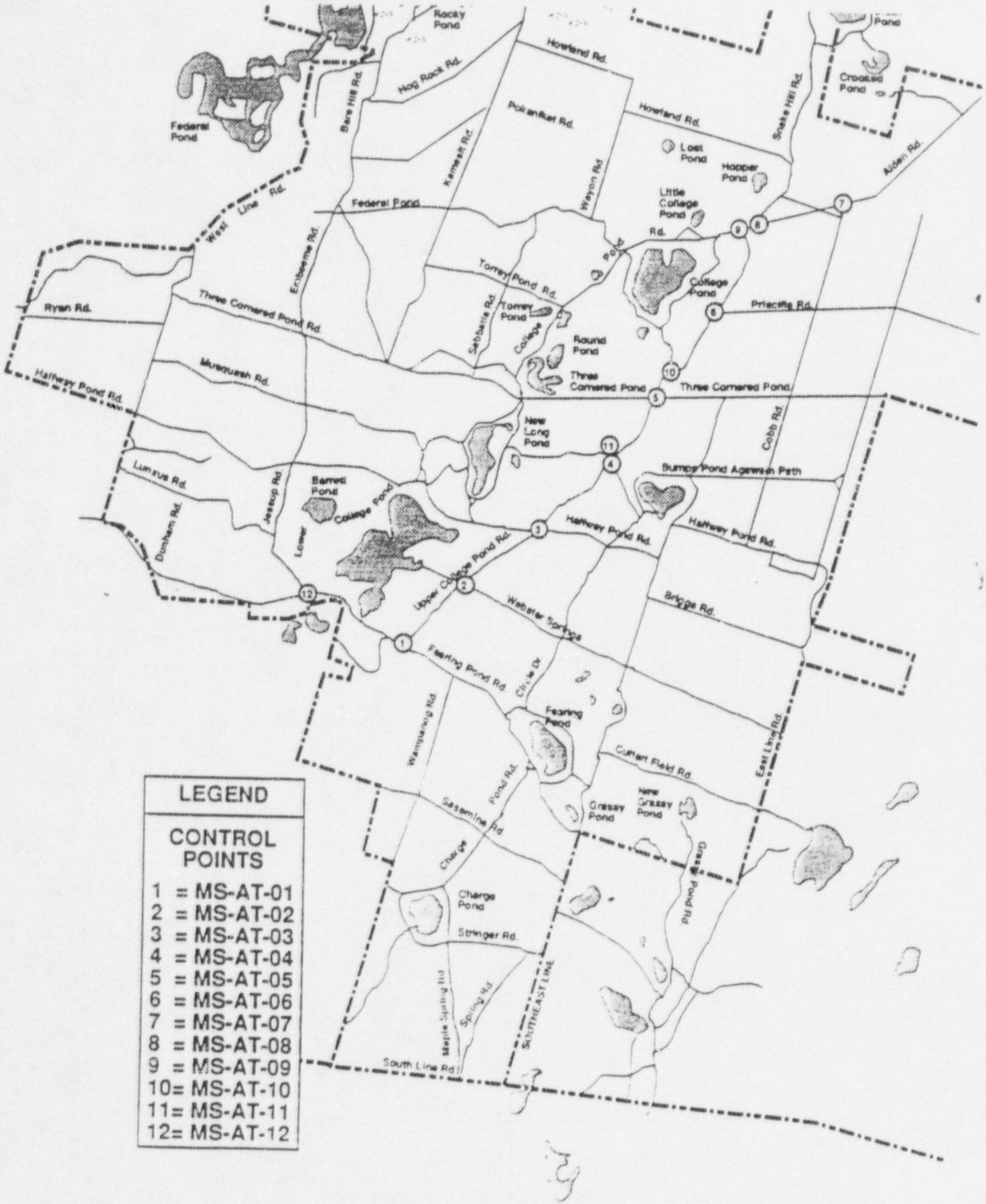


Table I-MS-1. Location, Manpower, and Equipment Requirements for All Traffic and Access Control Points

TOWN: Myles Standish State Forest

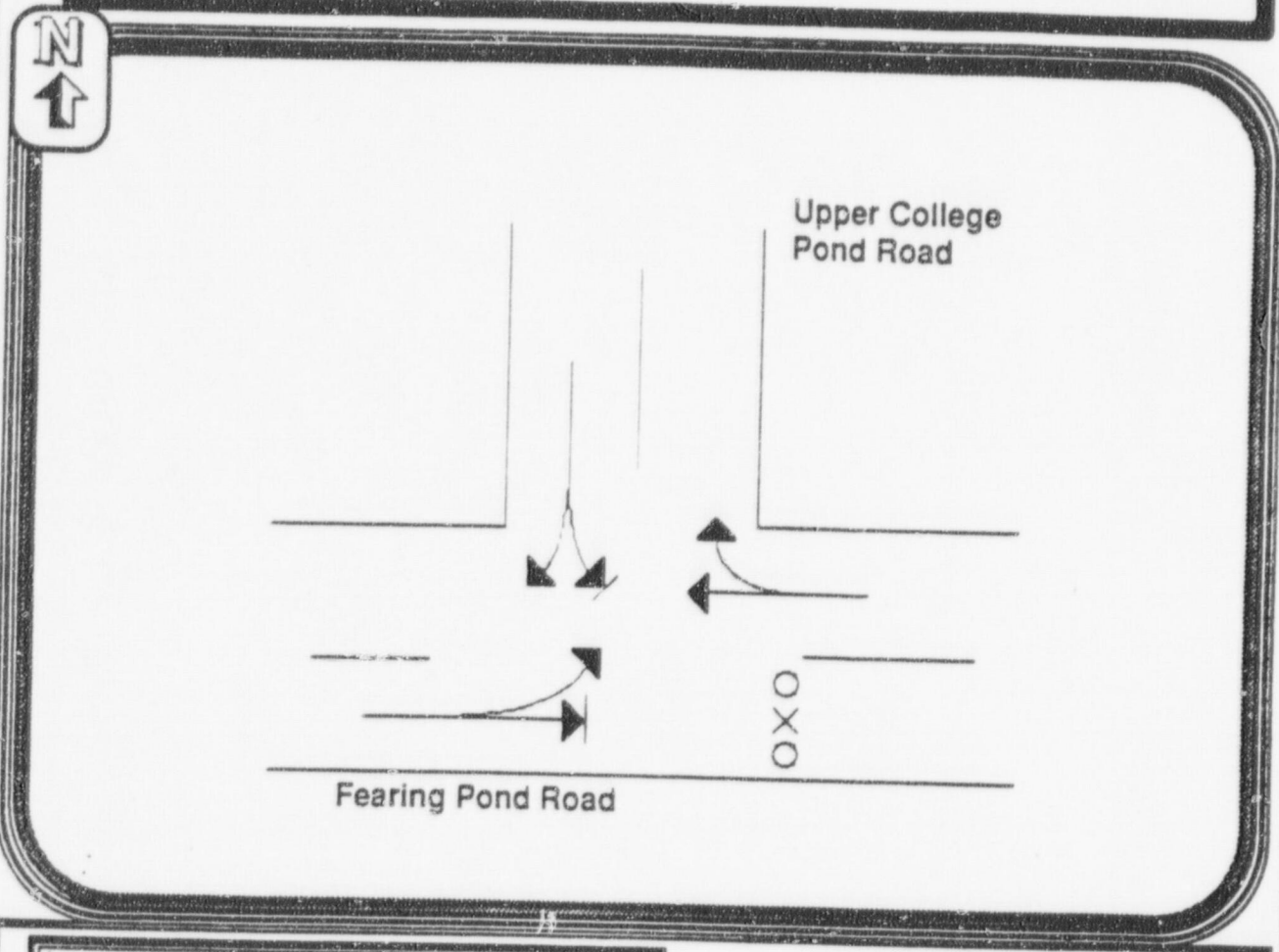
ACP	Location	Agency Priority	Guides	Cones	Barricades	Lights
MS-AT-01	Upper College Pond Rd. & Fearing Pond Rd.	MS-4		2	1	1
MS-AT-02A	Upper College Pond Rd. & Webster Springs Rd.	MS-4		2	1	1
MS-AT-02B	Upper College Pond Rd. & Webster Springs Rd.	MS-4		2	1	1
MS-AT-03A	Upper College Pond Rd. & Halfway Pond Rd.	MS-4		2	1	1
MS-AT-03B	Upper College Pond Rd. & Halfway Pond Rd.	MS-4		2	1	1
MS-AT-4	Upper College Pond Rd. & Circle Dr.	MS-4		2	1	1
MS-A-05A	Upper College Pond Rd. & Three Cornered Pond Rd.	MS-4		2	1	1
MS-AT-05B	Upper College Pond Rd. & Three Cornered Pond Rd.	MS-4		2	1	1
MS-AT-06	Upper College Pond Rd. & Priscilla Rd.	MS-4		2	1	1
MS-AT-07	Alden Rd. & Cobb Rd.	MS-4		2	1	1
MS-AT-08	Upper College Pond Rd. & Snake Hill Rd.	MS-4		2	1	1
MS-AT-09	Upper College Pond Rd. & Lower College Pond Rd.	MS-4		2	1	1
MS-AT-10	Upper College Pond Rd. & Cranford Rd.	MS-4		2	1	1
MS-AT-11	Upper College Pond Rd. & Negas Rd.	MS-4		2	1	1
MS-AT-12	East Head Rd. & Lower College Pond Rd	MS-4		2	1	1

Table I-MS-1. Allocation of Access Control Points to Towns

TOWN: Myles Standish State Forest

ACCESS CONTROL POINT	ACTIVATED FOR FOLLOWING REGIONS:
MS-AT-01	7, 10, 11, 12
MS-AT-02A	7
MS-AT-02B	10, 11, 12, 13, 14
MS-AT-03A	7
MS-AT-03B	10, 11, 12, 13, 14
MS-AT-04	7
MS-AT-05A	7
MS-AT-05B	10, 11, 12, 13, 14
MS-AT-06	7
MS-AT-07	7
MS-AT-08	10, 11, 12, 13, 14
MS-AT-09	10, 11, 12, 13, 14
MS-AT-10	10, 11, 12, 13, 14
MS-AT-11	10, 11, 12, 13, 14
MS-AT-12	10, 11, 13, 14

Point No. MS-AT-01



Location:
Upper College Pond Road & Fearing Pond Road
(Myles Standish State Forest)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

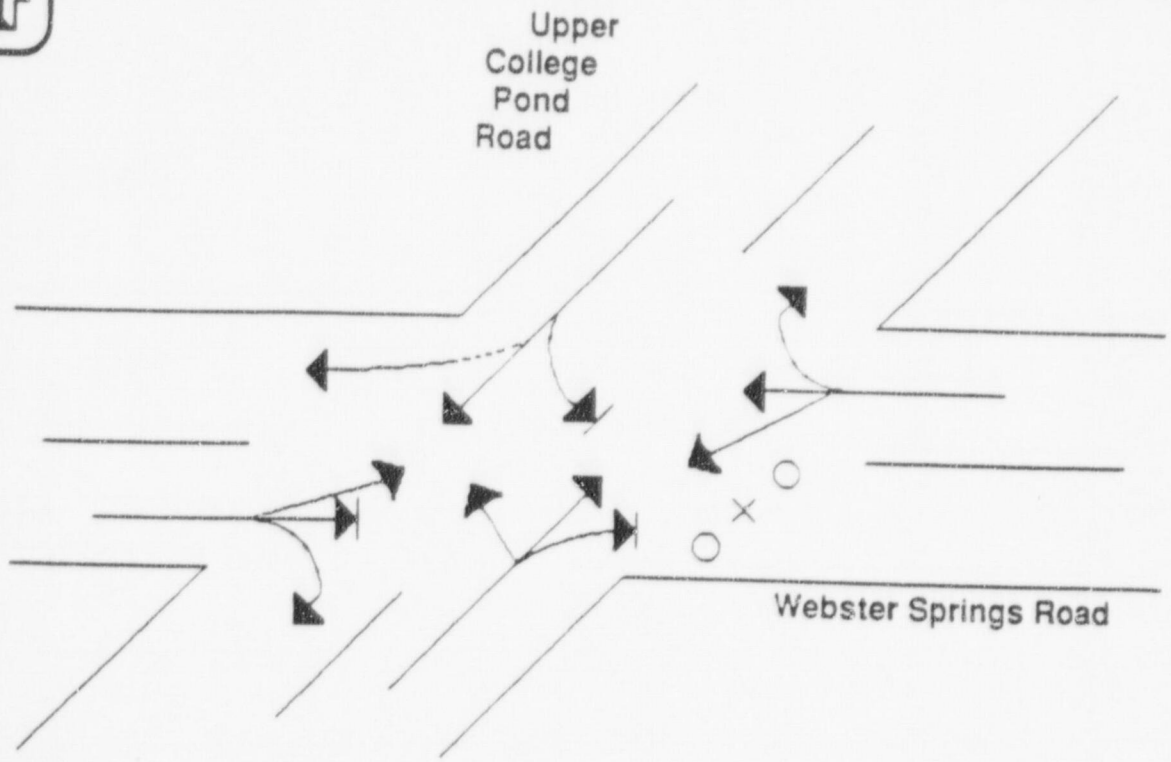
2 Traffic Cones
1 Traffic Barricade

Description:

Discourage eastbound traffic on Fearing Pond Road.

Rev

Point No. MS-AT-02a



Location:
Upper College Pond Road & Webster Springs Road
(Myles Standish State Forest)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

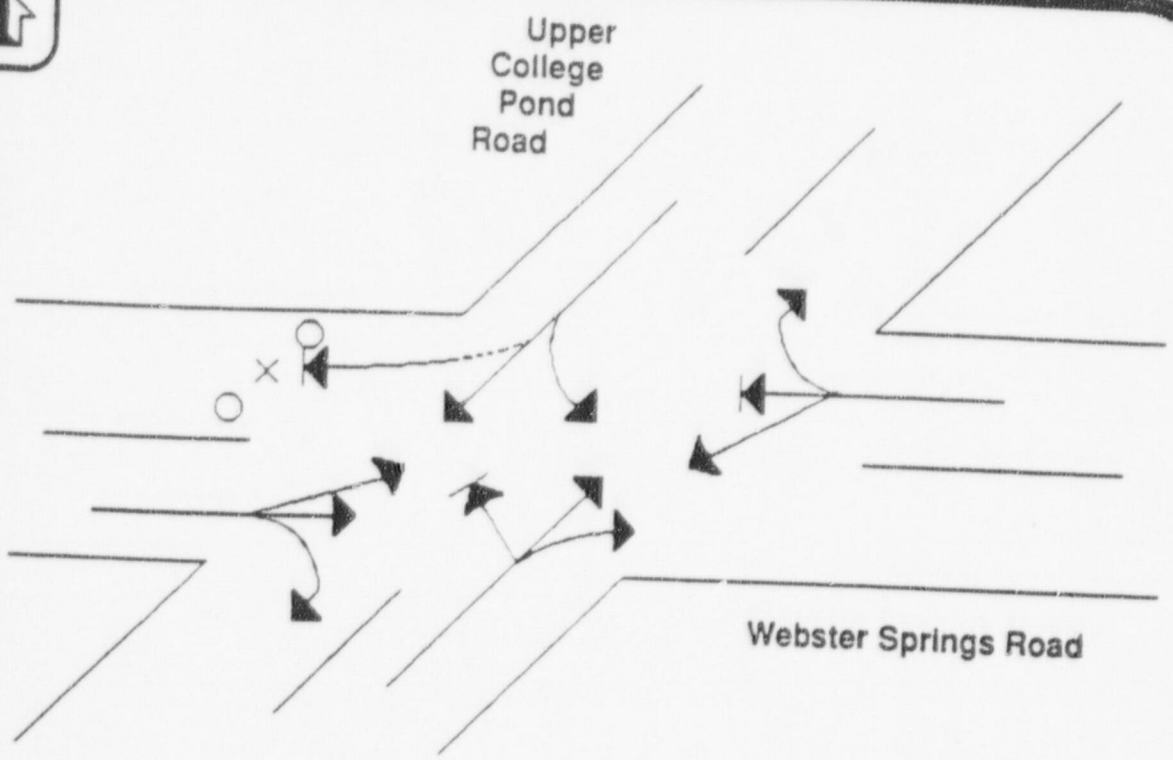
Manpower/Equipment:

2 Traffic Cones

1 Traffic Barricade

Description: Discourage eastbound traffic on Webster Springs Road.

Point No. MS-AT-02b



Location:
Upper College Pond Road & Webster Springs Road
(Myles Standish State Forest)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

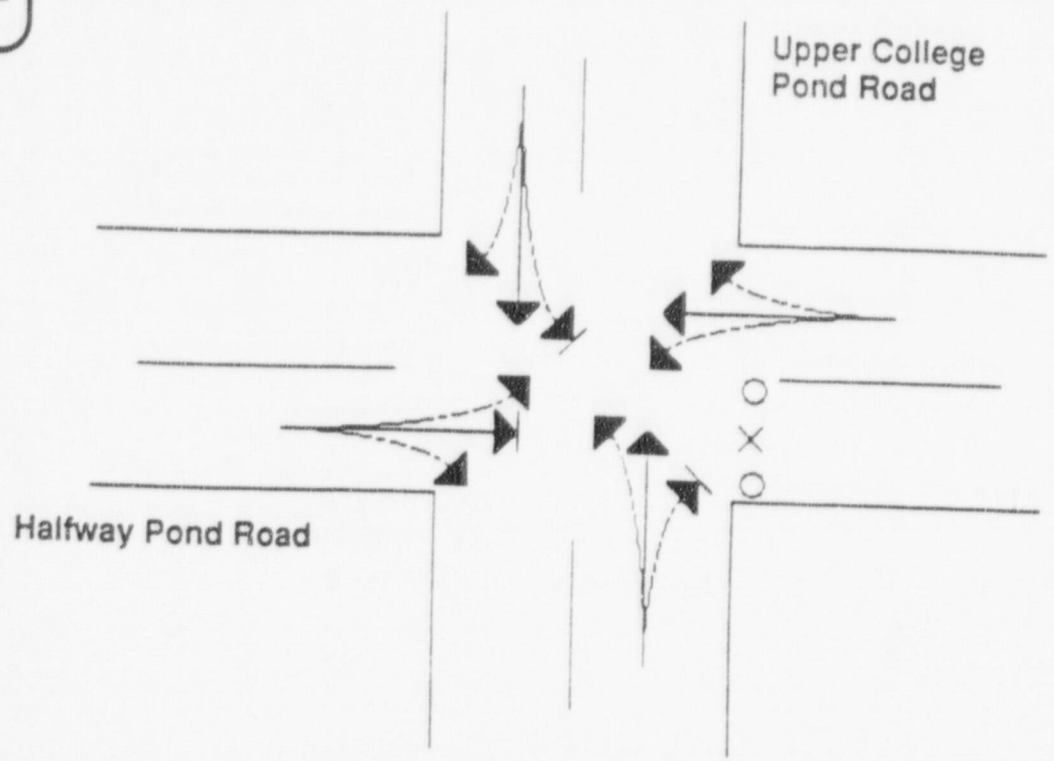
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage westbound traffic on Webster Springs Road.

Point No. WS-AT-03a



Location:
Upper College Pond Road & Halfway Pond Road
(Myles Standish State Forest)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

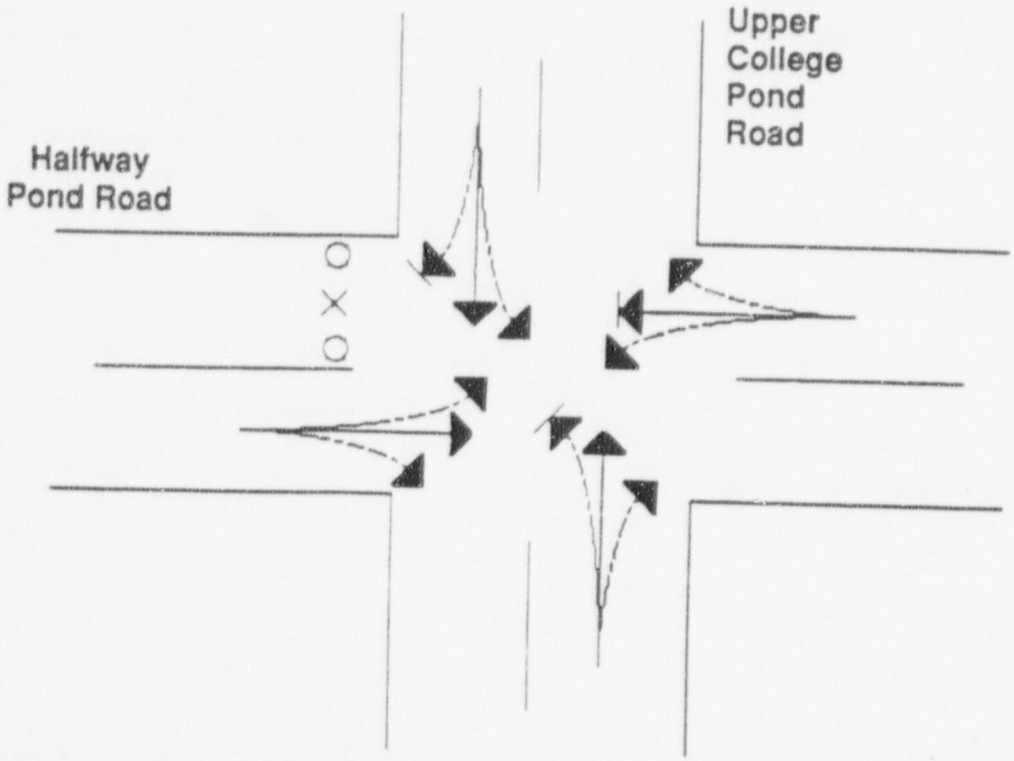
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage eastbound traffic on Halfway Pond Road.

Point No. MS-AT-03b



Location:
Upper College Pond Road & Halfway Pond Road
(Myles Standish State Forest)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

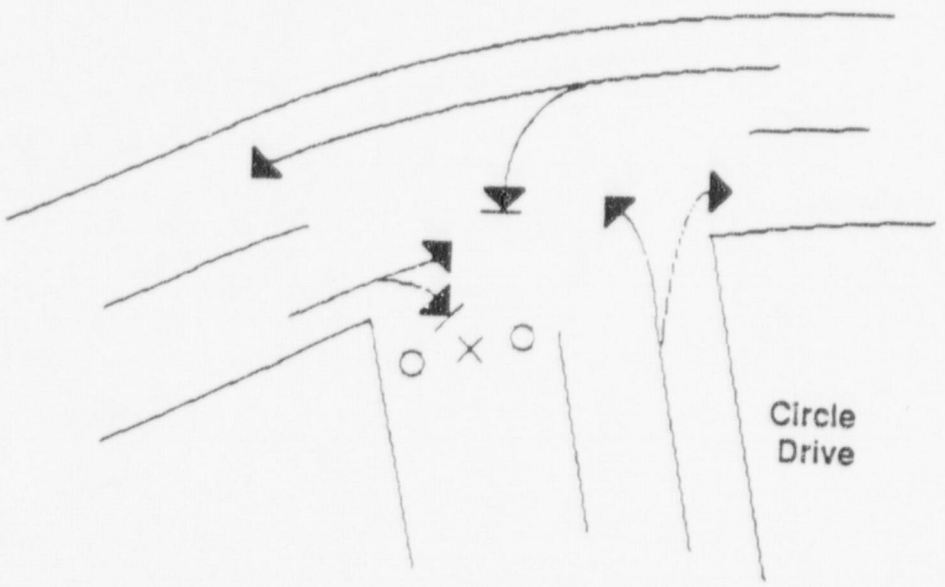
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage westbound traffic on Halfway Pond Road.

Point No. MS-AT-04



Location:
Upper College Pond Road & Circle Drive (Myles Standish State Forest)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

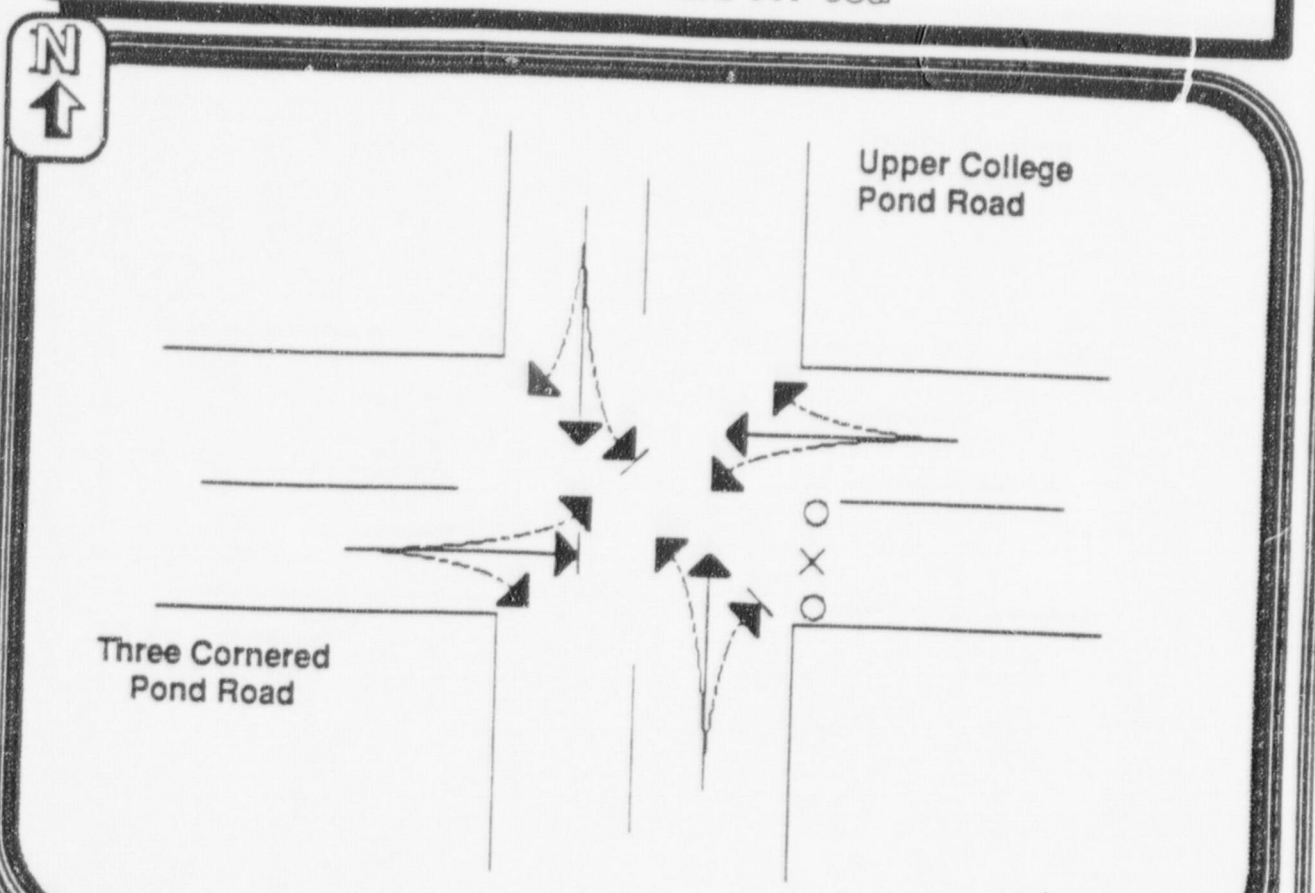
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage south-east bound traffic on Circle Drive.

Point No. MS-AT-05a



Location:
Upper College Pond Road & Three Cornered Pond Road (Myles Standish State Forest)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

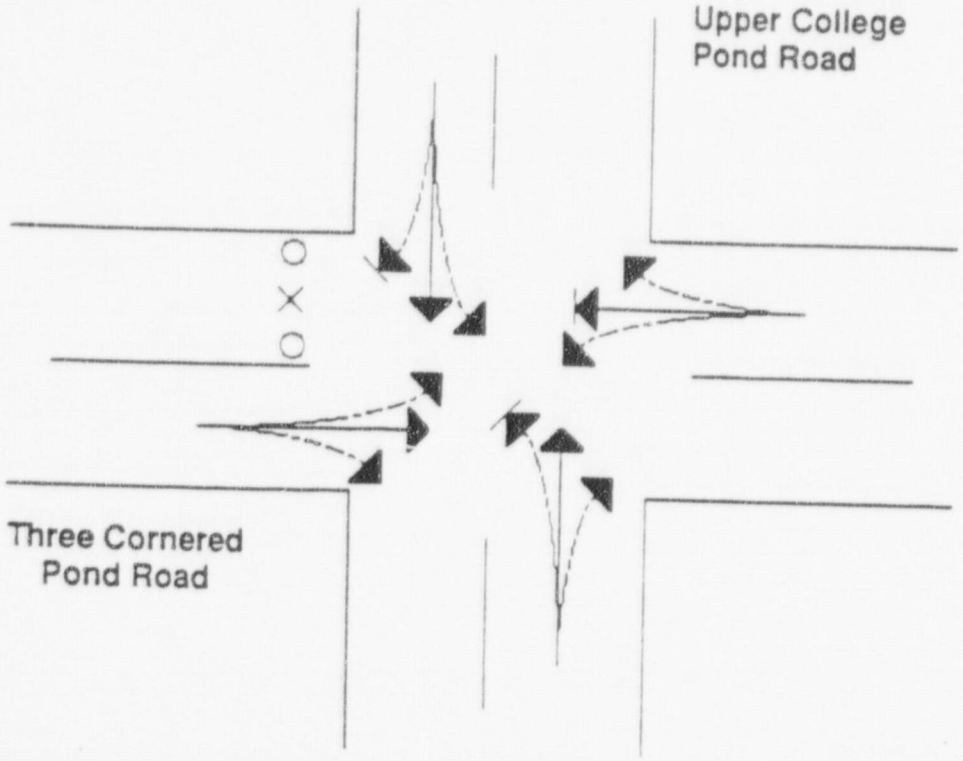
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage eastbound traffic on Three Cornered Pond Road.

Point No. MS-AT-05b



Location:
Upper College Pond Road & Three Cornered Pond Road (Myles Standish State Forest)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

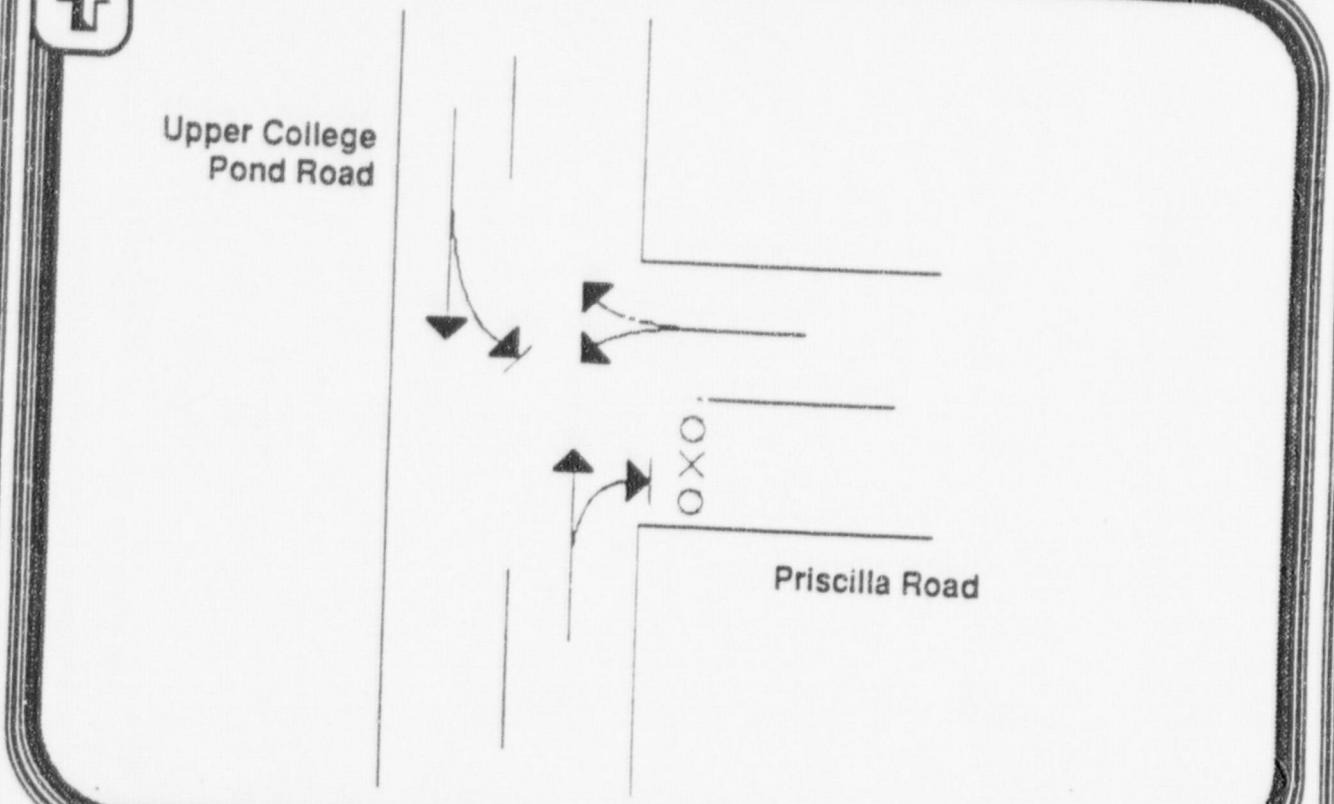
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage westbound traffic on Three Cornered Pond Road.

Point No. MS-AT-06



Location:
Upper College Pond Road & Priscilla Road (Myles Standish State Forest)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

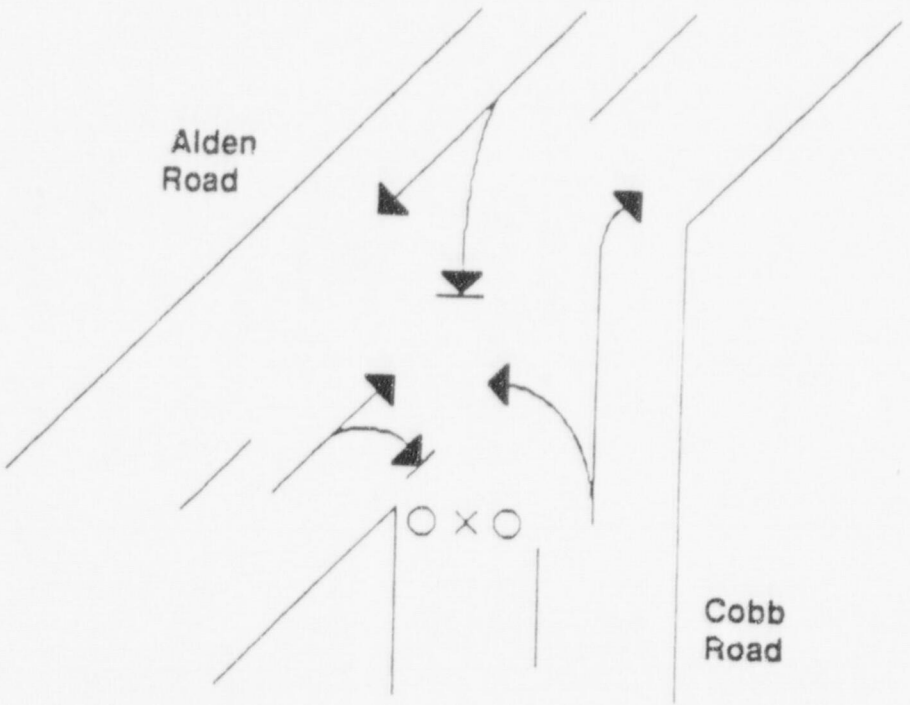
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage eastbound traffic on Priscilla Road.

Point No. MS-AT-07



Location:
Alden Road & Cobb Road (Myles Standish State Forest)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

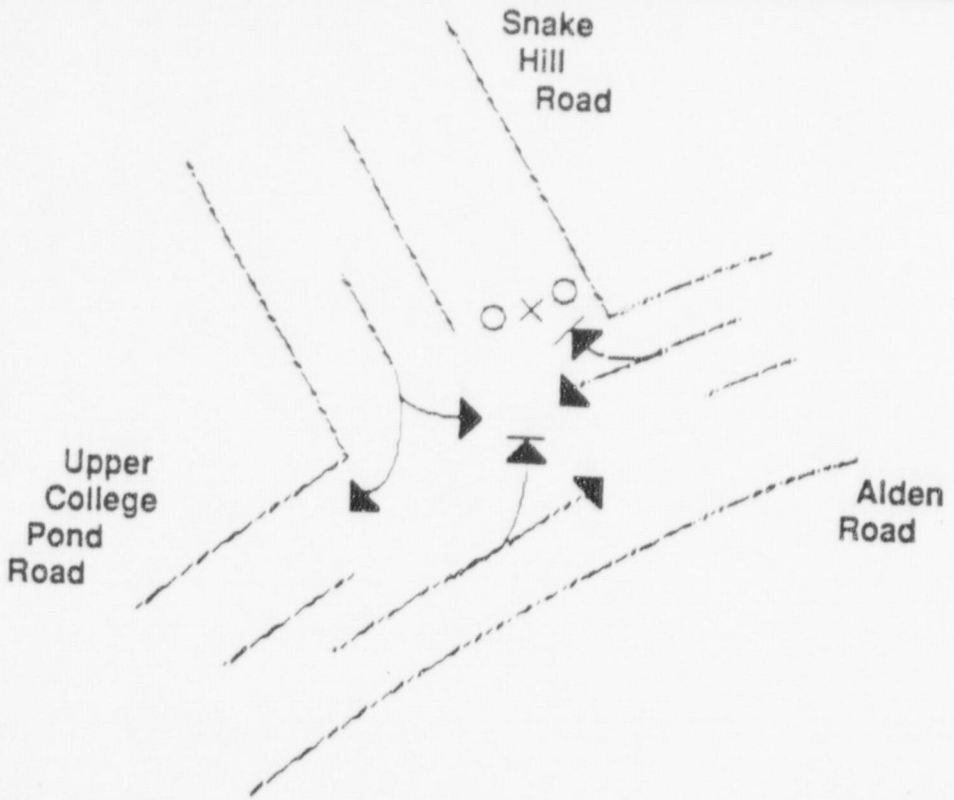
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage southbound traffic on Cobb Road.

Point No. MS-A-08



Location:
Upper College Pond Road & Snake Hill Road (Myles Standish State Forest)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

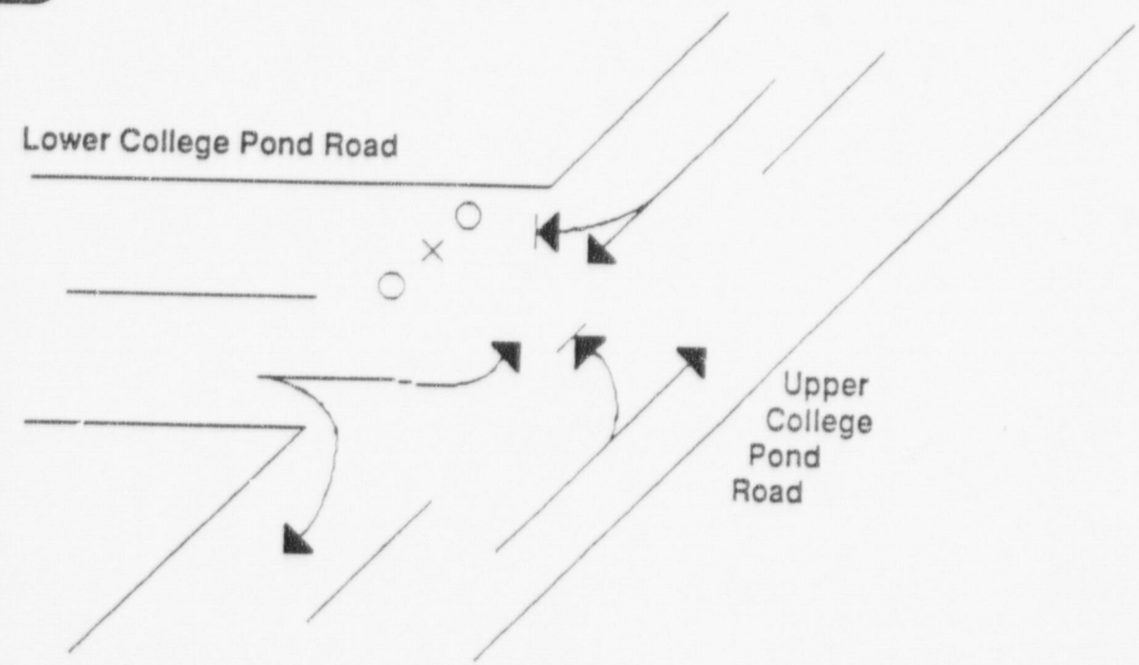
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage northbound traffic on Snake Hill Road.

Point No. MS-AT-09



Location:
Upper College Pond Road & Lower College Pond Road
(Myles Standish State Forest)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

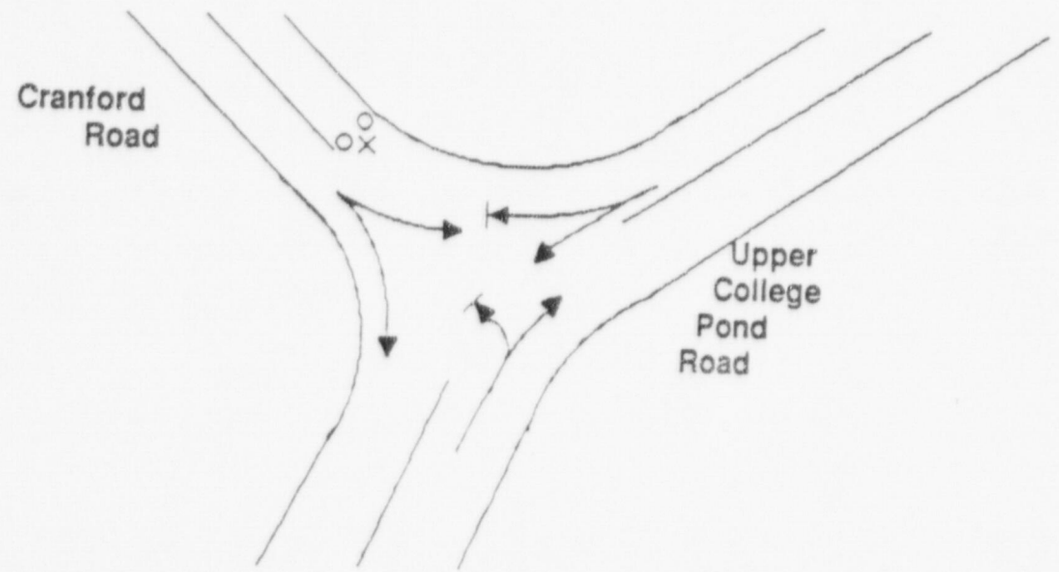
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage westbound traffic on Lower College Pond Road.

Point No. MS-AT-10



Location:
Upper College Pond Road & Cranford Road (Myles Standish State Forest)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

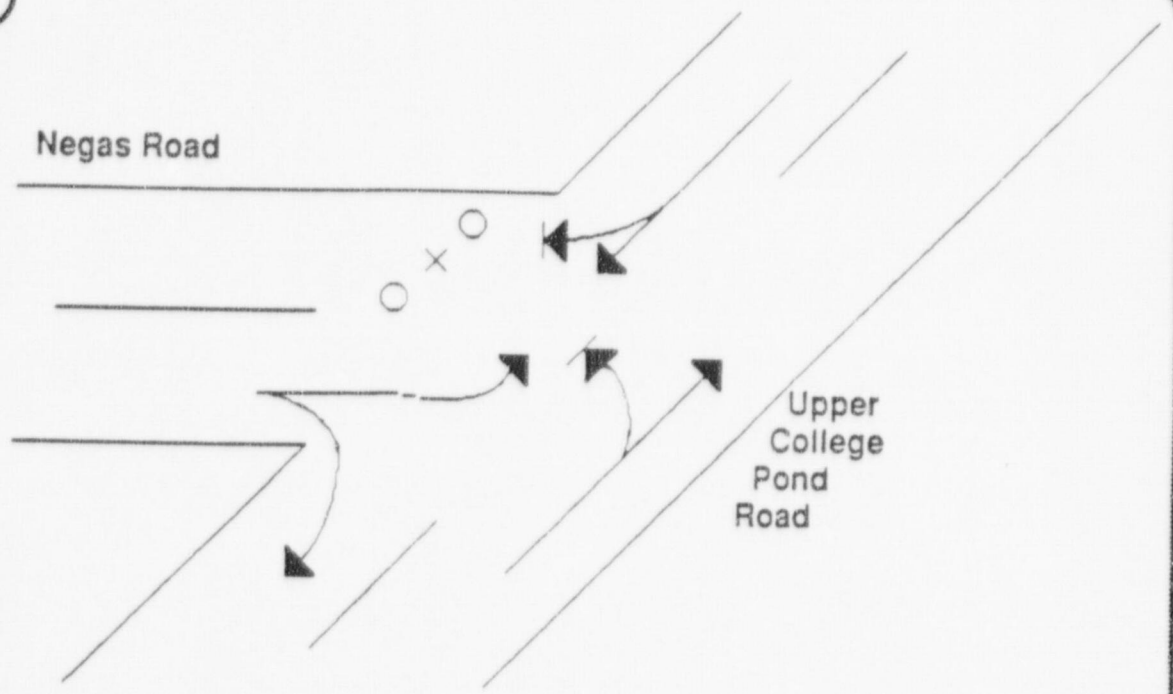
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage northbound traffic on Cranford Road.

Point No. MS-AT-11



Location:
Upper College Pond Road & Negas Road (Myles Standish State Forrest)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

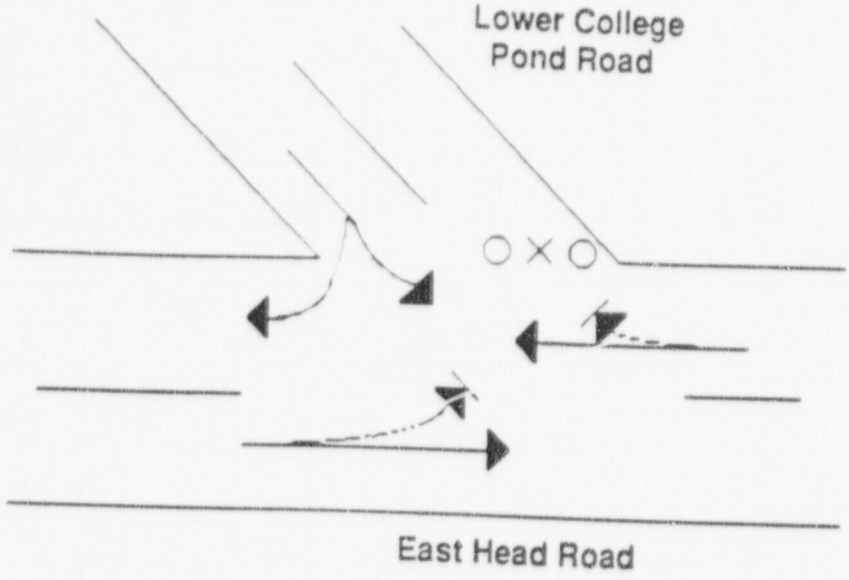
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage westbound traffic on Negas Road.

Point No. MS-AT-12



Location:
East Head Road & Lower College Pond Road
(Myles Standish State Forest)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

2 Traffic Cones

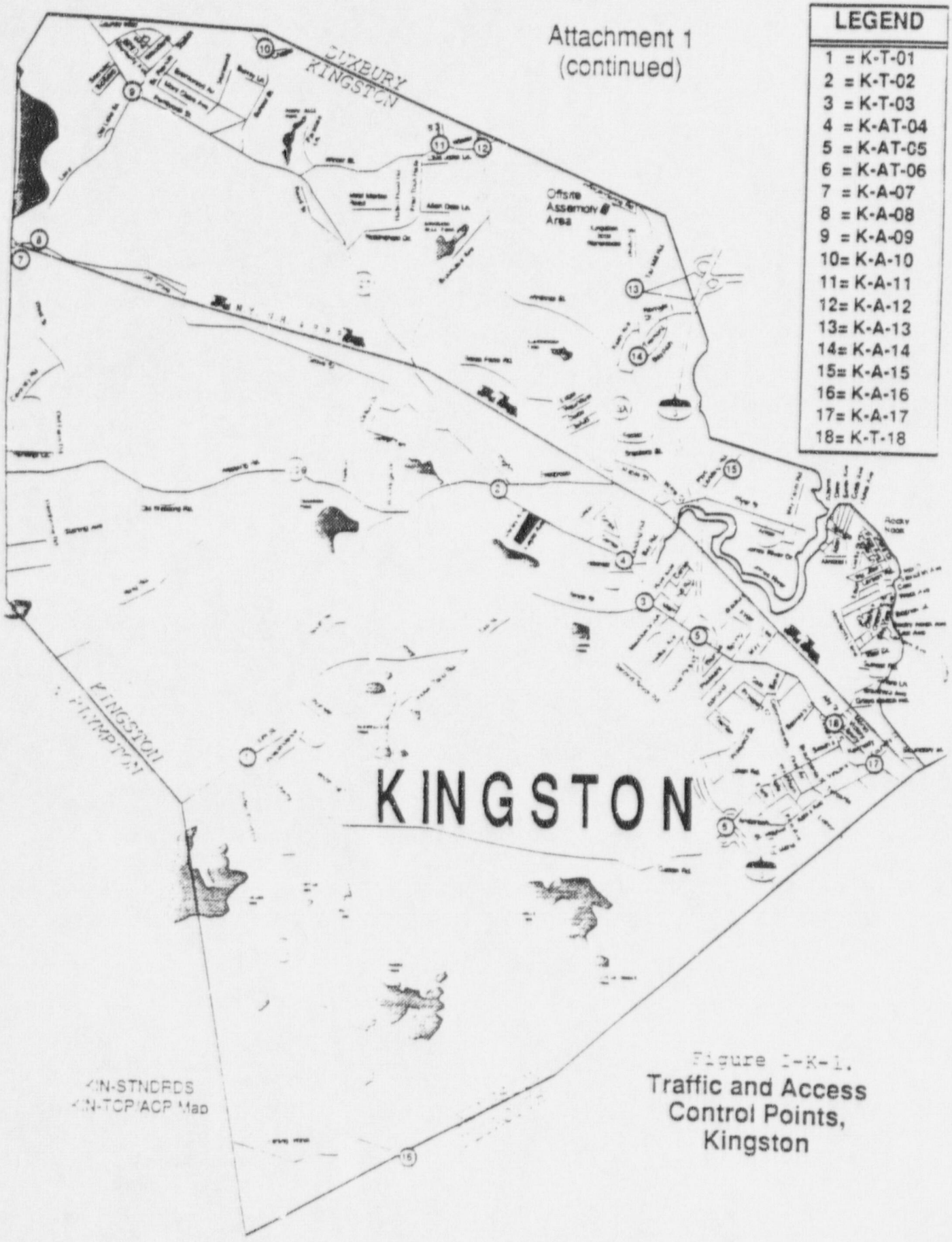
1 Traffic Barricade

Description:

Discourage northbound traffic on Lower College Pond Road.

KINGSTON

Attachment 1
(continued)



KIN-STNDRDS
KIN-TCP/ACP Map

Figure I-K-1.
Traffic and Access Control Points, Kingston

Table I-K-1. Location, Manpower, and Equipment Requirements for All Traffic and Access Control Points

TOWN: Kingston

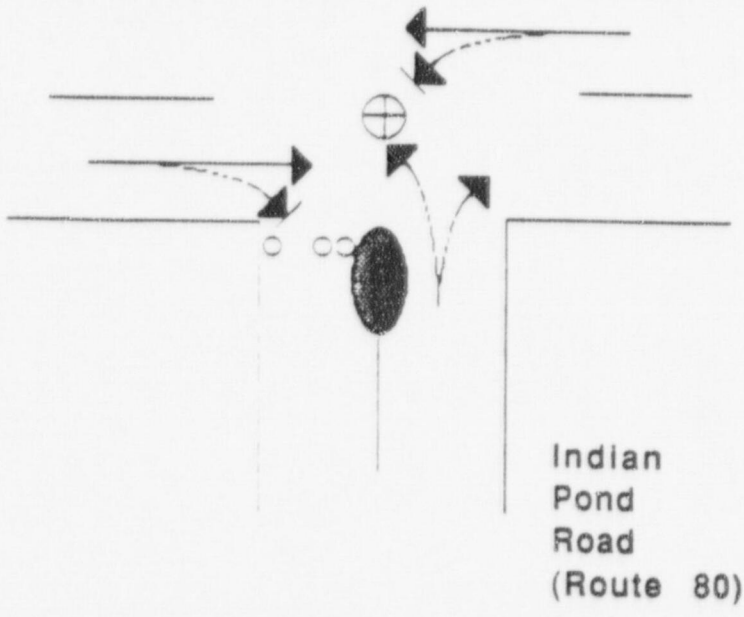
ACP	Location	Agency Priority	Guides	Cones	Barricades	Lights
K-T-01	Brook St. & Elm St.	K-2	1	3		
			1			
K-T-02	Wapping Rd. & Rte. 27	K-1	1	2	1	1
K-T-03	Main St.(Rte.3A) & Rte. 80	S-2	1	6		2
K-AT-04A	Main St. & Summer St.	S-2	1	3		1
K-AT-04B	Main St. & Summer St.	S-2	1	3		1
K-AT-05A	Rte. 3 & Main St., Exit 9	S-1	1	2	7	7
K-AT-05B	Rte. 3 & Main St., Exit 9	S-1	1	2	7	7
K-AT-06A	Rte. 3 & Smith's La., Exit 8	S-2	1		6	6
K-AT-06B	Rte. 3 & Smith's La., Exit 8	S-2	1		10	10
K-A-07	West St. & Lake St.	K-4		2	1	1
K-A-08	Lake St. & Grove St.	K-3	1	6	3	3
K-A-09	Lake St. & Pembroke St.	K-3	1	4	2	2
K-A-10	School St. & Chapel St.	K-3	1	2	1	1
K-A-11A	Winter St. & Pine St.	K-4		2	1	1
K-A-11B	Winter St. & Pine St.	K-4		2	1	1
K-A-12A	Brookdale Ave. & Winter St.	K-3	1	2	1	1
K-A-12B	Winter St. & Brookdale Ave.	K-3	1	2	1	1
K-A-13A	Rte. 53 & Rte. 3A	S-2	1	4	2	2
K-A-13B	Rte. 53 & Rte. 3A	S-2	1	4	2	2
K-A-14	Summer St. & Tremont St.	K-4		2	1	1
K-A-15A	Parks St. & Landing Rd.	K-4		2	1	1
K-A-15B	Parks St. & Landing Rd.	K-4		4	2	2
K-A-16A	Route 80 & Parting Ways	K-4		2	1	1
K-A-16B	Route 80 & Parting Ways	K-4		2	1	1
K-A-17	Route 3A & Crescent St.	K-2	1	2	1	1
K-T-18	Route 3A & Howlands Lane	K-1	1	3	0	1

Table I-K-2. Allocation of Access Control Points to Towns

TOWN: Kingston

ACCESS CONTROL POINT	ACTIVATED FOR FOLLOWING REGIONS:
K-AT-04A	11
K-AT-04B	19
K-AT-05A	All regions except 19
K-AT-05B	19
K-AT-06A	All regions except 19
K-AT-06B	19
K-A-07	12, 13, 14, 15, 16, 17, 18, 22
K-A-08	12, 13, 14, 15, 16, 17, 18, 22
K-A-09	12, 13, 14, 15, 16, 17, 18, 22
K-A-10	12, 13, 14, 15, 16, 17, 18, 22
K-A-11A	12
K-A-11B	19
K-A-12A	12
K-A-12B	19
K-A-13A	12
K-A-13B	19
K-A-14	19
K-A-15A	12
K-A-15B	19
K-A-16A	11
K-A-16B	18
K-A-17	11

Point No. K-T-01



Location:
Route 80 & Elm Street (Kingston)

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

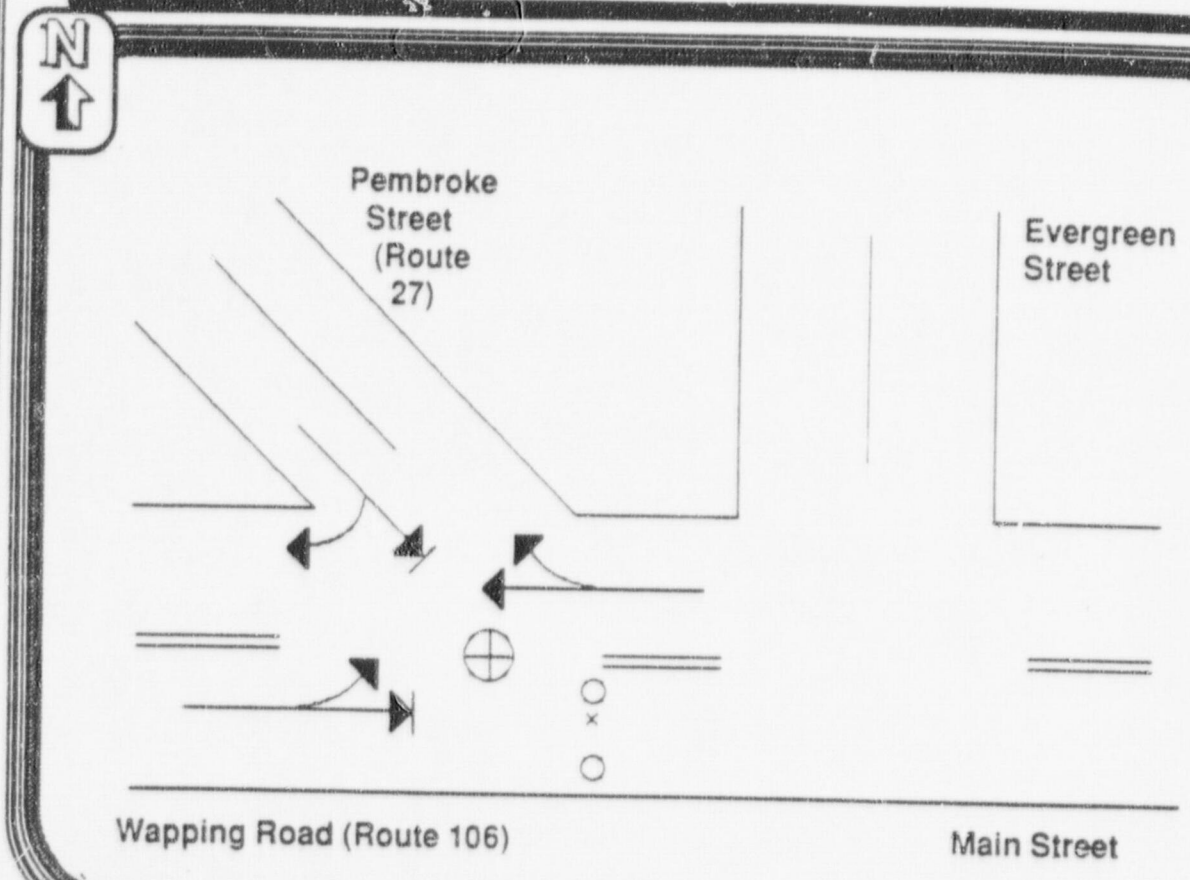
1 Traffic Guide

3 Traffic Cones

Description:

Facilitate northbound traffic on Route 80. Facilitate all traffic on Elm Street. Discourage southbound traffic on Route 80.

Point No. K-T-02



Location:
Wapping Road & Route 27 (Kingston)

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

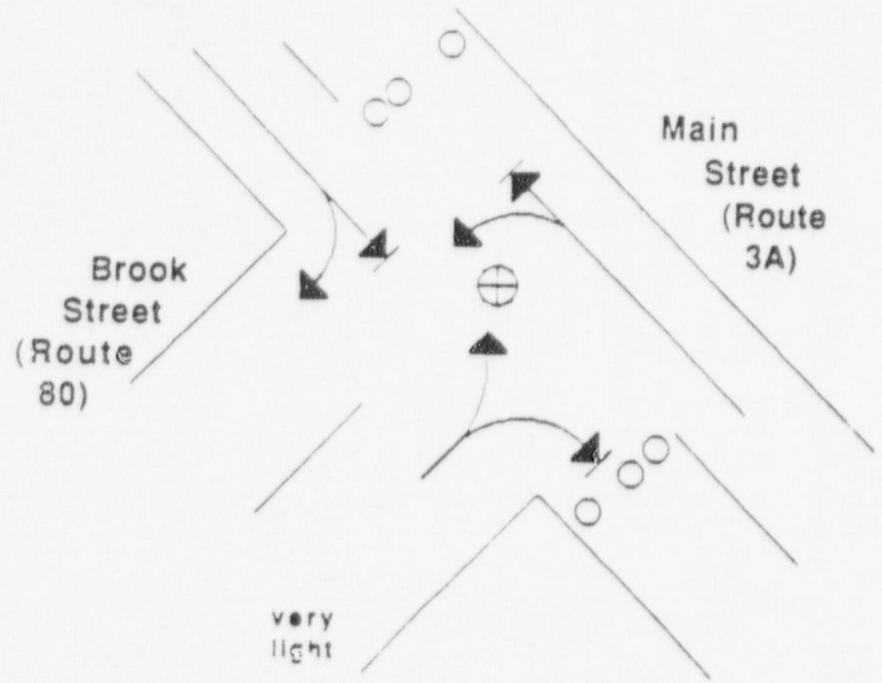
Manpower/Equipment:

1 Traffic Guide
2 Traffic Cones
1 Traffic Barricade

Description:

Facilitate westbound traffic along Wapping Road and northbound traffic on Route 27. Discourage eastbound traffic on Main Street.

Plan No. K-T-93



Location:
Main Street & Route 80 (Kingston)

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

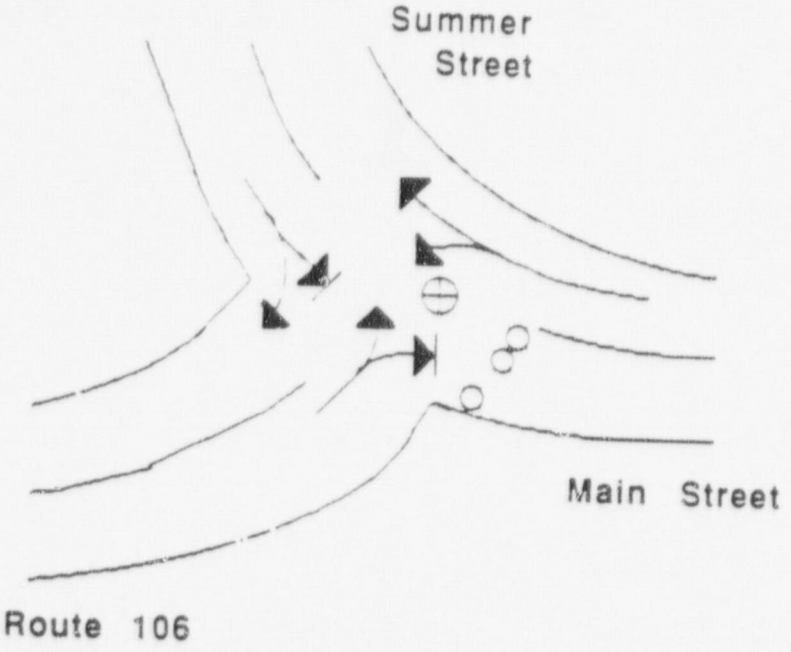
Manpower/Equipment:

1 Traffic Guide
6 Traffic Cones

Description:

Facilitate westbound traffic on Route 80. Discourage southbound and northbound traffic on Main Street.

Detour No. K-AT-048



Location:
Main Street & Summer Street (Kingston)

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

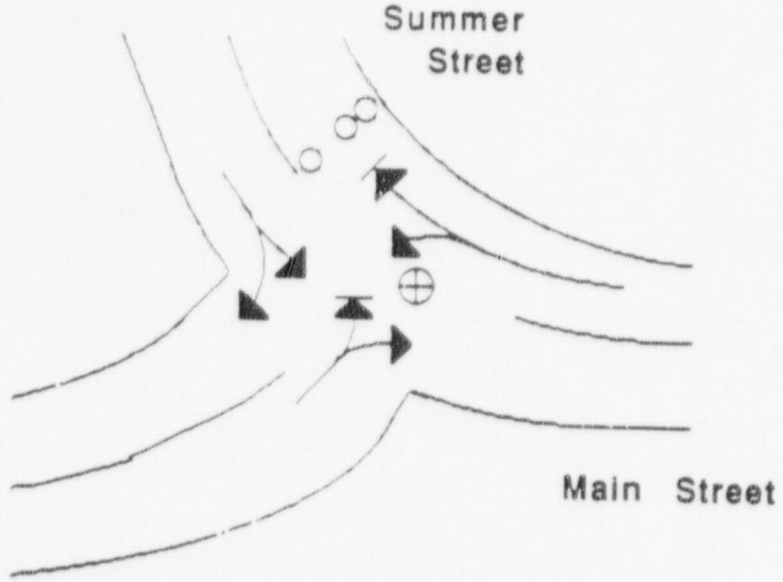
Manpower/Equipment:

1 Traffic Guide
3 Traffic Cones

Description:

Discourage southbound traffic on Summer Street.

Plan No. K-AT-04b



Route 106

Location:
Main Street & Summer Street (Kingston)

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

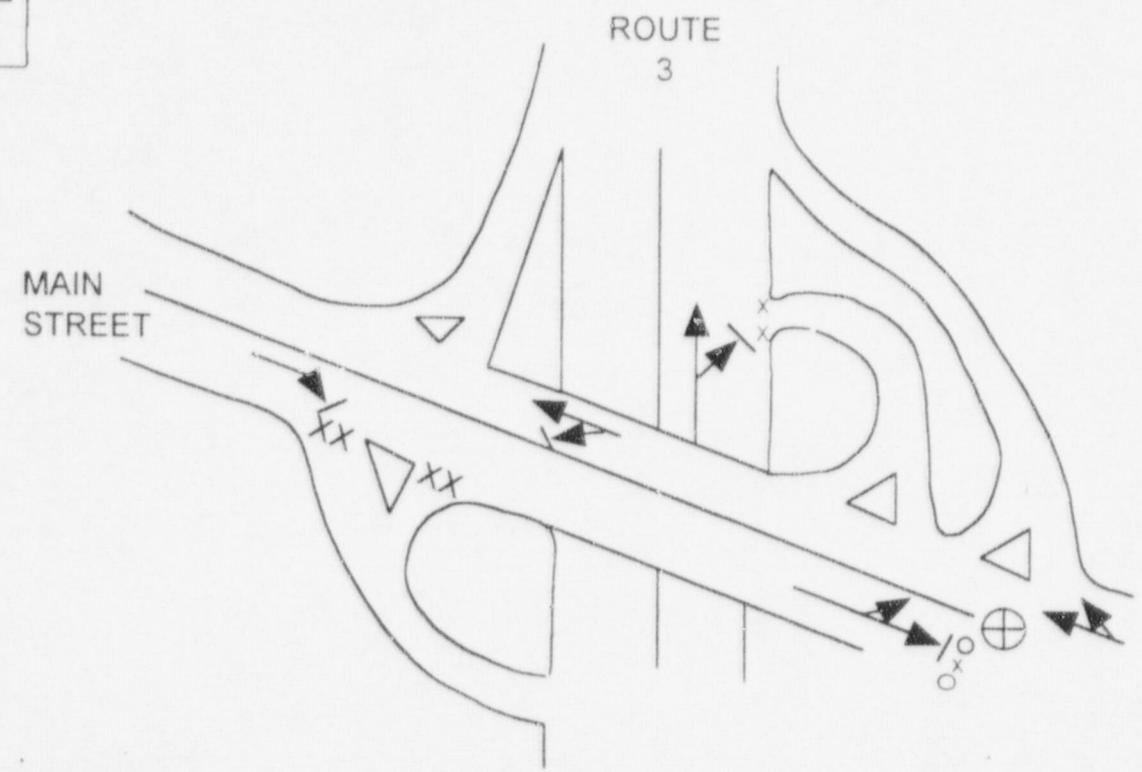
1 Traffic Guide

3 Traffic Cones

Description:

Discourage northbound traffic on Summer Street.

Point No. K-AT-05a



Location:
Route 3 and Main Street (Exit 8) Kingston

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

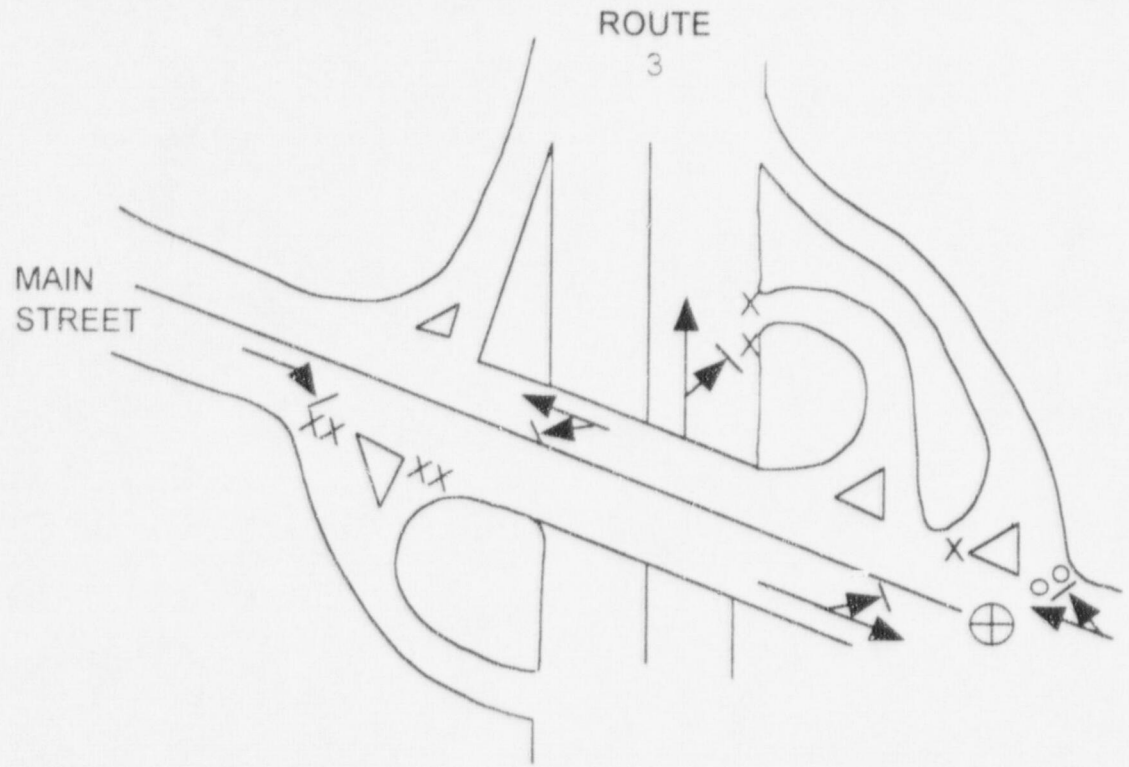
Manpower/Equipment:

1 Traffic Guide
2 Traffic Cones
7 Traffic Barricade

Description:

Facilitate entry onto northbound Route 3. Discourage entry onto southbound Route 3. Discourage southbound traffic on Main Street

Point No. K-AT-05b



Location:
Route 3 and Main Street (Exit 8) Kingston

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

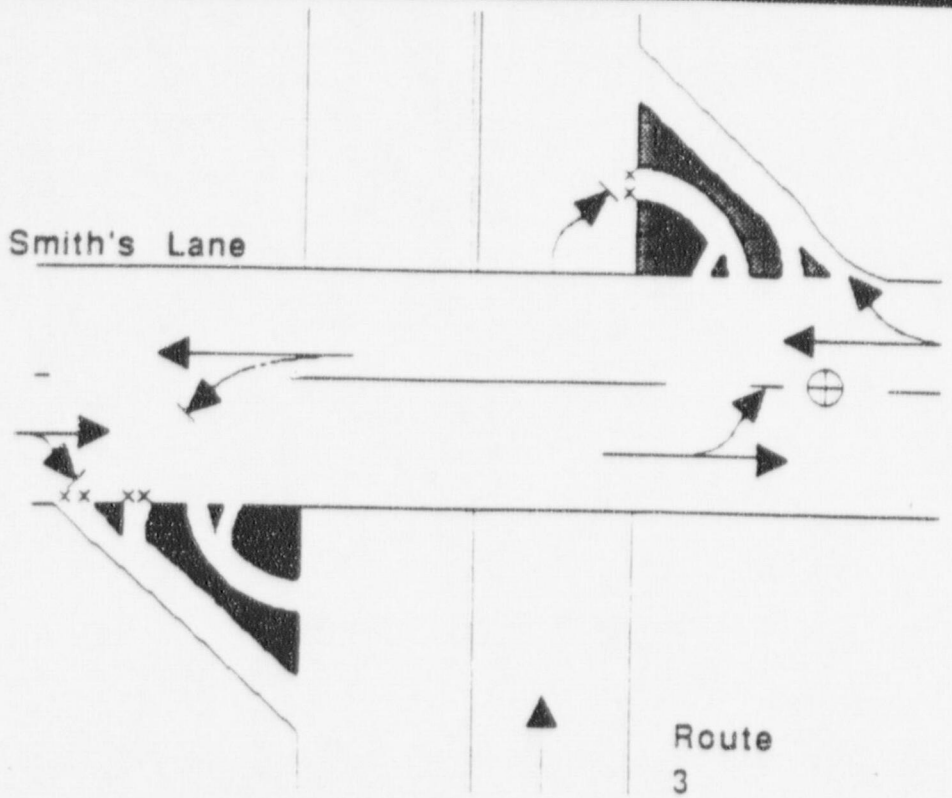
Manpower/Equipment:

1 Traffic Guide
2 Traffic Cones
7 Traffic Barricade

Description:

Discourage entry onto northbound and southbound Route 3.

Point No. K-AT-38a



Location:
Route 3 & Smith's Lane (Kingston), Exit 8

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

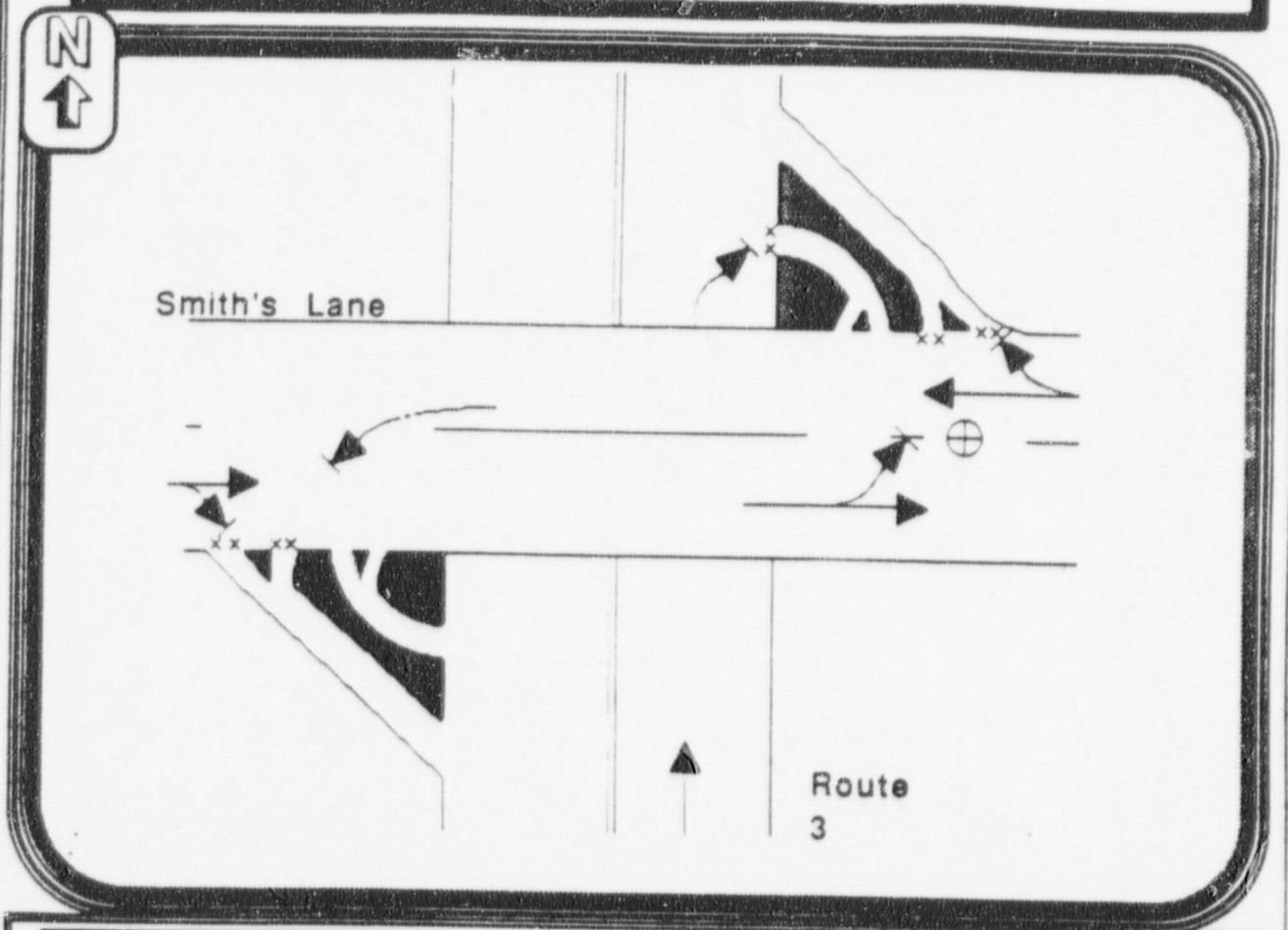
Manpower/Equipment:

1 Traffic Guide
6 Traffic Barricades

Description:

Facilitate entry onto northbound Route 3. Discourage entry onto southbound Route 3.

Point No. K-AT-36b



Location:
Route 3 & Smith's Lane (Kingston), Exit 8

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

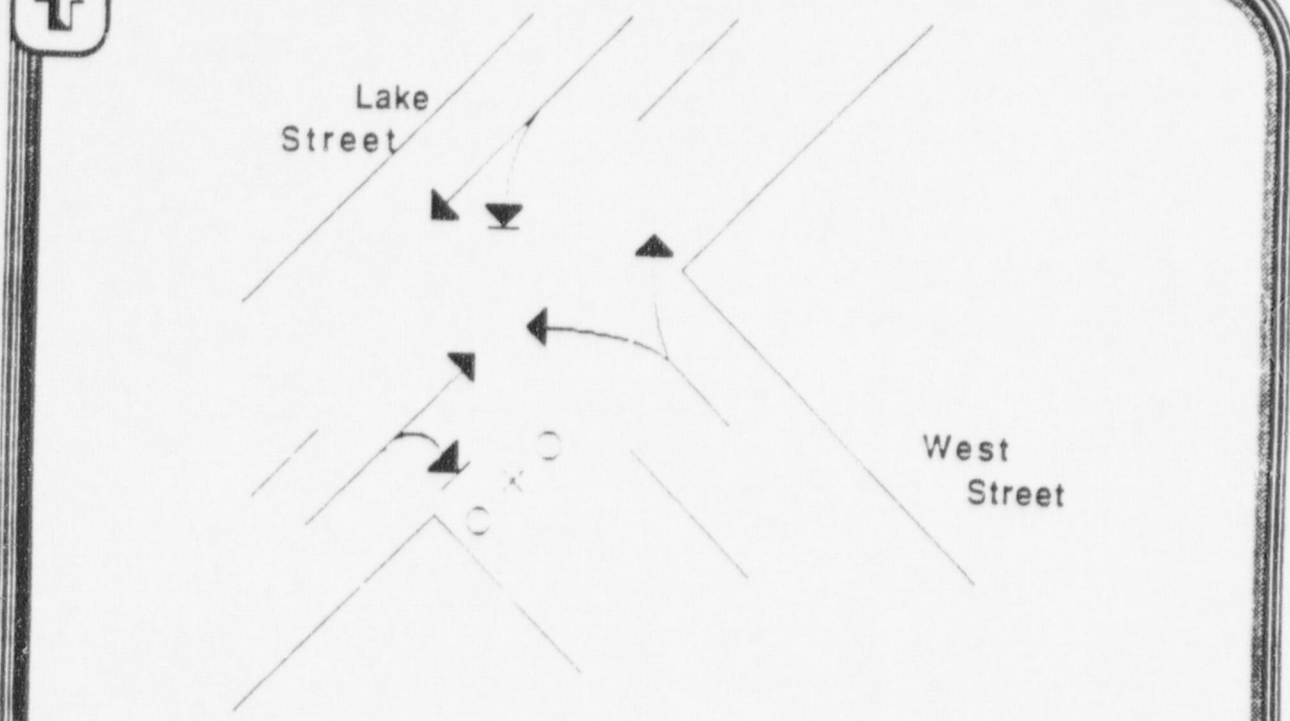
1 Traffic Guide

10 Traffic Barricades

Description:

Discourage entry onto northbound and southbound Route 3.

KIN-ACP-K-A-06b | 072888 | 1 of 1 | A3
Kingston Access Control Point #06b



Location:
West Street & Lake Street (Kingston)

Priority: 4

KEY

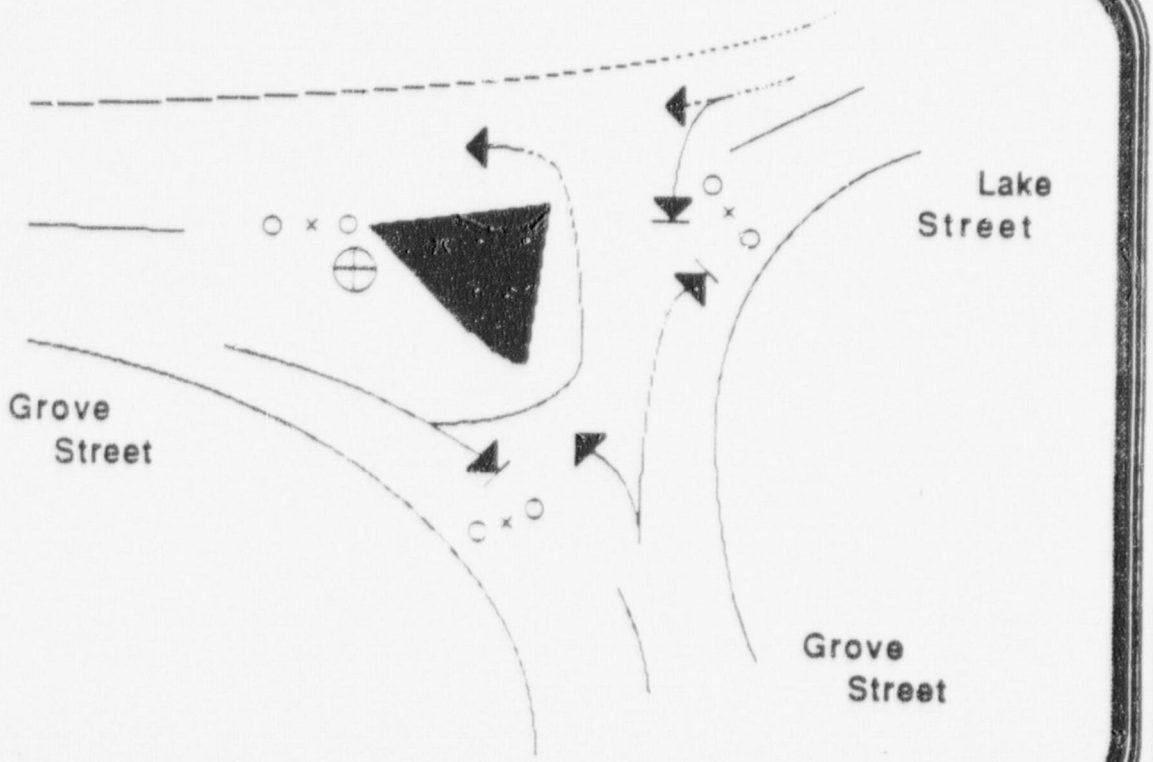
- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

2 Traffic Cones
1 Traffic Barricade

Description: Discourage southbound traffic on West Street.

Point No. K-A-38



Location:
Lake Street & Grove Street (Kingston)

Priority: 3

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

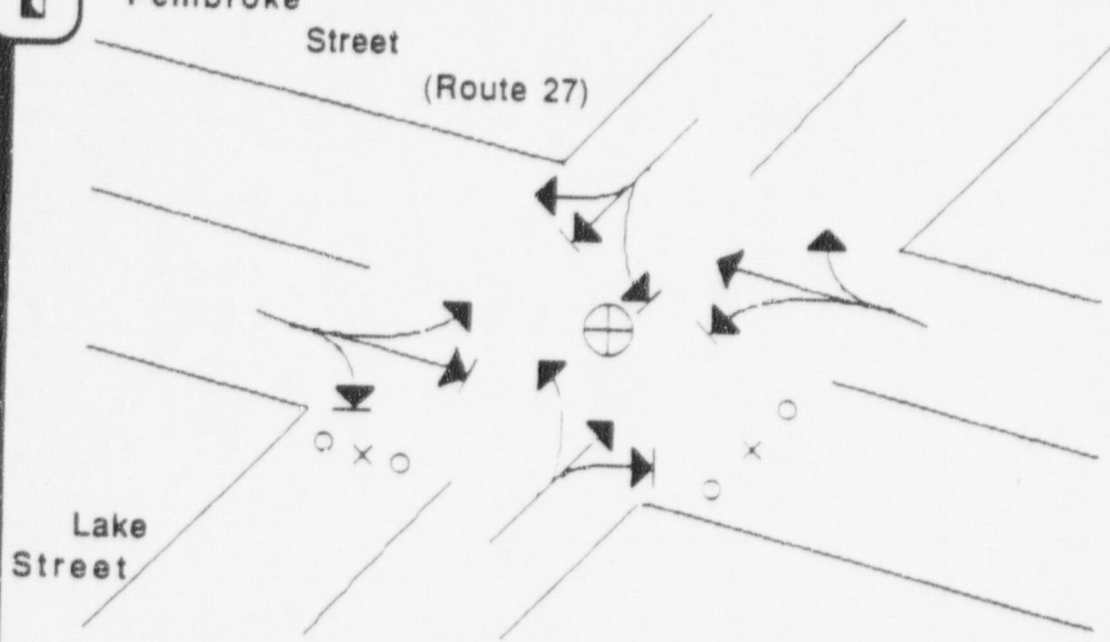
Manpower/Equipment:

1 Traffic Guide
6 Traffic Cones
3 Traffic Barricades

Description:

Discourage southbound traffic on Grove Street. Discourage northbound traffic on Lake Road.

Plan No. K-A-38



Location:
Lake Street & Pembroke Street (Kingston)

Priority: 3

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

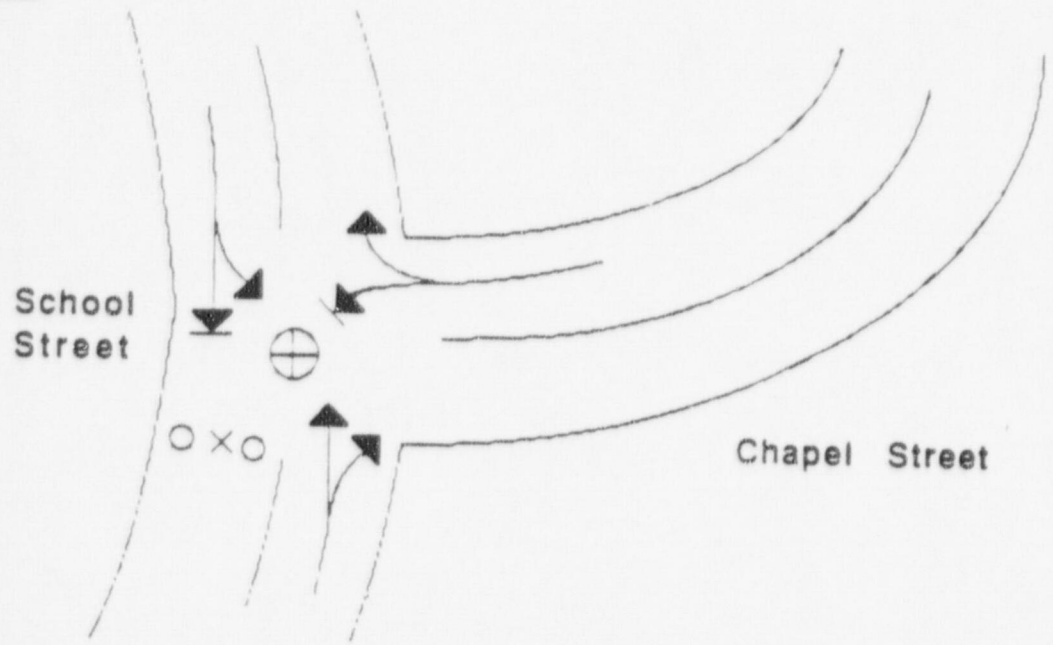
Manpower/Equipment:

1 Traffic Guide
4 Traffic Cones
2 Traffic Barricades

Description:

Discourage southbound traffic on Lake Street. Discourage eastbound traffic on Route 27.

Point No. K-A-10



Location:
School Street & Chapel Street (Kingston)

Priority: 3

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

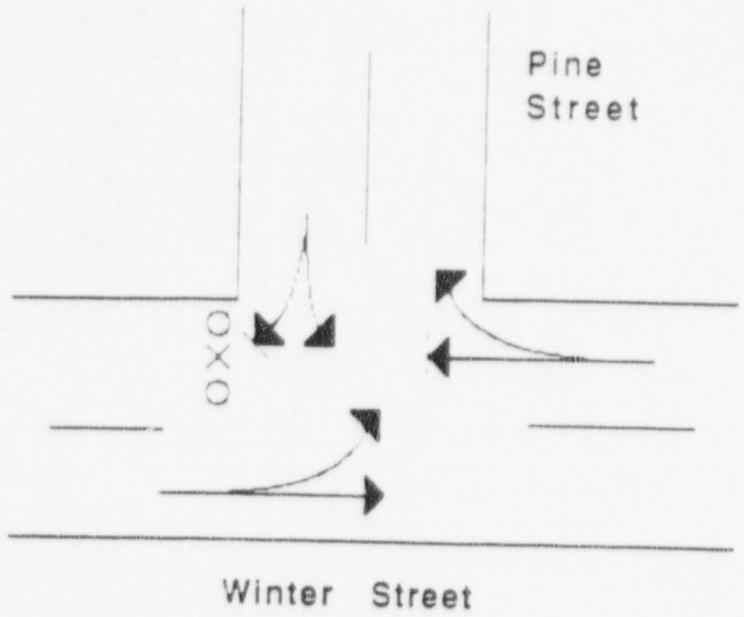
Manpower/Equipment:

1 Traffic Guide
2 Traffic Cones
1 Traffic Barricade

Description:

Discourage southbound traffic on School Street.

Point No. K-A-[illegible]



Location:
Winter Street & Pine Street (Kingston)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

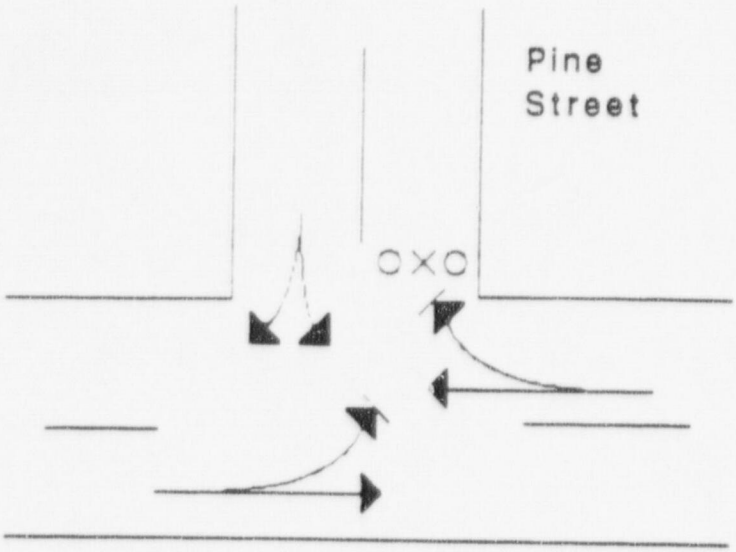
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage westbound traffic on Winter Street.

Plan No. K-A-11b



Location:
Winter Street & Pine Street (Kingston)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

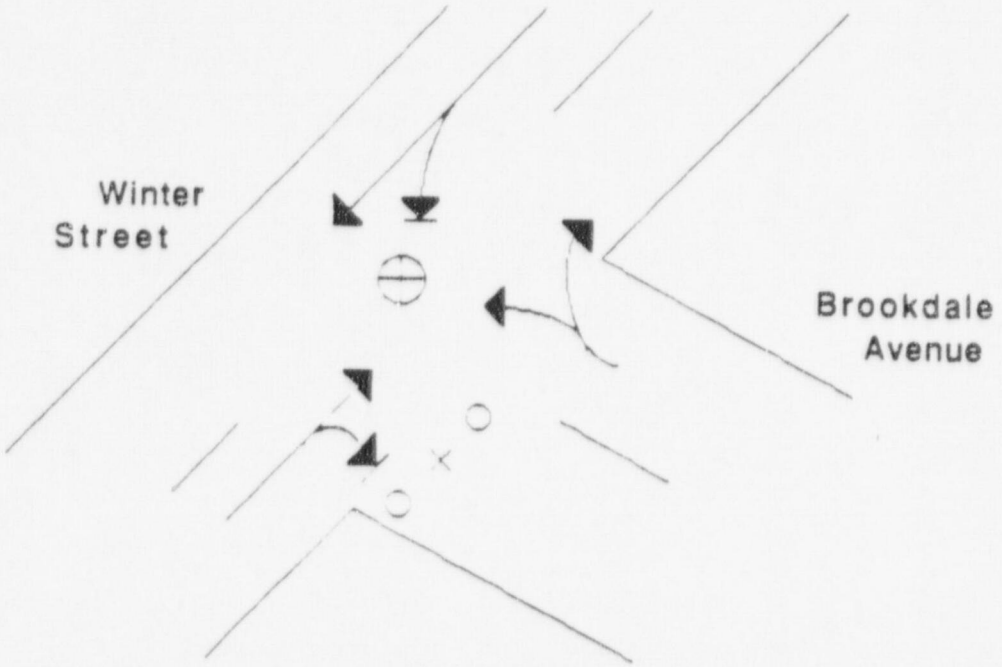
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage northbound traffic on Pine Street.

Point No. K-A-12a



Location:
Brookdale Avenue & Winter Street (Kingston)

Priority: 3

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

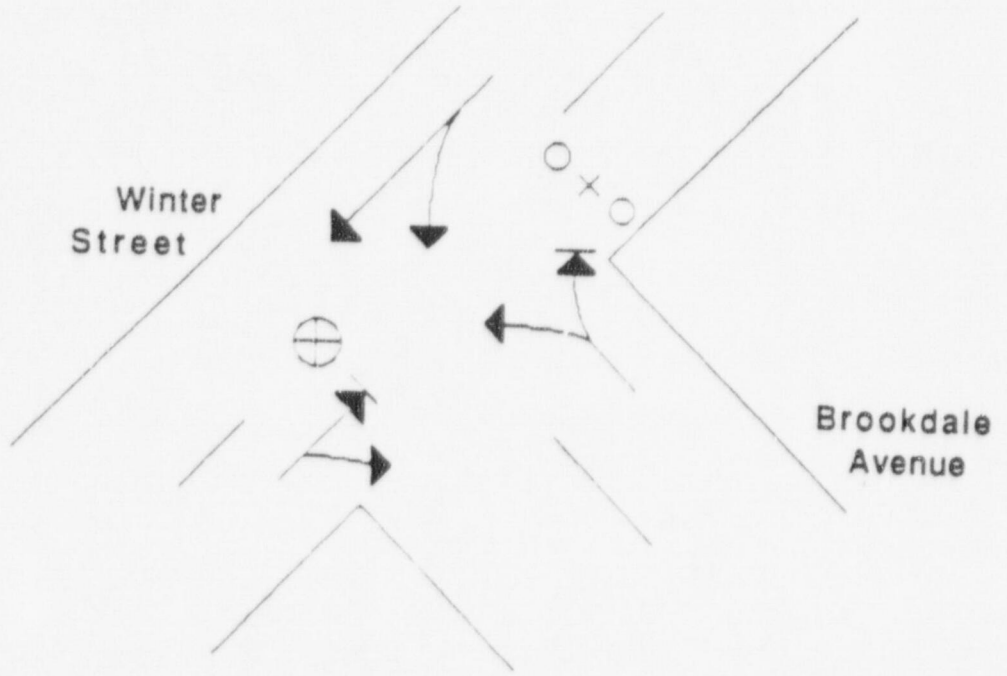
1 Traffic Guide
2 Traffic Cones
1 Traffic Barricade

Description:

Discourage southbound traffic on Brookdale Avenue.

KIN-ACP-K-A-12a	072888	
Kingston Access Control Point #12a	1 of 1	A0

Point 3. K-A-12b



Location:
Winter Street & Brookdale Avenue (Kingston)

Priority: 3

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

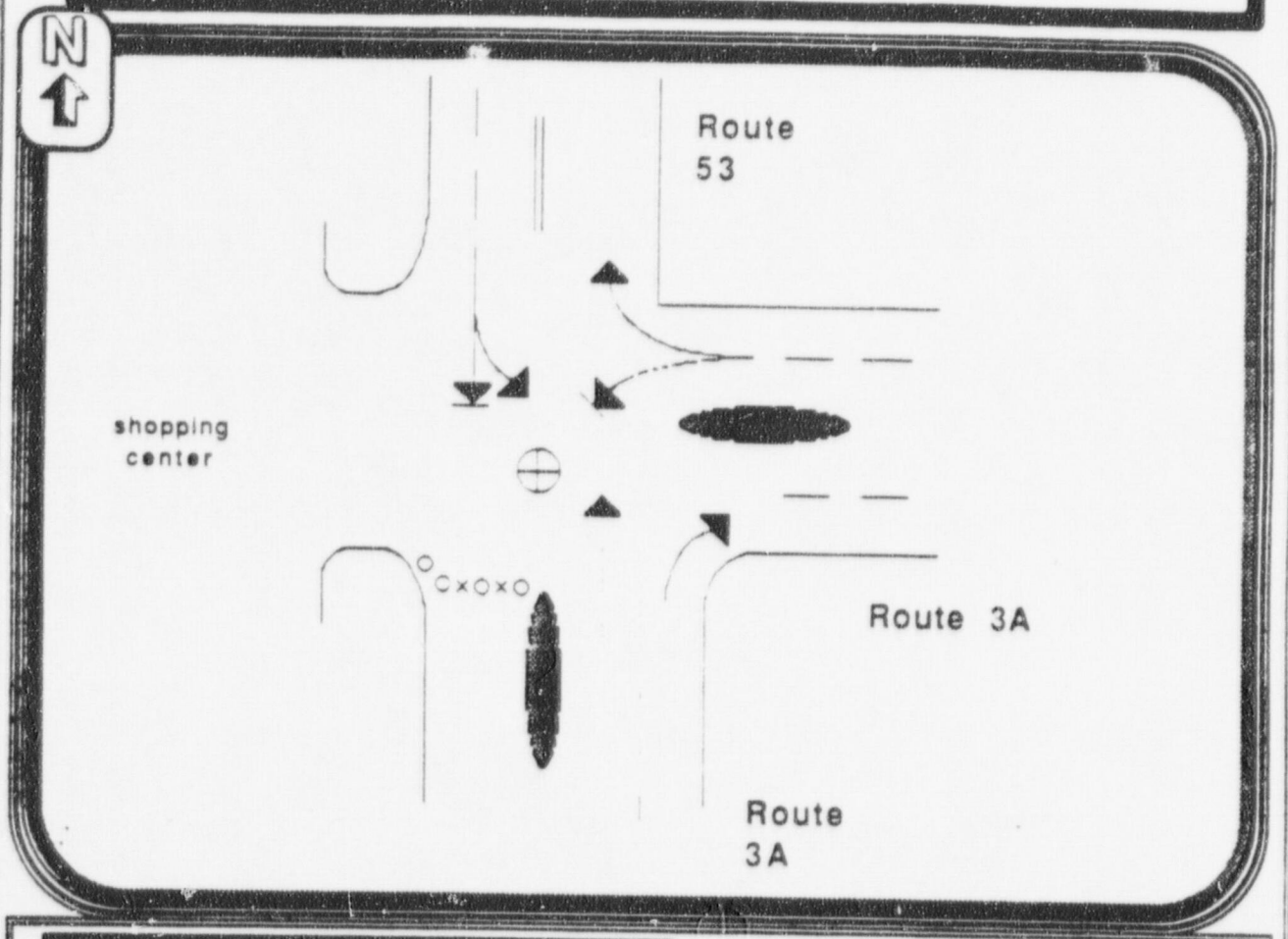
1 Traffic Guide
2 Traffic Cones
1 Traffic Barricade

Description:

Discourage eastbound traffic on Winter Street.

K-N-ACP-K-A-12b	072888	
Kingston Access Control Point #12b	1 of 1	12

Point No. K-A-13a



Location:
Route 53 & Route 3A (Kingston)

Priority: 2

KEY

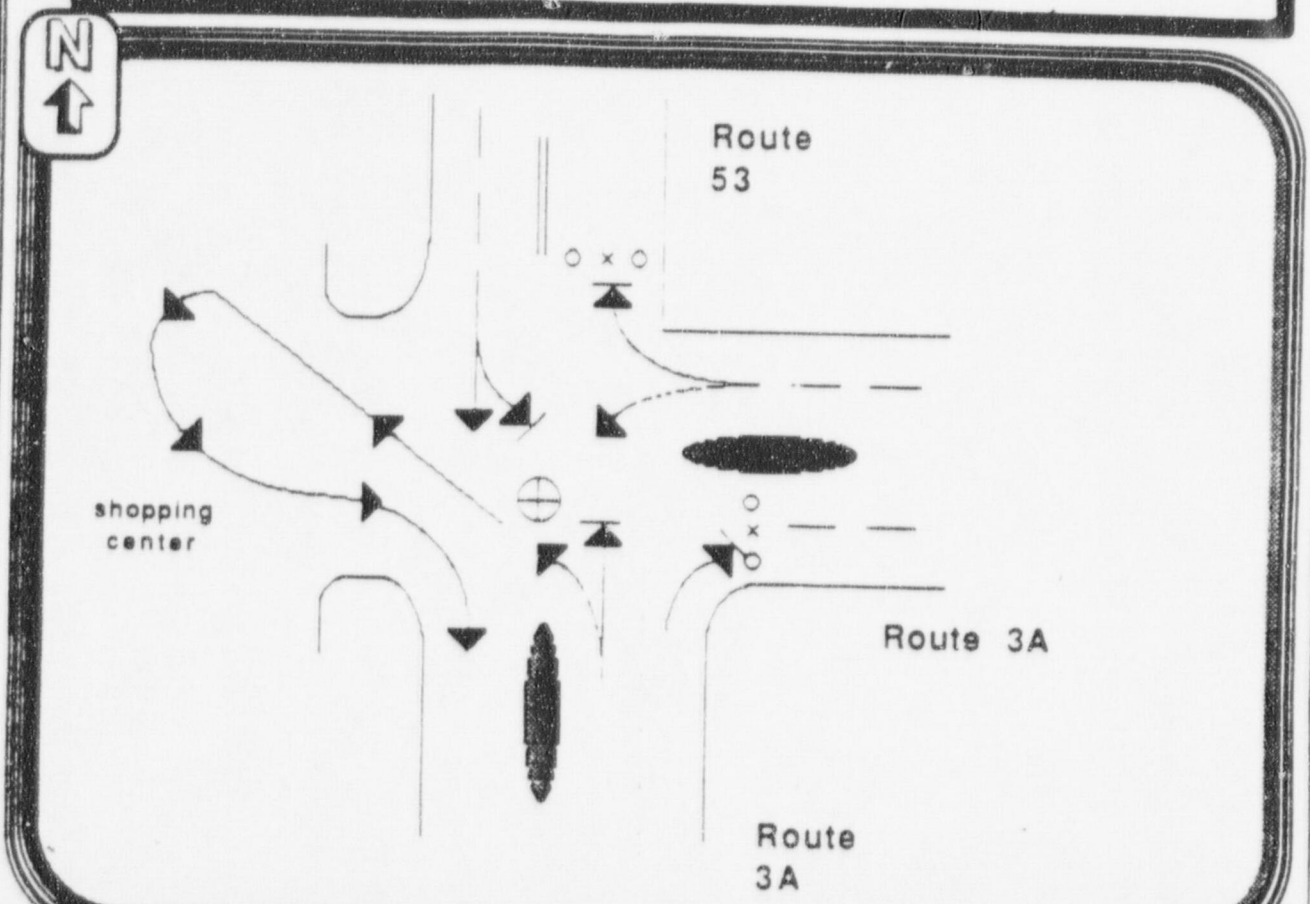
- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

1 Traffic Guide
4 Traffic Cones
2 Traffic Barricades

Description:
Discourage southbound traffic on Route 3A.

Point No. K-A-13b



Location:
Route 53 & Route 3A (Kingston)

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

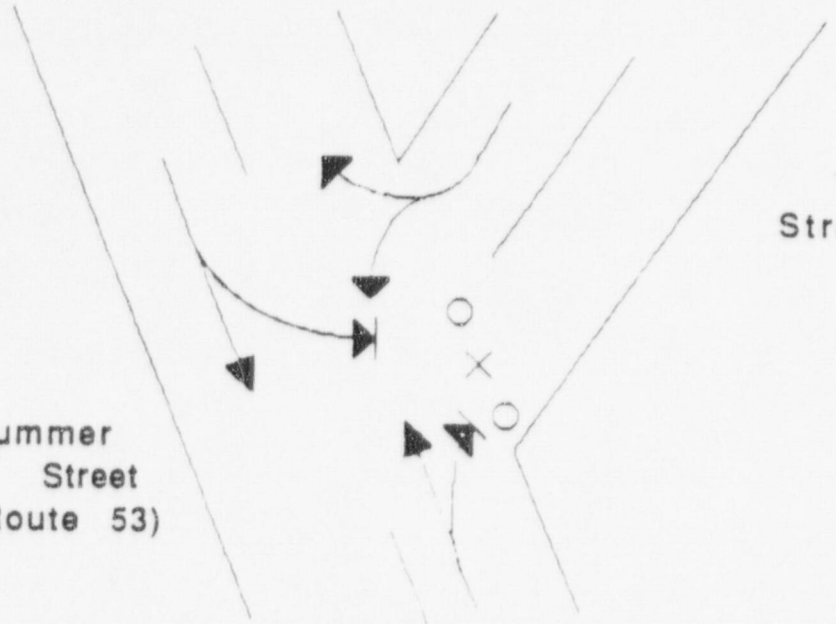
Manpower/Equipment:

1 Traffic Guide
4 Traffic Cones
2 Traffic Barricades

Description:

Discourage northbound traffic on Route 53 and eastbound traffic on Route 3A.

Plan No. K-A-14



Location:
Summer Street & Tremont Street (Kingston)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

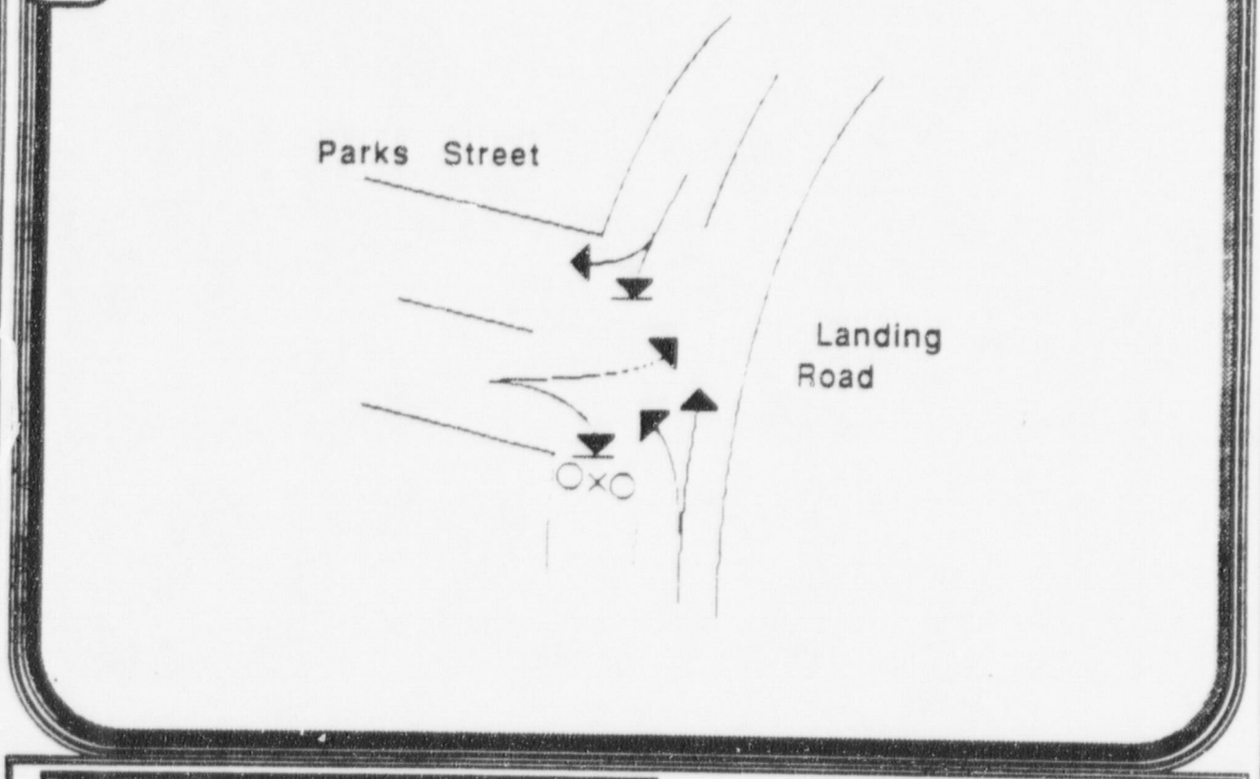
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage northbound traffic on Tremont Street.

Point No. K-A-1Es



Location:
Parks Street & Landing Road (Kingston)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

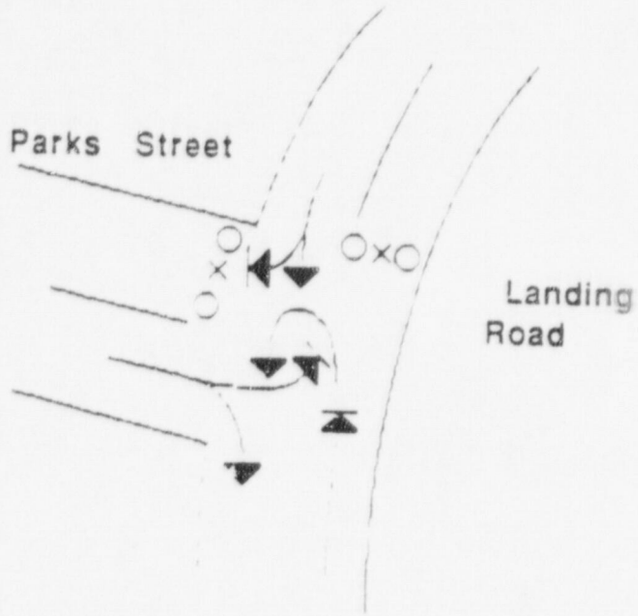
Manpower/Equipment:

2 Traffic Cones

1 Traffic Barricade

Description:

Discourage southbound traffic on Landing Road.



Location:
Parks Street & Landing Road (Kingston)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

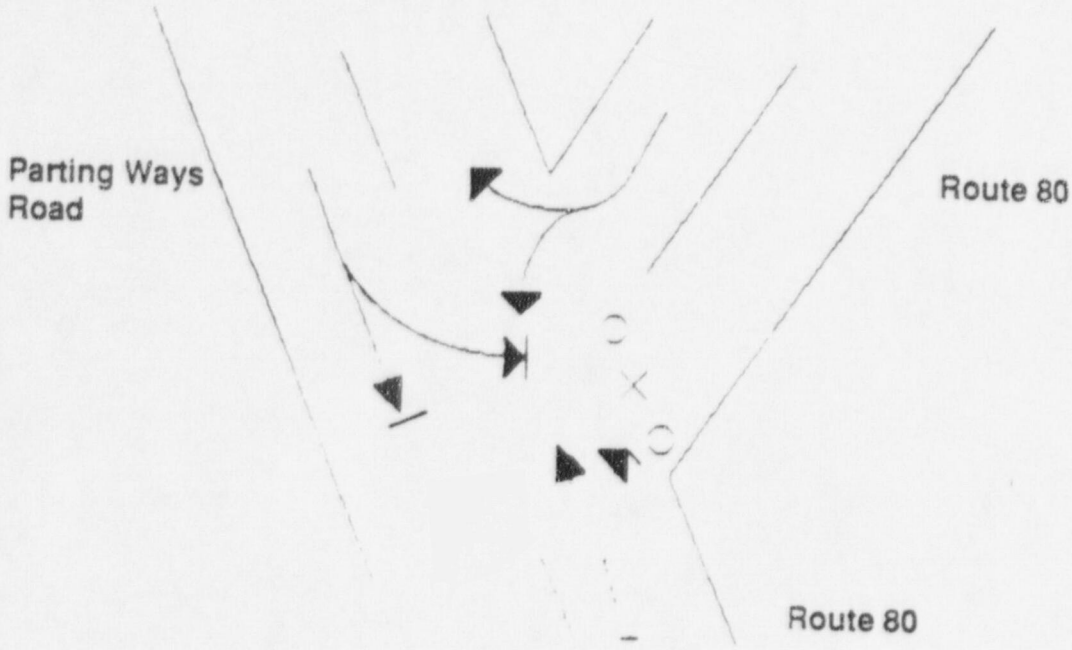
4 Traffic Cones

2 Traffic Barricades

Description:

Discourage northbound traffic on Landing Road and Parks Street.

Point No. K-A-16A



Location:
Route 80 and Parting Ways Road (Kingston)

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

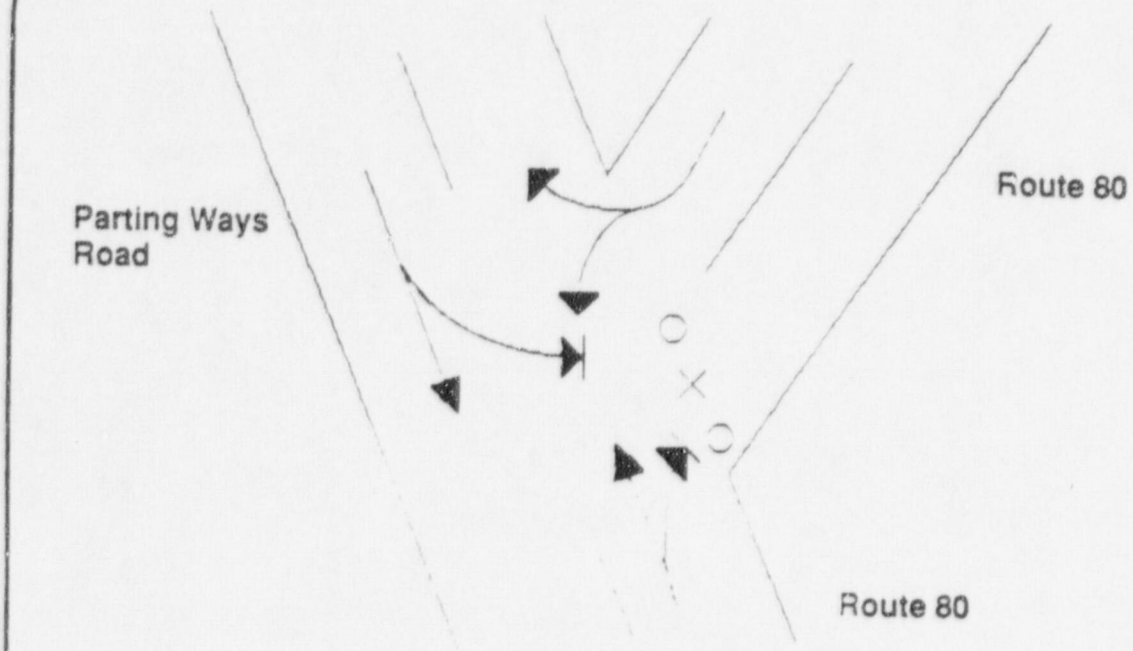
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage eastbound traffic on Route 80.

Point No. K-A-16B



Location:
Route 80 and Parting Ways Road (Kingston)

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

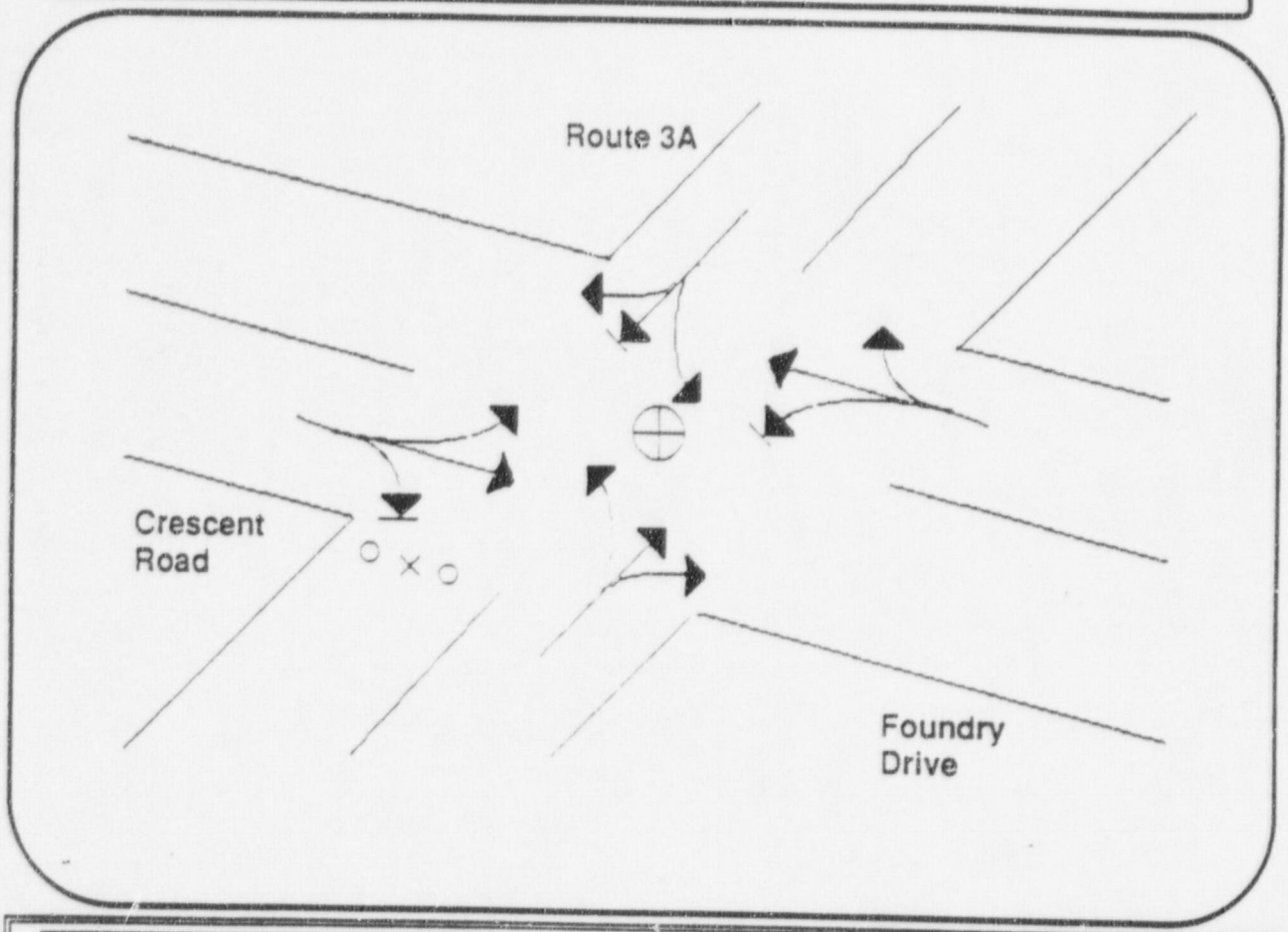
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage northbound traffic on Route 80.

Point No. K-A-17



Location:
Route 3A and Foundry Drive/Crescent Road (Kingston)

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

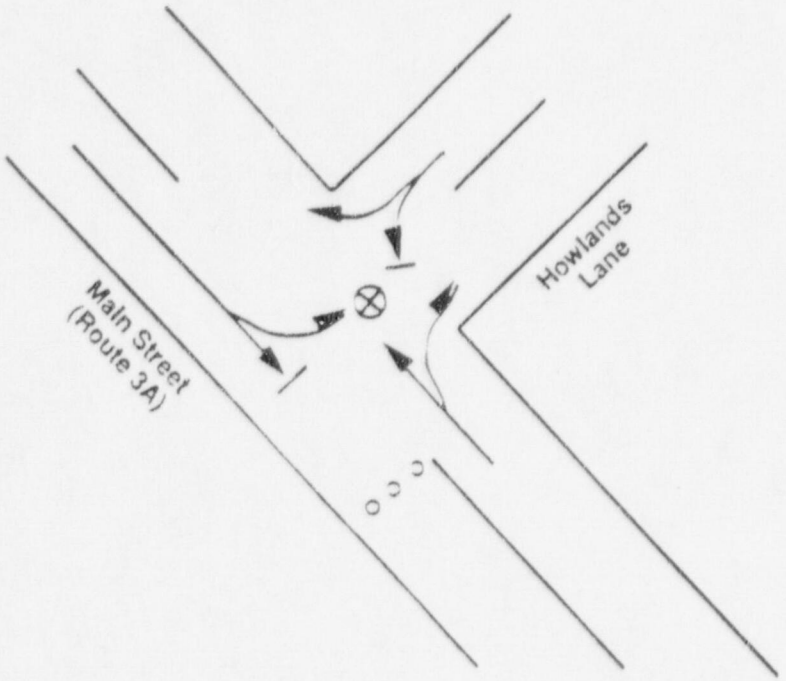
Manpower/Equipment:

1 Traffic Guide
2 Traffic Cones
1 Traffic Barricade

Description:

Discourage southbound traffic on Route 3A.

Point No. K-T-18



Location:
Main Street (Route 3A) & Howlands Lane
(Kingston).

Priority:

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

1 Traffic Guide

3 Traffic Cones

Description:

Facilitate traffic moving from Howlands Lane to Northbound Main Street (Route 3A)

Discourage Southbound traffic on Main Street (Route 3A)

Activation Sequence
For Traffic and Access Control Points

A total of 18 Traffic and Access Control Points have been identified for Kingston. Of these:

- 4 Control Points have purely traffic control functions associated with them (K-T-01 through K-T-03, K-T-18).
- 3 Control Points have mixed traffic and access control functions associated with them (K-AT-04 through K-AT-06).
- 11 Control Points have purely access control functions associated with them (K-A-07 through K-A-17).

Control Points which have purely traffic control functions are designed to be active during the period of time that an evacuation is under way. They are designed to assist motorists exiting the area in an orderly manner. As traffic flow through these points diminishes during the course of an evacuation, they can be abandoned and personnel reassigned to other areas or activities.

Control Points which have mixed traffic and access control functions are designed to be active throughout the course of the evacuation. During this period of time, the traffic control function is applied to assist evacuees until the completion of the evacuation. Following the evacuation, the location is needed to restrict access to an area. The access control at a given location might have several configurations depending on the Regions evacuated.

Control Points which have purely access control functions are designed to secure an area after evacuation has been completed. As such, these points should be established in a manner and time so as not to conflict with an orderly movement of evacuation traffic. The access control at a given location might have several configurations depending on the Region evacuated.

The emergency plan for a response to an accident at Pilgrim Station recognizes four event classification levels. At each level, we can define the requirements for traffic and access control functions:

Unusual Event

Unusual events are in process or have occurred which indicate a potential degradation of the level of safety of the plant.

No traffic or access control actions required.

Alert

Events are in process or have occurred which involve an actual or potential substantial degradation of the level of safety of the plant.

At an Alert, State authorities may initiate a precautionary evacuation of schools within the EPZ. Traffic control personnel should be dispatched to schools to assist with this evacuation.

Site Area Emergency

Events are in process or have occurred which involve actual or likely major failures of plant functions needed for protection of the public.

At a Site Area Emergency, school children will be evacuated to host schools. Traffic control personnel should be dispatched to schools to assist with this evacuation.

In anticipation of an escalating event, traffic control resources should be mobilized. Personnel and equipment are transported to the traffic control points. A manning sequence for the traffic control activities follows:

1. K-T-18
2. K-AT-03
3. K-AT-04
4. K-T-02
5. K-T-01
6. K-AT-05
7. K-T-06

Since an evacuation recommendation to the general public will not be issued until a General Emergency is declared, it will not be known which Region of the EPZ is to be evacuated. Consequently, access control points cannot be manned until the Region to be evacuated is defined.

General Emergency

Events are in process or have occurred which involve actual or imminent substantial core degradation or melting with potential for loss of containment integrity.

After the declaration of a General Emergency, a Protective Action Recommendation will be made. If evacuation is the recommended action, then the public will be asked to evacuate a specific Region of the EPZ. Upon the issuance of the evacuation recommendation to the public, the traffic control plan should be activated.

The manning sequence for access control points is based upon the Region:

Regions 1-10,20,21
1. K-AT-06A
2. K-AT-05A

Region 11
1. K-AT-06A
2. K-AT-05A
3. K-AT-04A
4. K-A-16A
5. K-A-17

Region 12
1. K-AT-06A
2. K-AT-05A
3. K-A-09
4. K-A-10
5. K-A-13
6. K-A-14
7. K-A-15
8. K-A-12
9. K-A-11
10. K-A-07
11. K-A-08

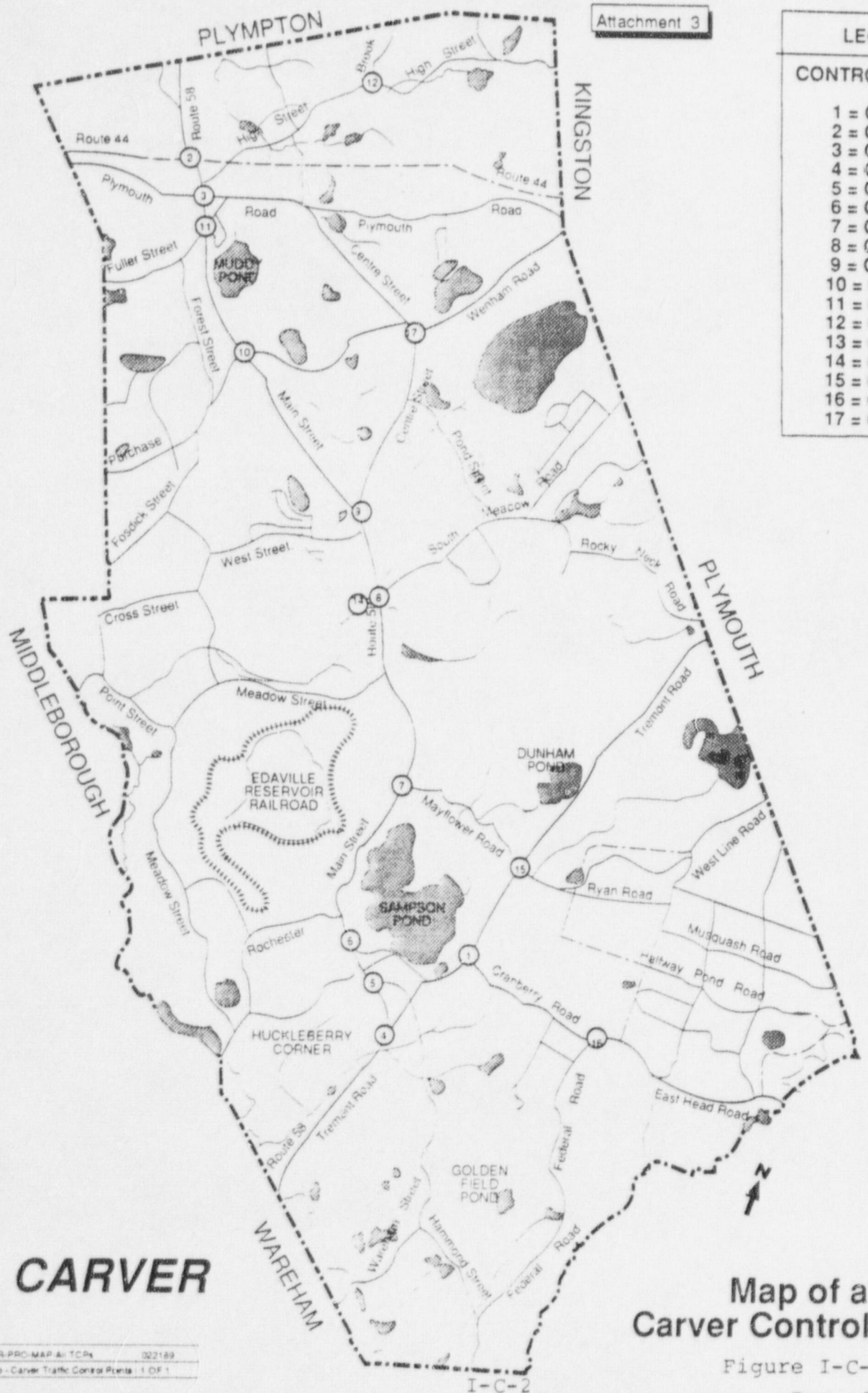
Region 13-17,22
1. K-AT-06A
2. K-AT-05A
3. K-A-09
4. K-A-10
5. K-A-07
6. K-A-08

Region 18
1. K-AT-06A
2. K-AT-05A
3. K-A-09
4. K-A-10
5. K-A-07
6. K-A-08
7. K-A-16B

Region 19
1. K-AT-06B
2. K-AT-05B
3. K-AT-04B
4. K-A-13B
5. K-A-14
6. K-A-11B
7. K-A-12B
8. K-A-15B

CARVER

Attachment 3



LEGEND

CONTROL POINTS

1 = C-T-01
2 = C-AT-02
3 = C-AT-03
4 = C-AT-04
5 = C-A-05
6 = C-A-06
7 = C-A-07
8 = C-A-08
9 = C-A-09
10 = C-A-10
11 = C-A-11
12 = C-A-12
13 = C-A-13
14 = C-A-14
15 = C-A-15
16 = C-A-16
17 = C-T-17

CARVER

CAR-PRO-MAP All TCPs	022189
Map - Carver Traffic Control Points - 1 OF 1	

Map of all Carver Control Points

Figure I-C-1

Rev. 5

Table I-C-1. Location, Manpower, and Equipment Requirements for All Traffic and Access Control Points

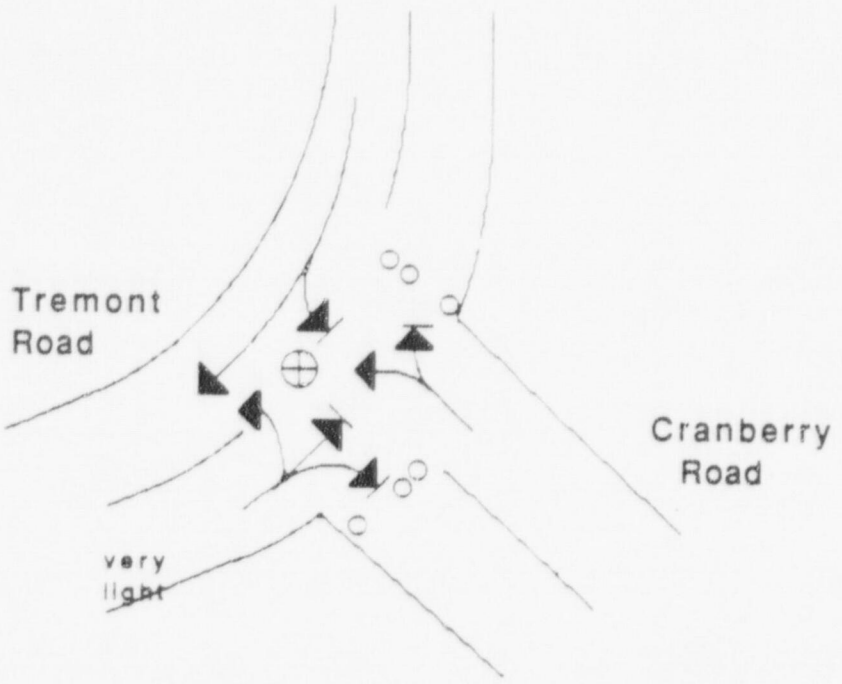
TOWN: Carver

TCP or ACP	Location	Agency Priority	Guides	Cones	Barricades	Lights
C-T-01	Tremont Rd. & Cranberry Rd.	C-2	1	6		2
C-AT-02	Rte. 44 & Main St. (Rte. 58)	S-2	2	10	5	5
C-AT-03	Old Rte. 44 & Main St. (Rte. 58)	C-1	1	4	2	2
C-AT-04	Main St. & Tremont Rd.	C-1	1	6	2	3
C-A-05	Church St. & Main St. (Rte. 58)	C-4		2	1	1
C-A-06	Lakeview St. & Main St.	C-4		2	1	1
C-A-07	Main St.(Rte. 58) & Mayflower Rd.	C-3	1	2	1	1
C-A-08	South Meadow Rd. & Main St. (Rte. 58)	C-2	1	4	2	2
C-A-09	Center St. & Main St. (Rte. 58)	C-2	1	4	2	2
C-A-10	Silva St. & Main St. (Rte. 58)	C-2	1	2	1	1
C-A-11	Main St. & Forest St.	C-4		2	1	1
C-A-12	Pleasant St. & Brook St.	C-3	1	8	1	3
C-A-13A	Parting Ways & Spring St.	C-4		2	1	1
C-A-13B	Parting Ways & Spring St.	C-4		2	1	1
C-A-14	South Meadow Rd. & Wade St.	C-4	1	2		1
C-A-15	Tremont Rd. & Mayflower Rd.	C-4	1	4		2
C-A-16	Cranberry Rd. & Federal Rd.	C-4	1	2		1
C-T-17	Wenham Rd. & Centre St.	C-3	1			

Table I-C-2. Allocation of Access Control Points to Towns

TOWN: Carver

ACCESS CONTROL POINT	ACTIVATED FOR FOLLOWING REGIONS:
C-AT-02	9, 11, 12, 13, 22
C-AT-03	9, 11, 12, 13, 22
C-AT-04	9, 11, 12, 13, 22
C-A-05	9, 11, 12, 13, 22
C-A-06	9, 11, 12, 13, 22
C-A-07	9, 11, 12, 13, 22
C-A-08	9, 11, 12, 13, 22
C-A-09	9, 11, 12, 13, 22
C-A-10	9, 11, 12, 13, 22
C-A-11	9, 11, 12, 13, 22
C-A-12	9, 11, 12, 13, 18, 22
C-A-13A	8, 10, 11, 12, 14, 15, 16, 17, 18, 22
C-A-13B	9
C-A-14	8, 10, 14
C-A-15	8, 10, 14
C-A-16	8, 10, 14



Location:
Tremont Road & Cranberry Road (Carver)

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

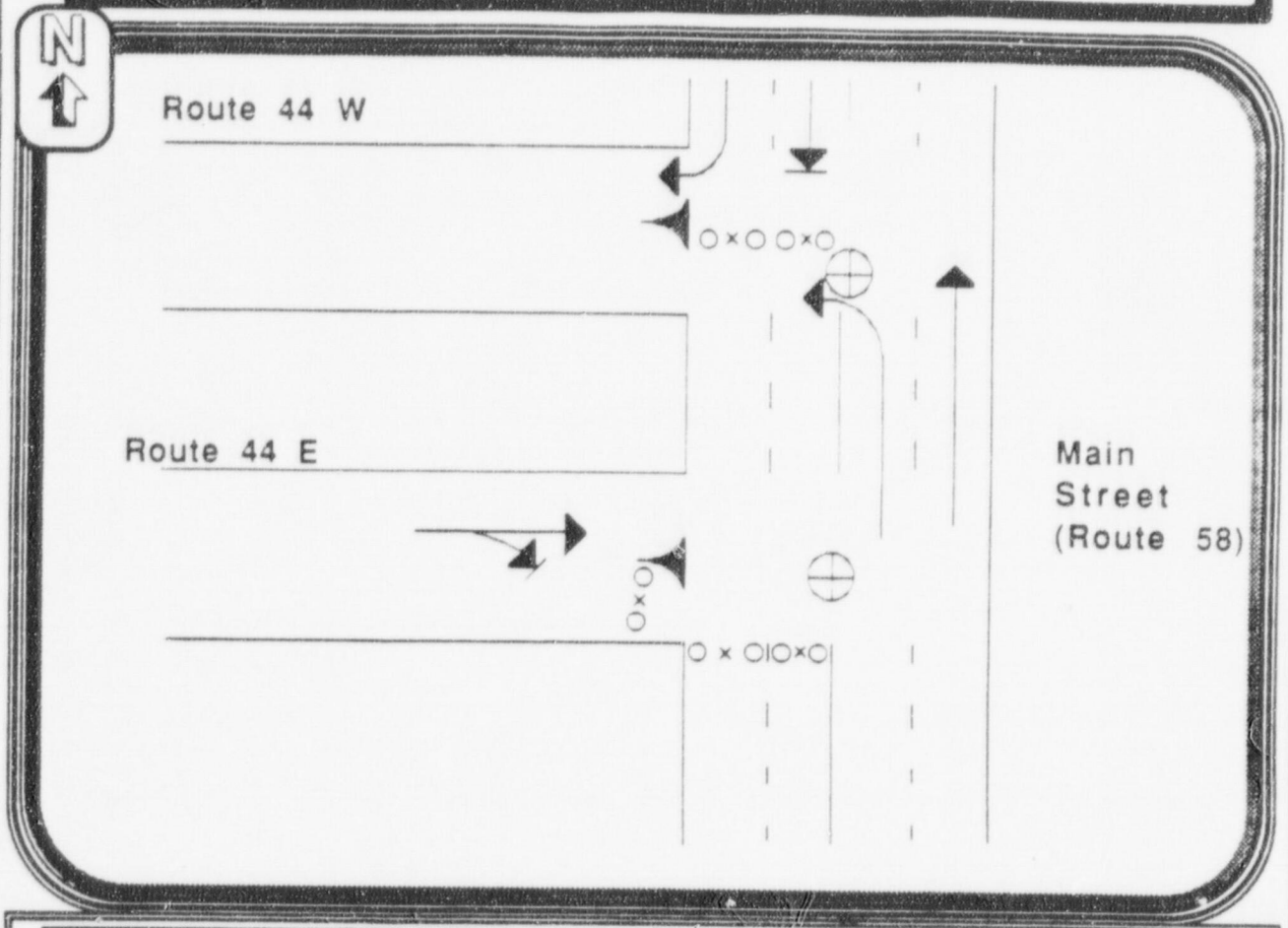
1 Traffic Guide

6 Traffic Cones

Description:

Facilitate southbound traffic on Tremont Road and turns from Cranberry Road to southbound Tremont Road. Discourage northbound traffic on Tremont Road and eastbound traffic on Cranberry Road.

Patrol No. 3-AT-02



Location:
Route 44 & Main Street (Carver)

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

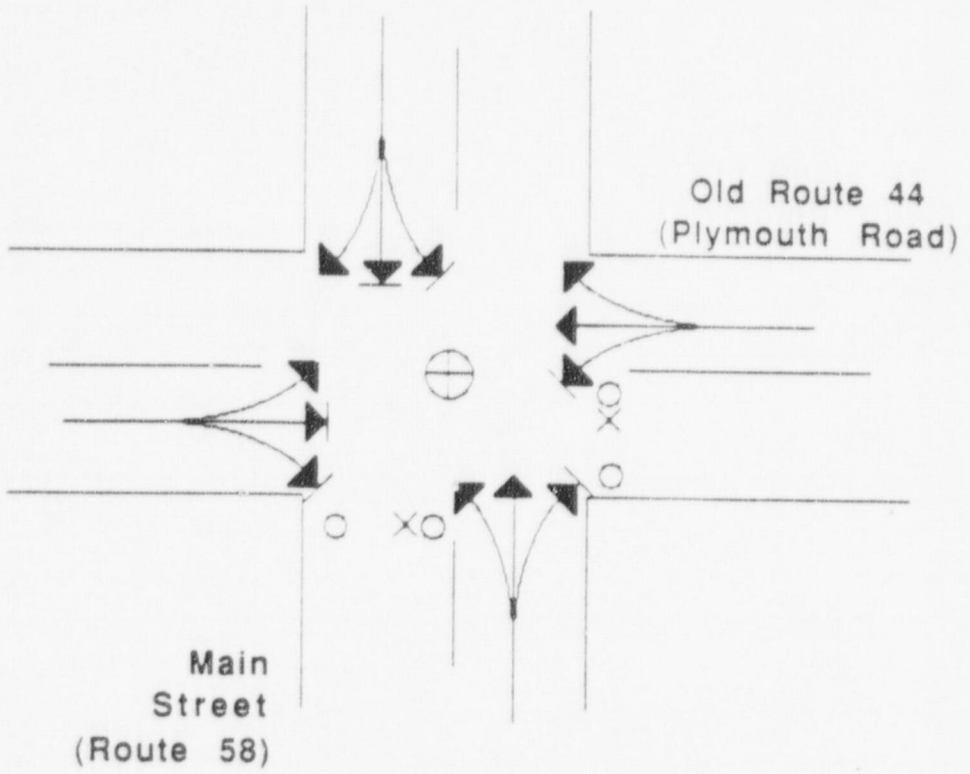
Manpower/Equipment:

2 Traffic Guides
10 Traffic Cones
5 Traffic Barricades

Description:

Facilitate westbound traffic on Route 44 and traffic turning west onto Route 44 from northbound Main Street. Discourage southbound traffic on Main Street.

Point No. C-AT-03



Location:
Old Route 44 & Main Street (Carver)

Priority: 1

KEY

——▶	Movement facilitated
——▶|	Movement discouraged
⊕	Traffic guide
○	Traffic cone
×	Traffic barricade

Manpower/Equipment:

1 Traffic Guide
4 Traffic Cones
2 Traffic Barricades

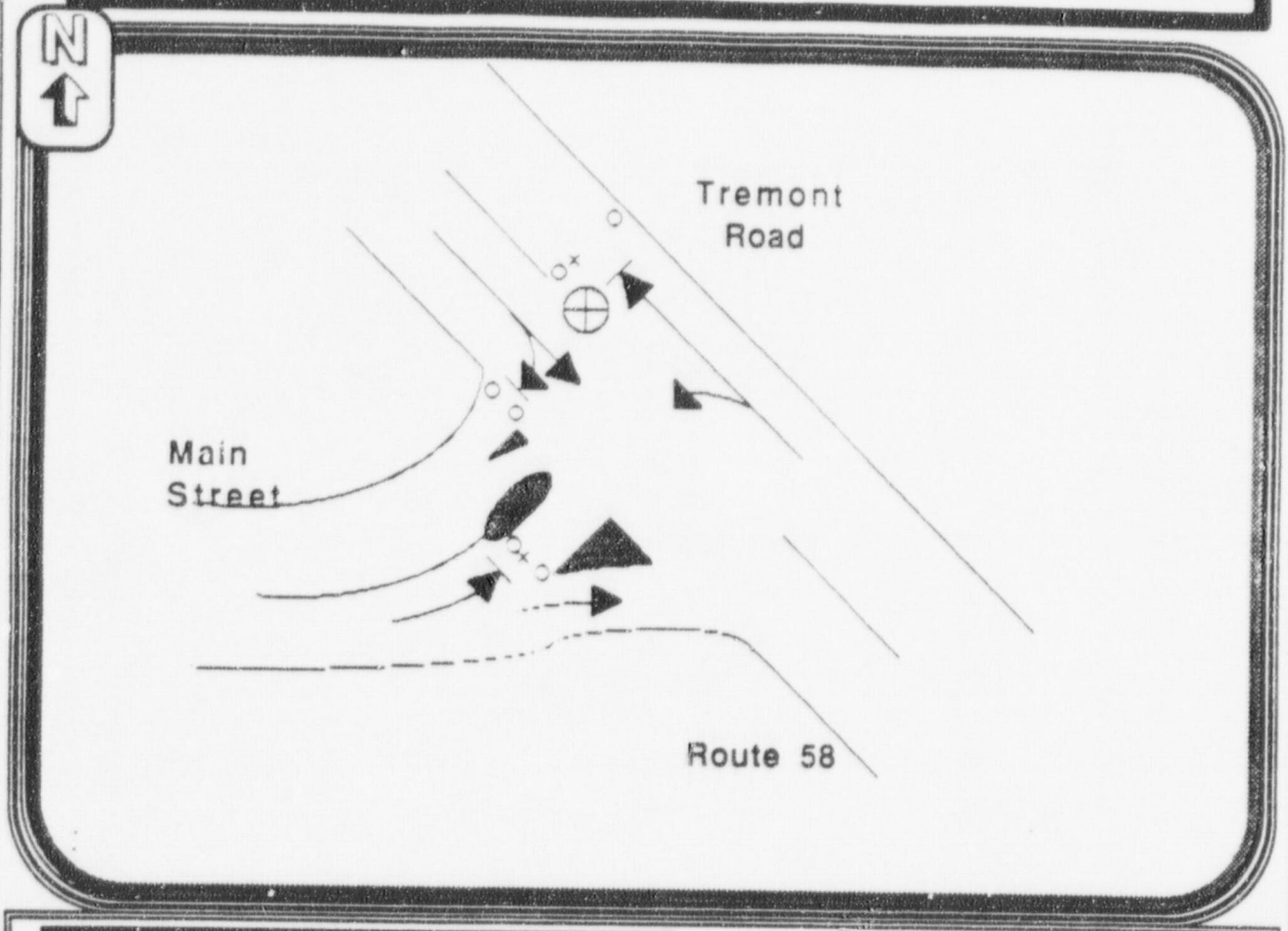
Description:

Facilitate westbound traffic on Old Route 44 and northbound traffic on Main Street. Discourage eastbound traffic on Old Route 44 and southbound traffic on Main Street.

CAR-ACP-C-AT-03	272588	
Carver Access Control Point #03	1 of 1	3A

Rev. 5

Point No. C-AT-04



Location:
Main Street & Tremont Road (Carver)

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

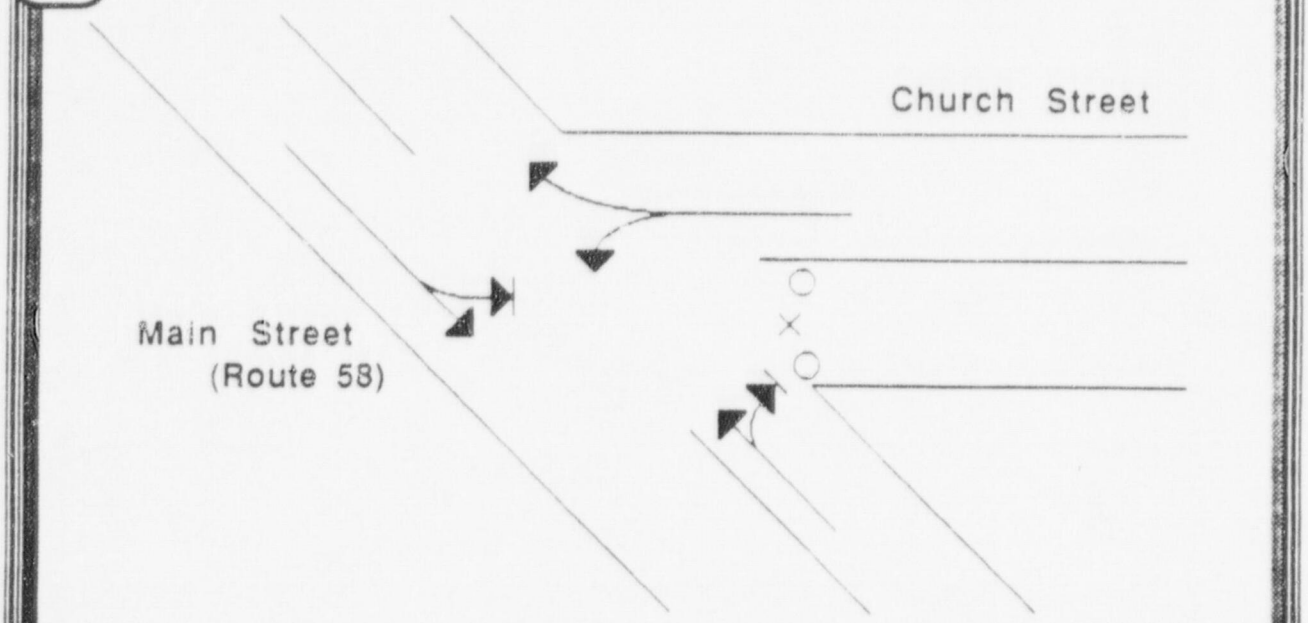
1 Traffic Guide
6 Traffic Cones
2 Traffic Barricades

Description:

Facilitate southbound traffic on Main Street and westbound traffic on Tremont Road. Discourage eastbound traffic on Tremont Road.

CAR ACP C AT 04	072688	
Carver Access Control Point #04	1 of 1	3A

Point No. 3-A-15



Location:
Church Street & Main Street (Route 58)
(Carver)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

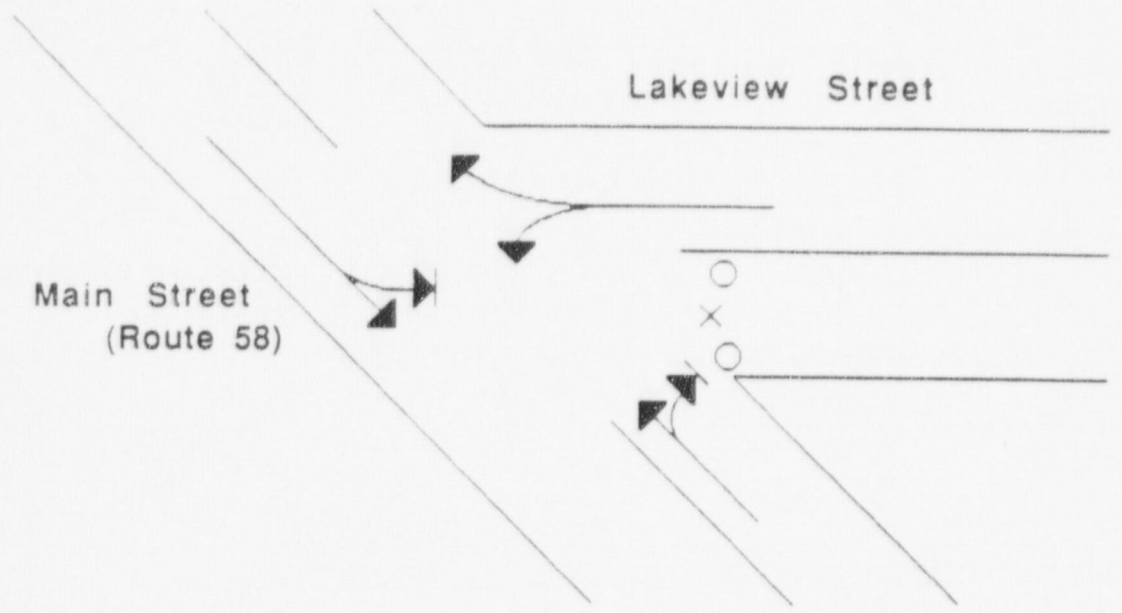
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage eastbound traffic on Church Street.

Point No. C-A-36



Location:
Lakeview Street & Main Street (Carver)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

2 Traffic Cones

1 Traffic Barricade

Description:

Discourage eastbound traffic on Lakeview Street.

CAR-ACP-C-A-36	072888	
Carver Access Control Point #36	1 of 1	3A

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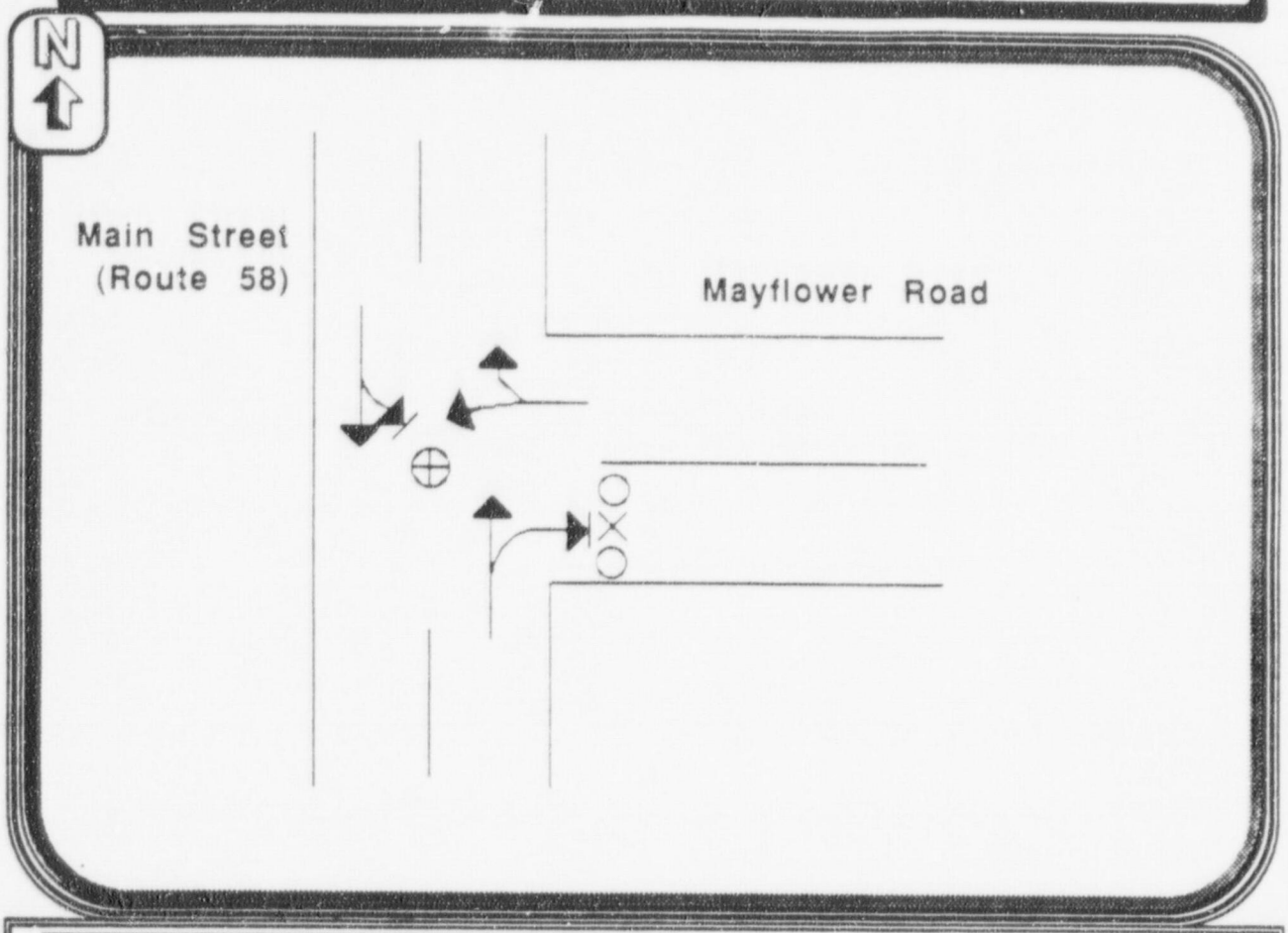
Point No. C-A-07



Location:
Main Street (Route 58) & Mayflower Road
(Carver)

Priority: 3

KEY

——▶	Movement facilitated
——▶|	Movement discouraged
⊕	Traffic guide
○	Traffic cone
×	Traffic barricade

Manpower/Equipment:

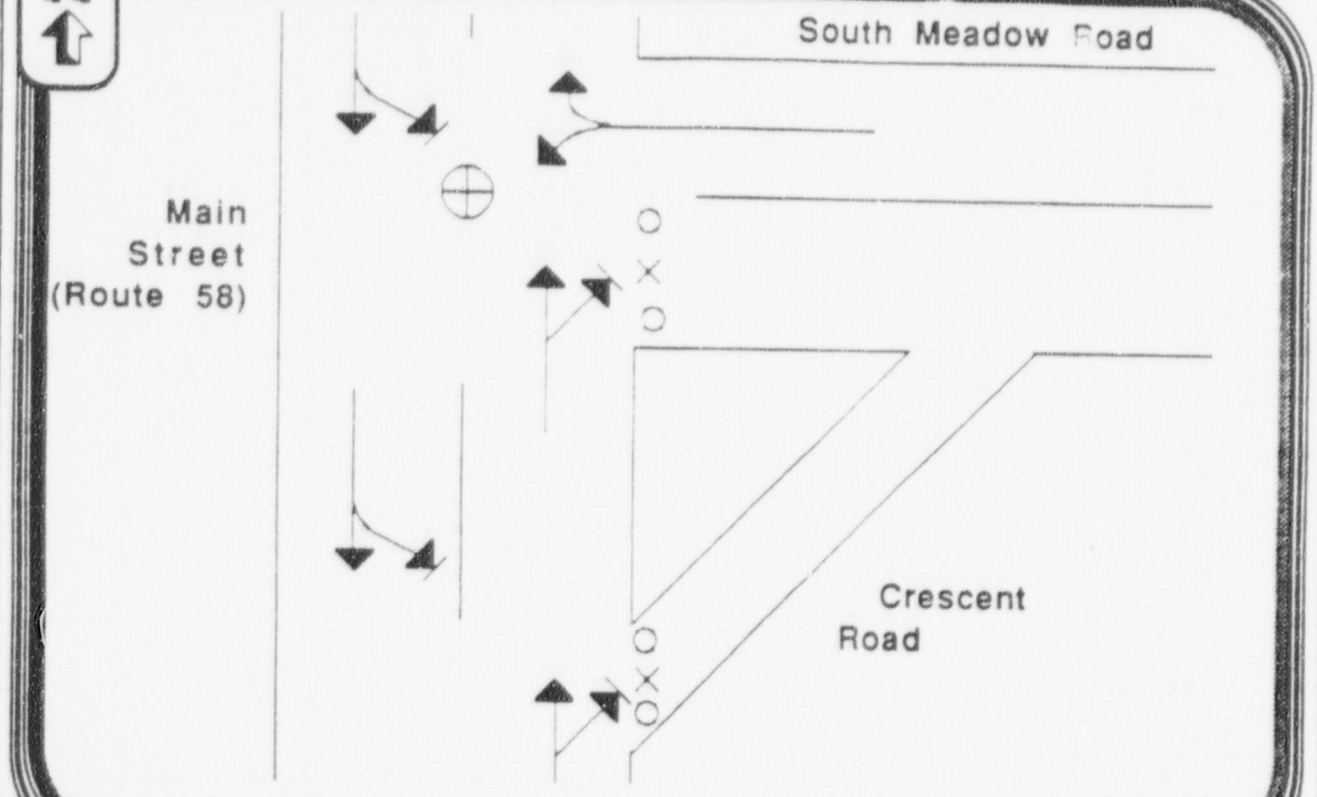
1 Traffic Guide
2 Traffic Cones
1 Traffic Barricade

Description:

Discourage eastbound traffic on Mayflower Road.

CAR-ACP-C-A-07	072688	
Carver Access Control Point #07	1 of 1	38

Point No. C-A-38



Location:
South Meadow Road & Main Street (Route 58)
(Carver)

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

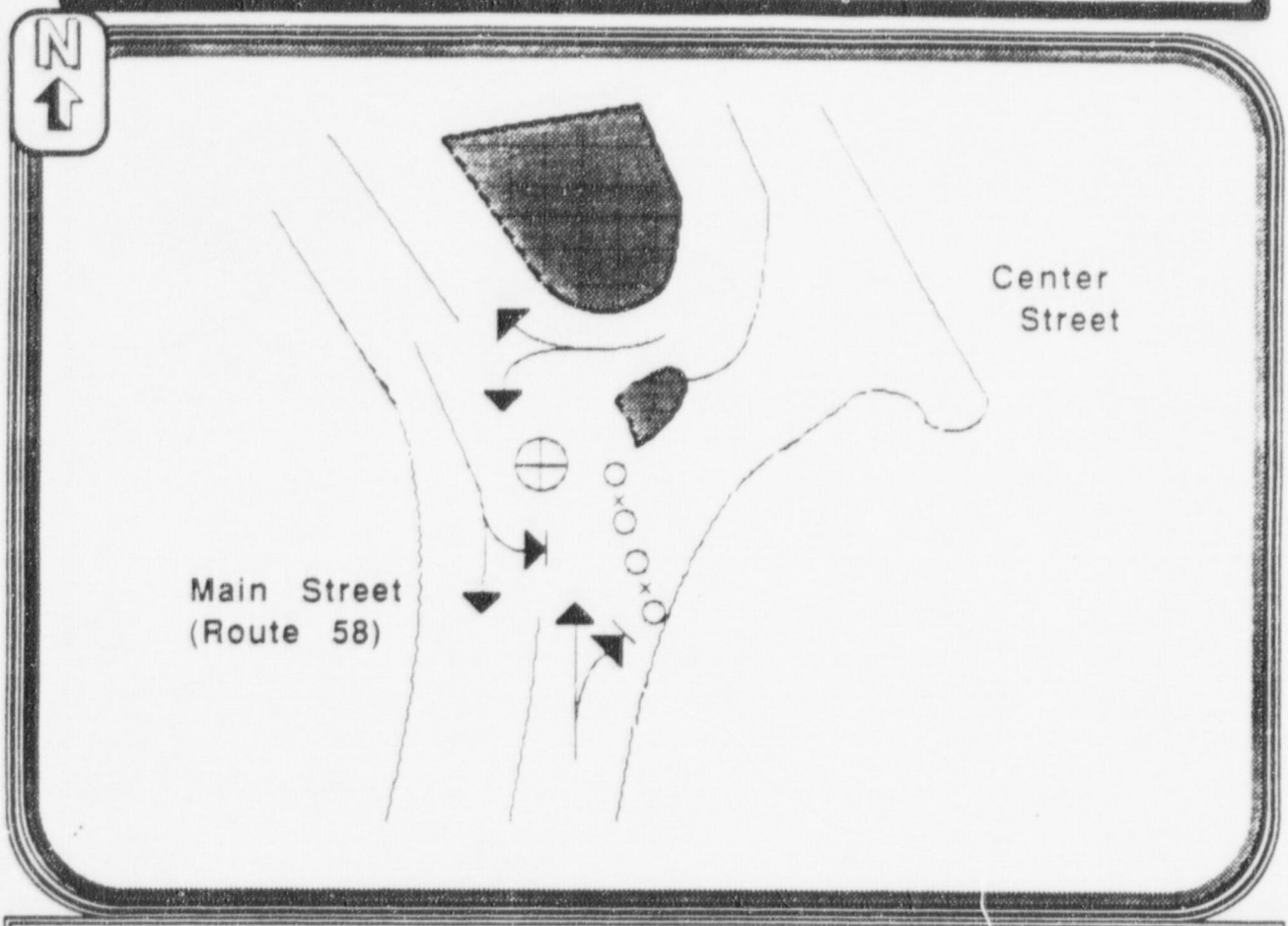
Manpower/Equipment:

1 Traffic Guide
4 Traffic Cones
2 Traffic Barricades

Description:

Discourage eastbound traffic on South Meadow Road and Crescent Road.

Point No. C-A-13



Location:
Center Street & Main Street (Route 58)
(Carver)

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

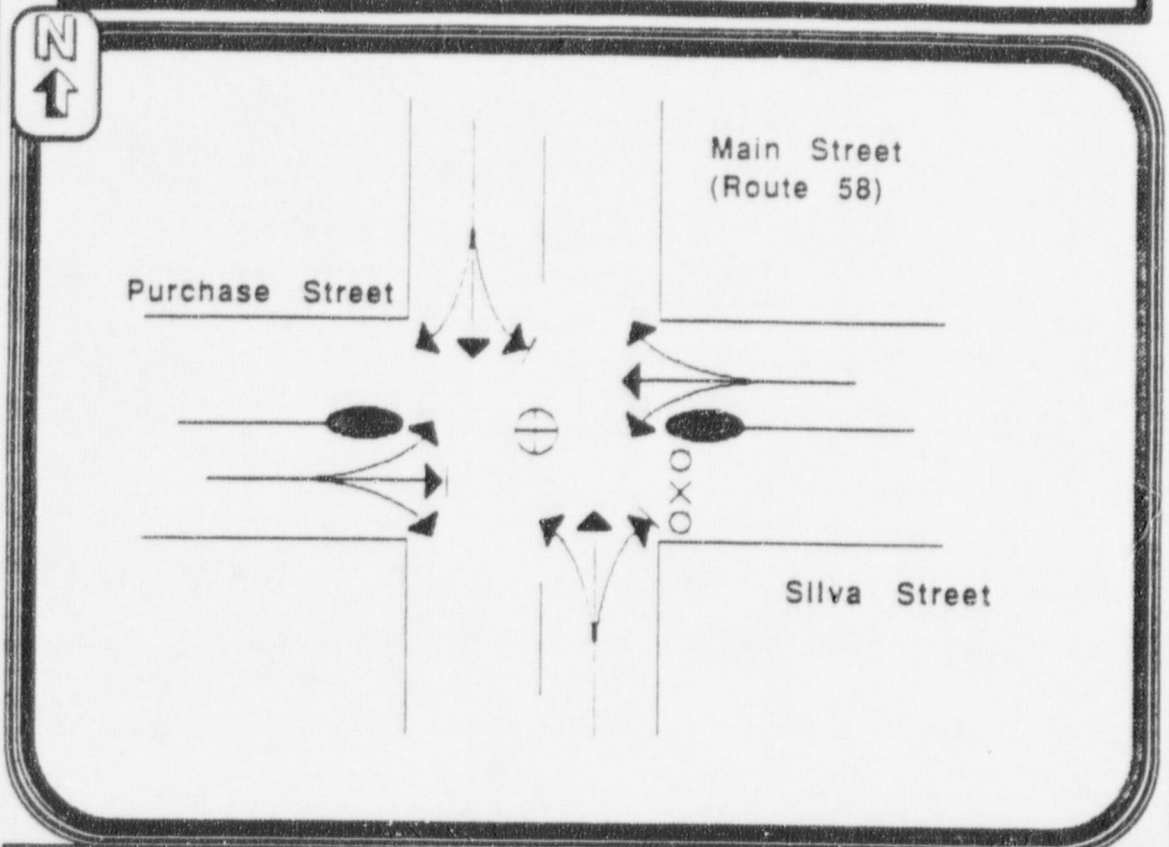
1 Traffic Guide
4 Traffic Cones
2 Traffic Barricades

Description:

Discourage eastcound traffic on Centre Street.

CAR-ACP-C-A-09	272788	
Carver Access Control Point #09		38

Point No. 3-A-10



Location:
Silva Street & Main Street (Route 58) (Carver)

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- ⊕ Traffic guide
- ○ Traffic cone
- × Traffic barricade

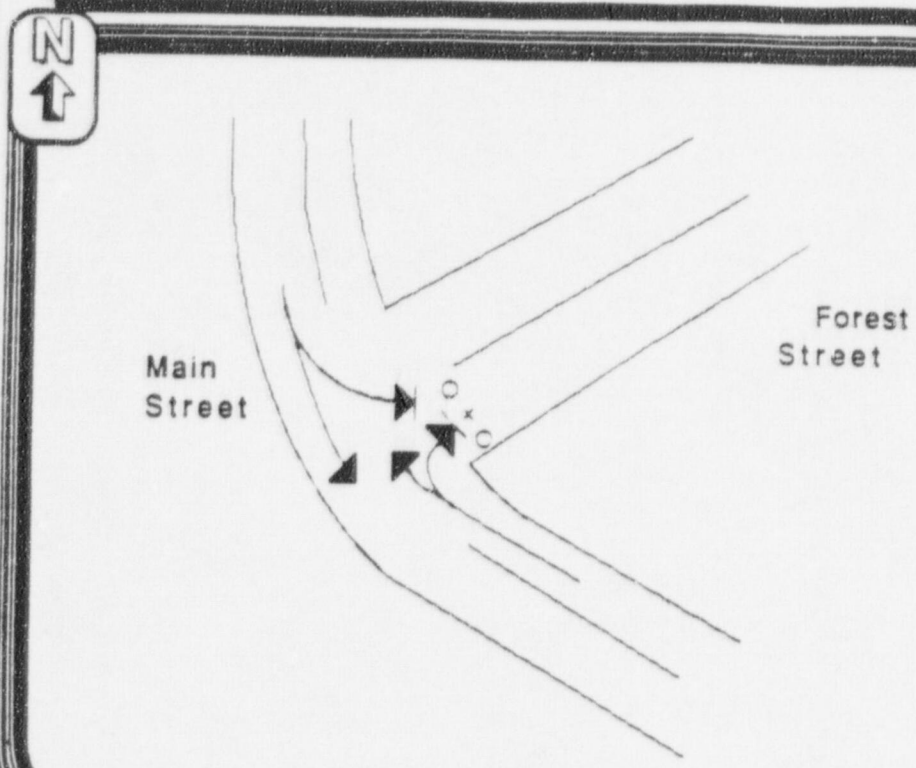
Manpower/Equipment:

1 Traffic Guide
2 Traffic Cones
1 Traffic Barricade

Description:

Discourage eastbound traffic on Silva Street.

Point No. 3-A-11



Location:
Main Street & Forest Street (Carver)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

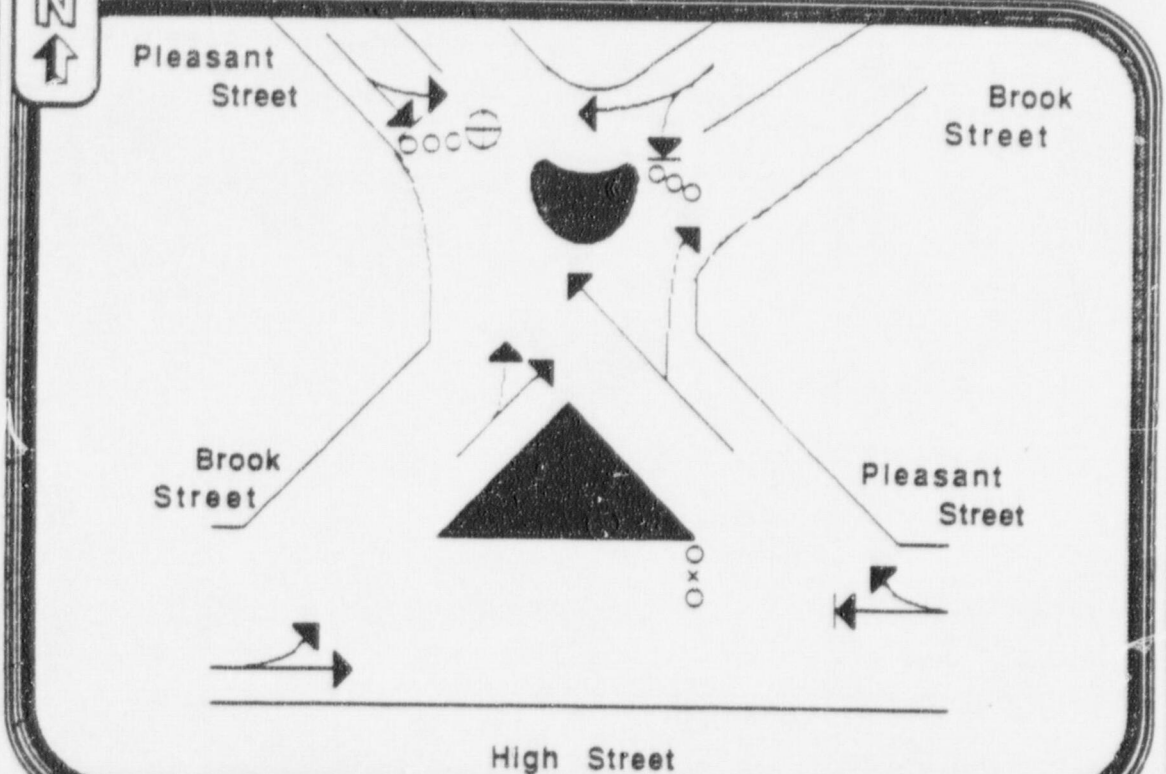
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage north-east bound traffic on Forest Street.

Point No. 3-A-12



Location:
Pleasant Street & Brook Street (Carver)

Priority: 3

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

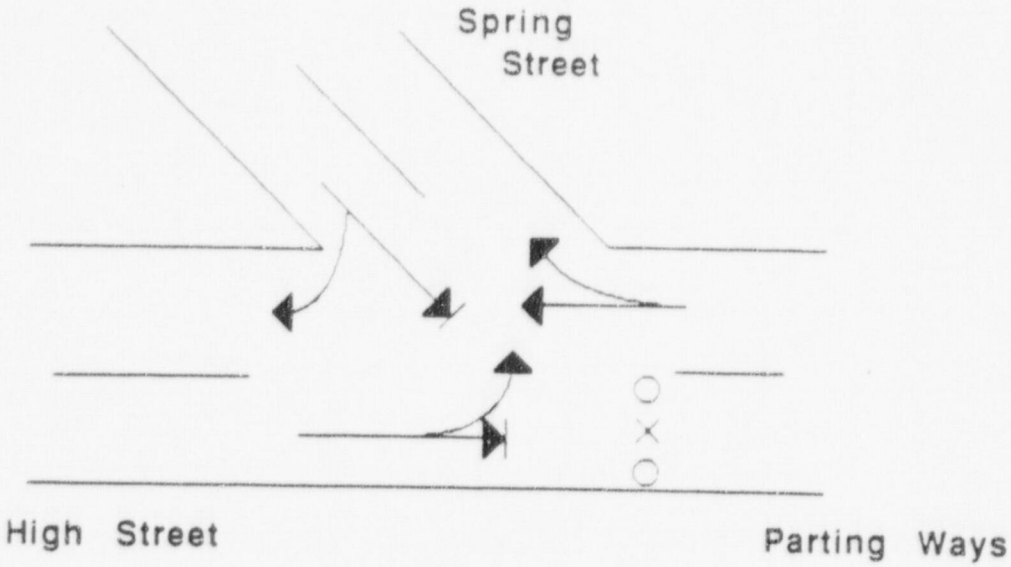
Manpower/Equipment:

1 Traffic Guide
8 Traffic Cones
1 Traffic Barricade

Description:

Discourage southbound traffic on Brook Street and Pleasant Street. Discourage westbound traffic on High Street.

Point No. C-A-10a



Location:
Parting Ways & Spring Street (Carver)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

2 Traffic Cones

1 Traffic Barricade

Description:

Discourage eastbound traffic on Parting Ways.

CAR-ACP-C-A-13	272788	
Carver Access Control Point #13	[illegible]	39

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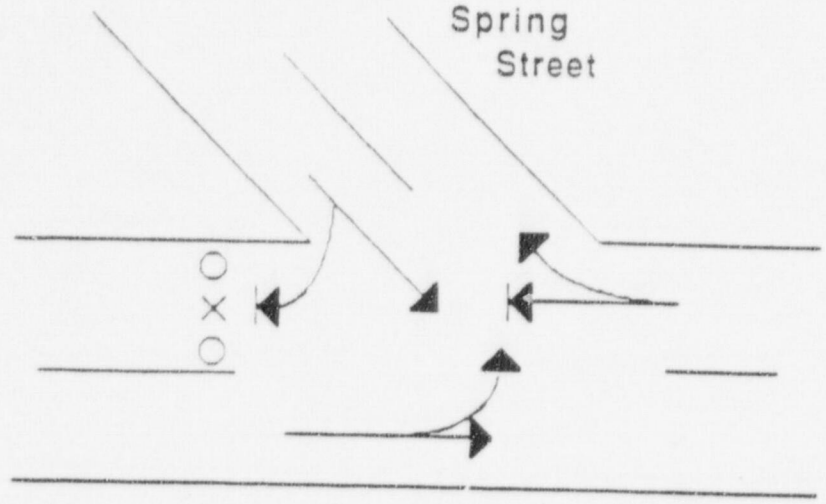
Point No. C-A-13b



Location:
Parting Ways & Spring Street (Carver)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

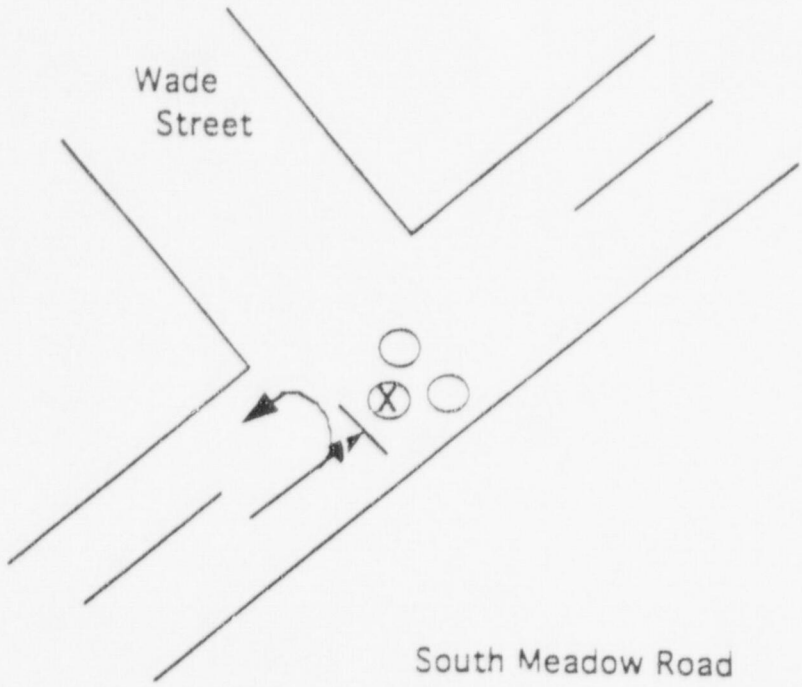
Manpower/Equipment:

2 Traffic Cones

1 Traffic Barricade

Description:

Discourage westbound traffic on Parting Ways.



Location:
South Meadow Road and Wade Street (Carver).

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

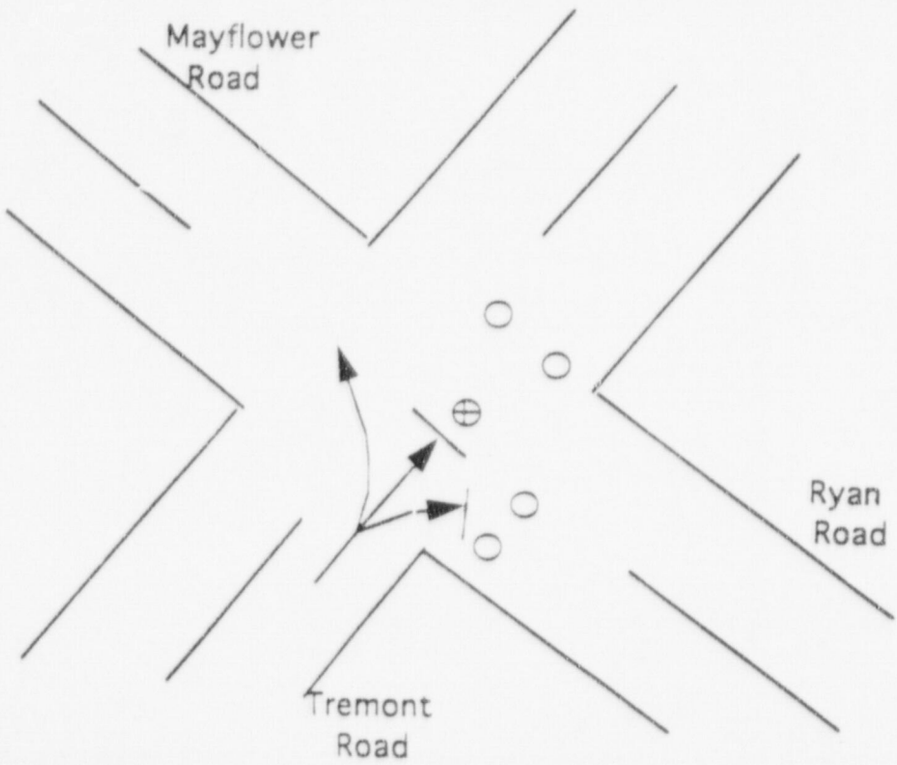
1 Traffic Guide

2 Traffic Cones

Description:

Discourage eastbound traffic on South Meadow Road.

Point No. C-A-15



Location:
Tremont Road and Mayflower Road (Carver).

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

1 Traffic Guide

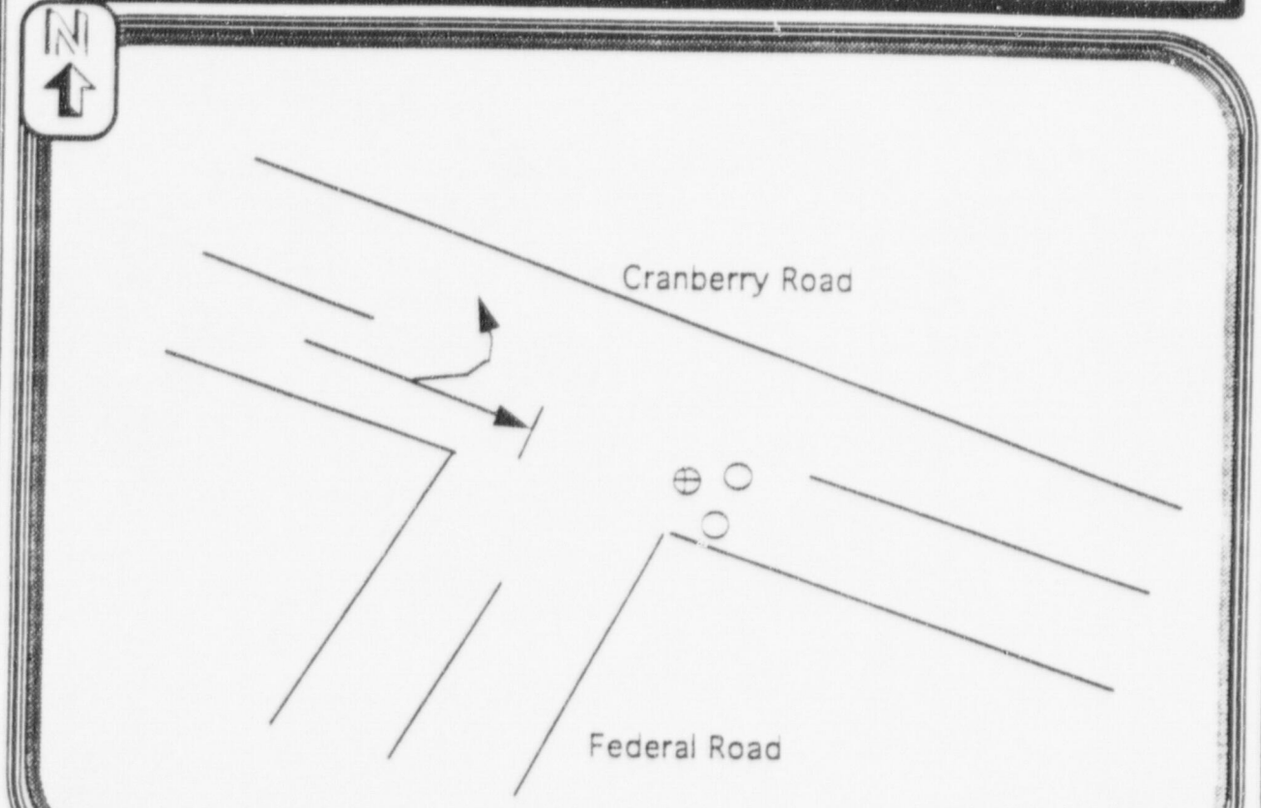
4 Traffic Cones

Description:

Discourage northbound traffic on Tremont Road and eastbound traffic on Ryan Road.

CAR-ACP-C-A-15	072788	
Carver Access Control Point #15	BY	79

Point No. C-A-16



Location:
Cranberry Road and Federal Road (Carver).

Priority: 4

KEY

——▶	Movement facilitated
——▶|	Movement discouraged
⊕	Traffic guide
○	Traffic cone
×	Traffic barricade

Manpower/Equipment:

1 Traffic Guide

2 Traffic Cones

Description:

Discourage eastbound traffic on Cranberry Road.

CAR-ACP-C-A-16
Carver Access Control Point #16

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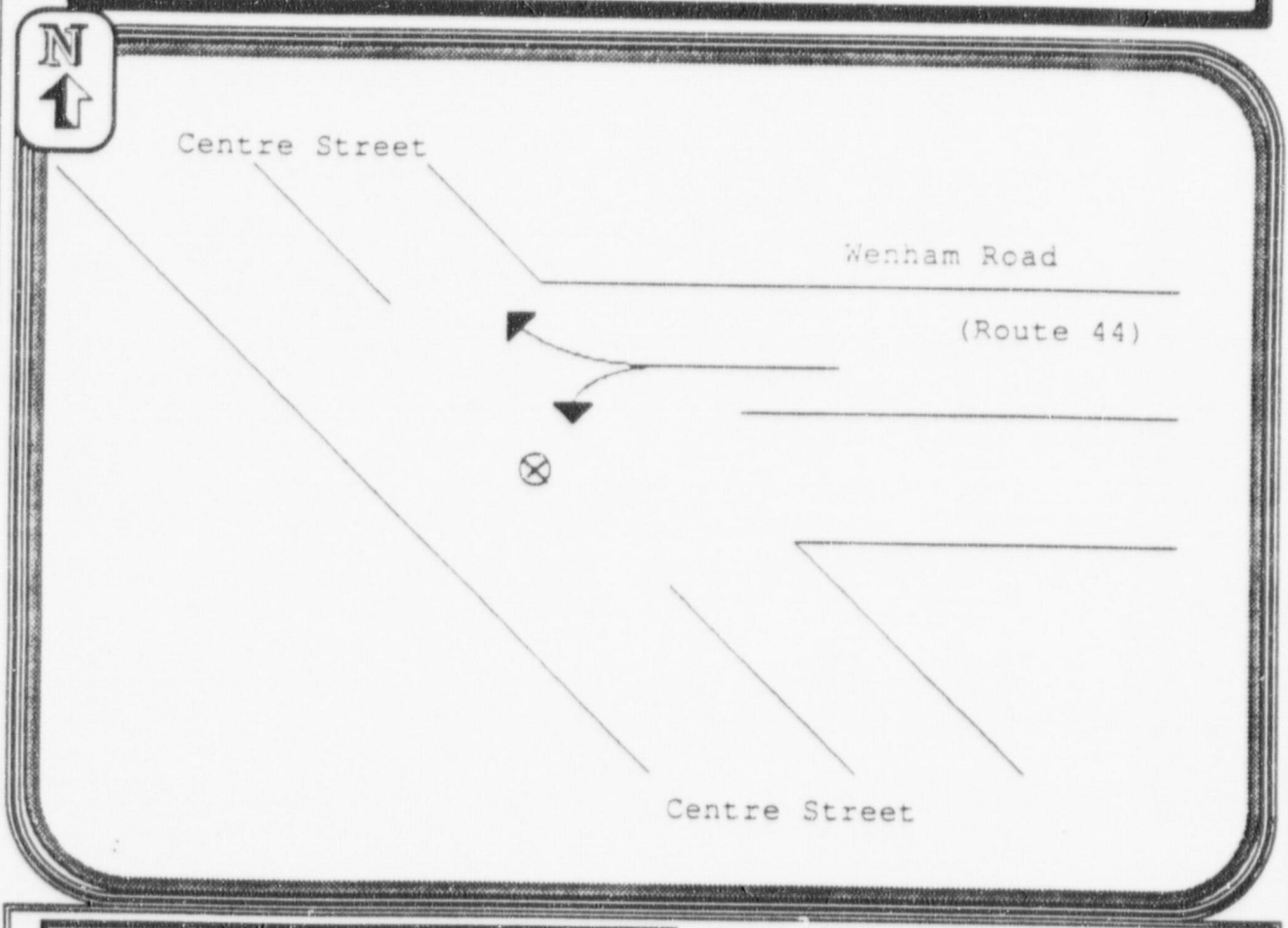
Point No. C-T-17



Location: Wenham Road (Route 44) and Centre Street (Carver)

Priority: 3

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

1 Traffic Guide

Description: Facilitate westbound traffic on Wenham Road.

DUXBURY

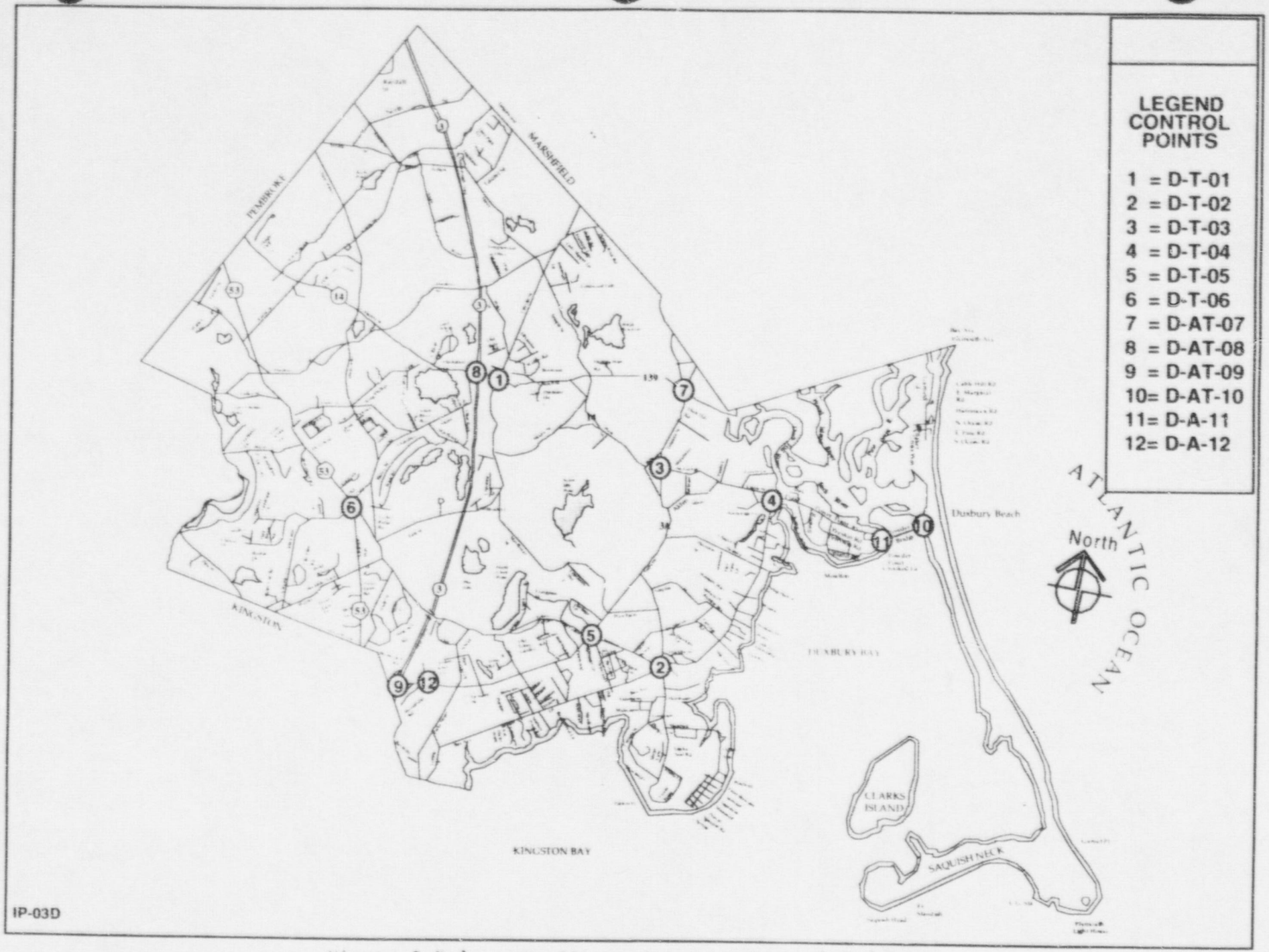


Figure I-D-1. Traffic and Access Control Points
Duxbury

Table I-D-1. Location, Manpower, and Equipment Requirements for All Traffic and Access Control Points

TOWN: Duxbury

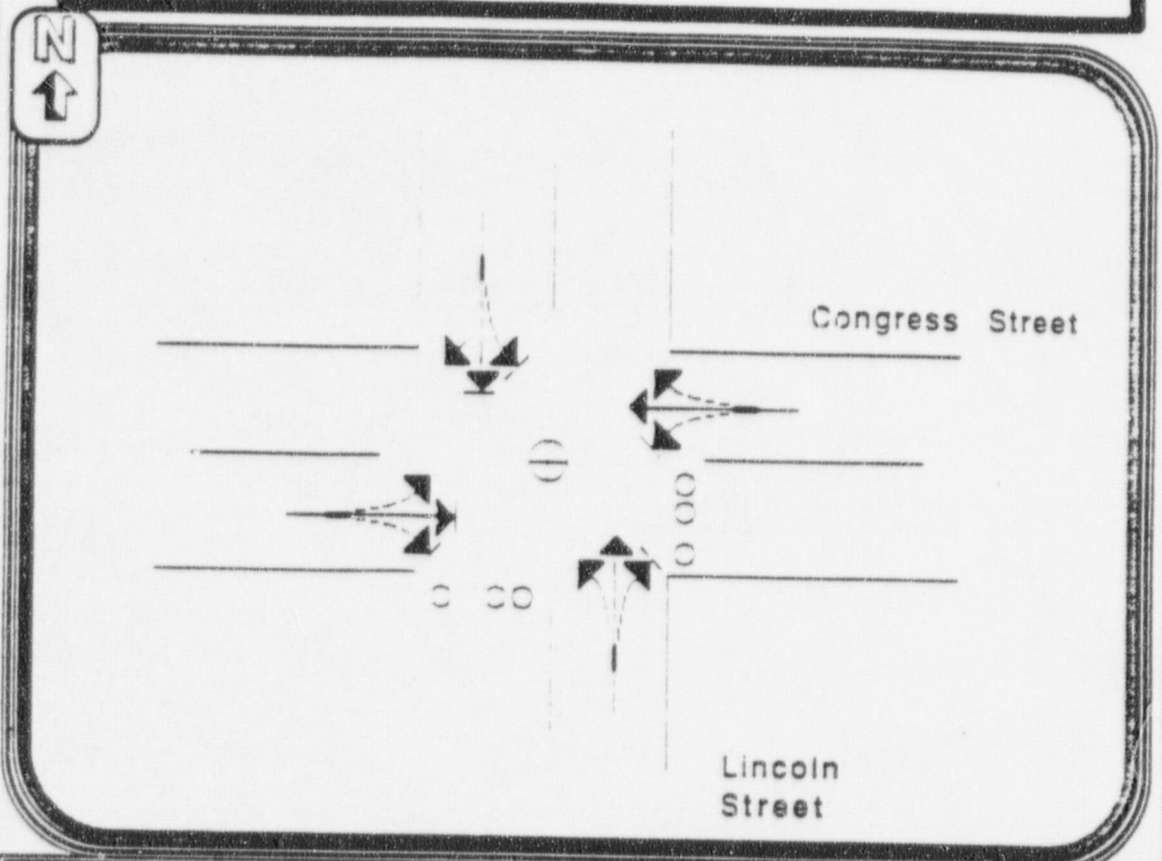
ACP	Location	Agency Priority	Guides	Cones	Barricades	Lights
D-T-01	Lincoln St. & Congress St.	D-1	1	6		2
D-T-02	Bay Ave. & Standish St.	D-2	1	6		2
D-T-03	Rte. 3A & West St. (Rte. 14)	S-1	1	9		3
D-T 04	Cove St. & Washington St.	D-2	1	9		3
D-T 05	Rte. 3A & Chestnut St.	D-3	1	3		1
D-T-06	Rte. 53 & Summer St.	D-3	1	4	2	2
D-AT-07A	Church St. (Rte. 139) & Rte. 3A	S-2	1	4	2	2
D-AT-07B	Church St. (Rte. 139) & Rte. 3A	S-2	1	4	2	2
D-AT-08	Rte. 3 & Congress St., Exit 11	S-1	1	2	9	9
D-AT-09A	Rte. 3 & Tremont St., Exit 10	S-1	1	2	7	7
D-AT-09B	Rte. 3 & Tremont St., Exit 10	S-1	1	2	7	7
D-AT-10	Duxbury Beach East of Powder Point Bridge	D-2 (Summer) D-4 (Winter)	1	2	1	1
D-A-11	Powder Point Bridge	D-4		2	1	1
D-A-12	Tremont St. & Woodridge Rd.	D-4		2	1	1

Table I-D-2. Allocation of Access Control Points to Towns

TOWN: Duxbury

ACCESS CONTROL POINT	ACTIVATED FOR FOLLOWING REGIONS:
D-AT-07B	13, 14, 15, 16, 17, 18, 19, 22
D-AT-08	All regions
D-AT-09A	All regions except 10, 11, & 19
D-AT-09B	10, 11, 19
D-AT-10	5, 6, 20, 21
D-A-11	5, 6, 21
D-A-12	12

Point No. D-T-31



Location:
Lincoln Street & Congress Street (Duxbury)

Priority:

KEY

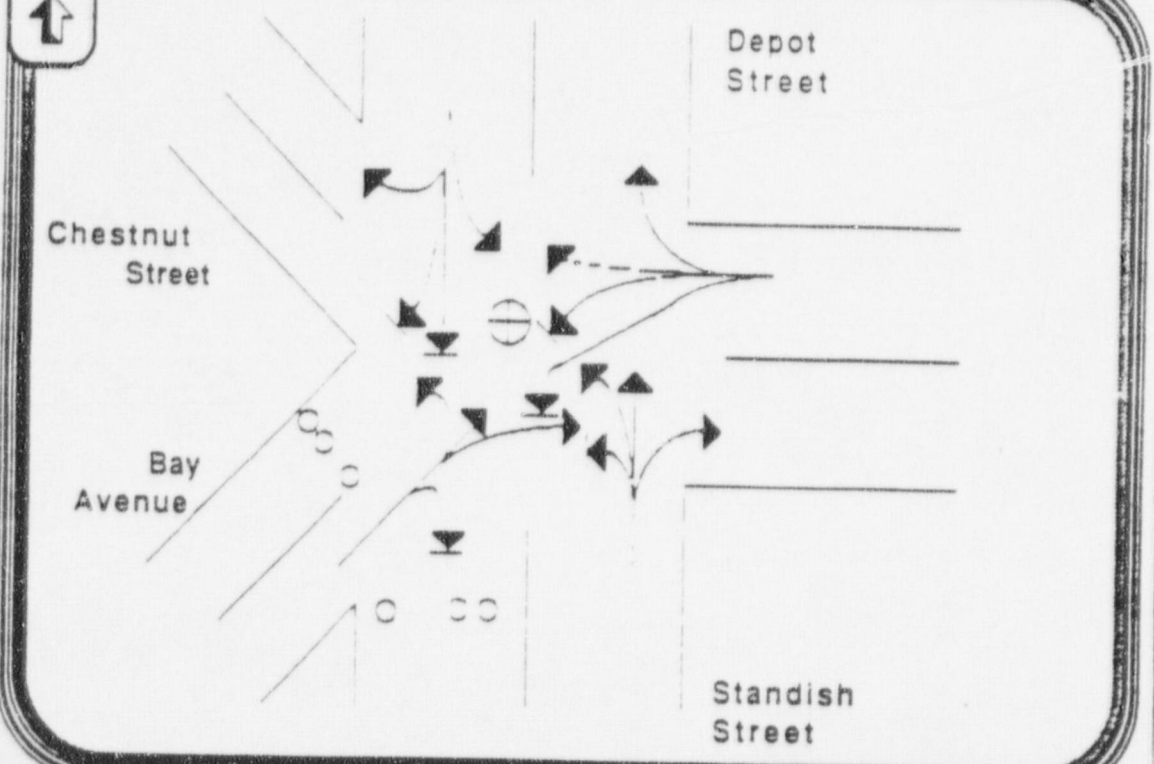
- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

1 Traffic Guide
6 Traffic Cones

Description:

Facilitate westbound and northbound traffic. Discourage southbound and eastbound traffic.



Location:
Bay Avenue & Standish Street (Duxbury)

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

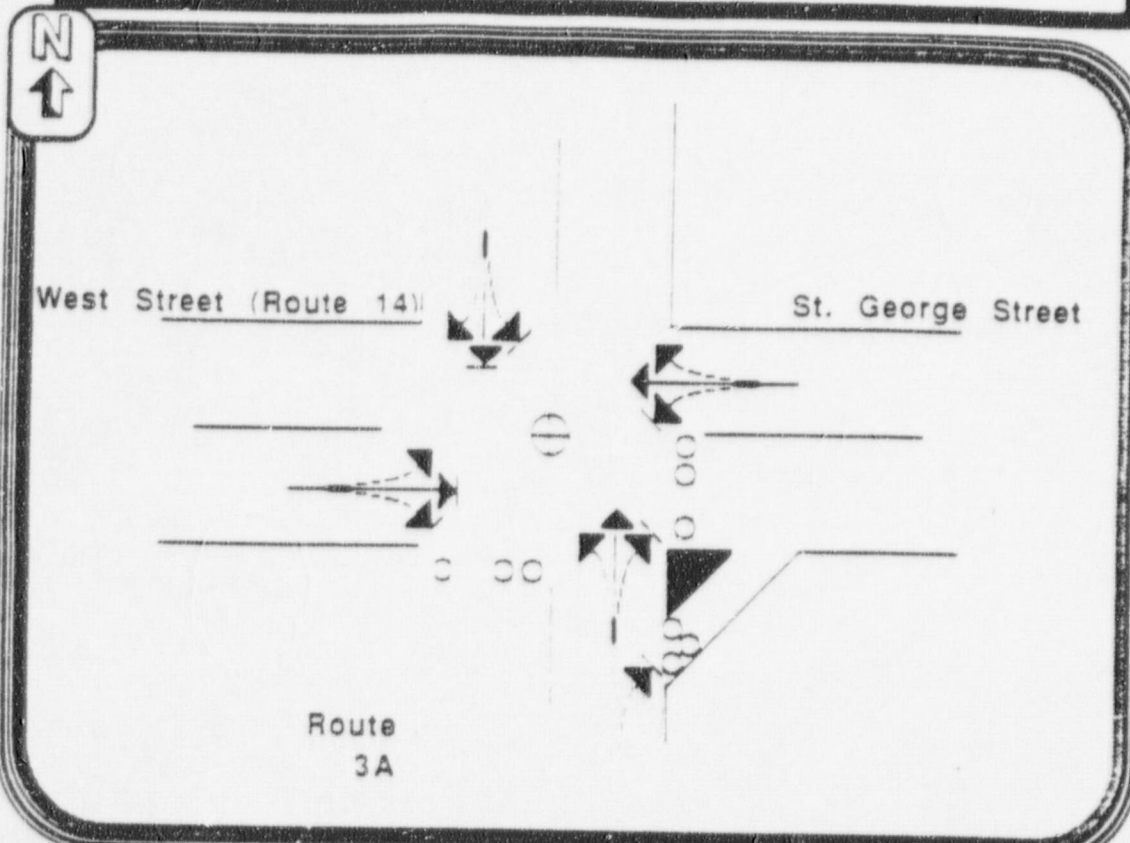
1 Traffic Guide

5 Traffic Cones

Description:

Facilitate northbound movements from all streets. Discourage southbound movements on Standish Street and Bay Avenue.

Point No. D-7-33



Location:
Route 3A & West Street (Route 14) Duxbury)

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

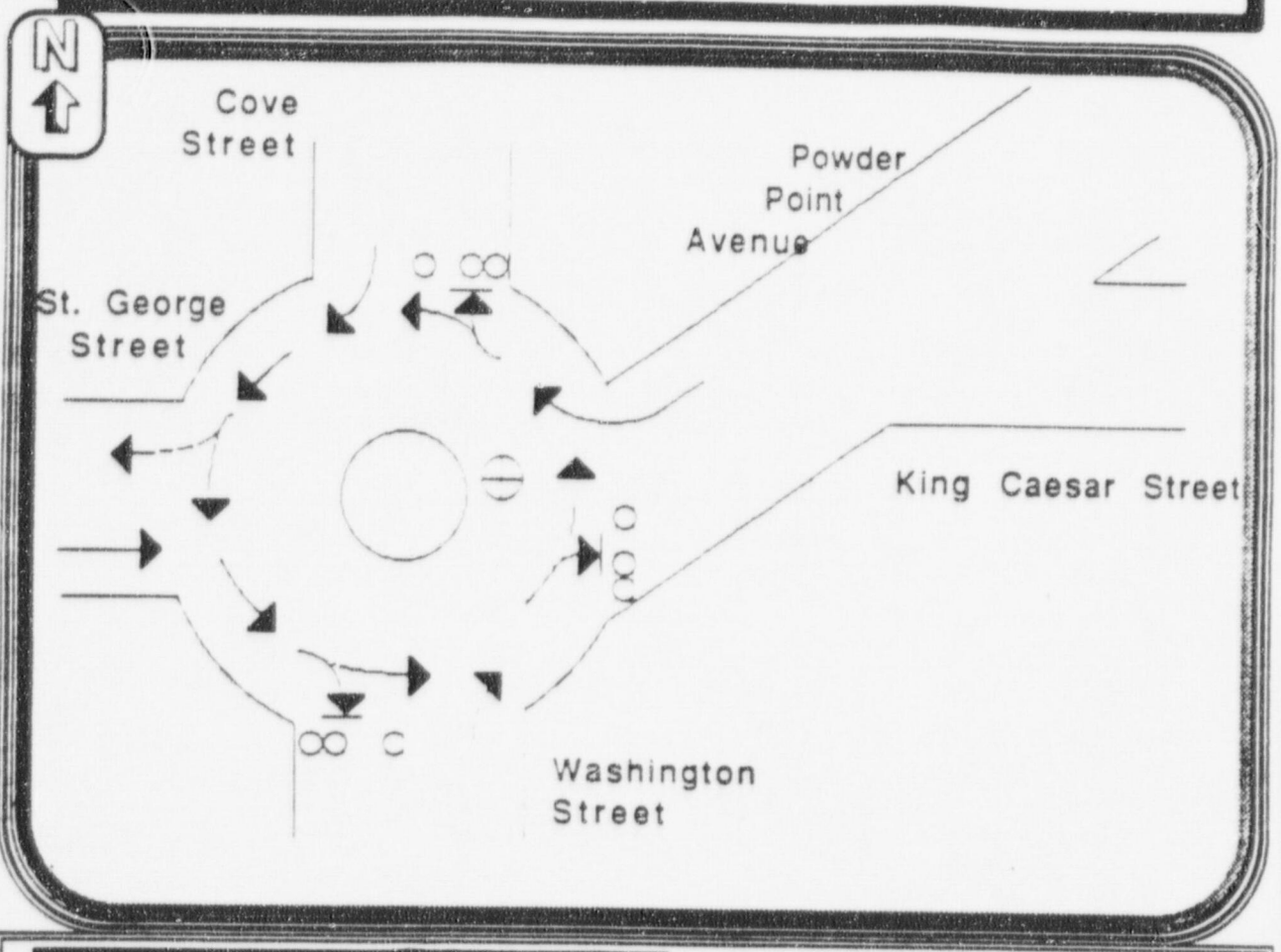
Manpower/Equipment:

1 Traffic Guide

9 Traffic Cones

Description:

Facilitate northbound traffic on Route 3A and westbound traffic on West Street (Route 14). Discourage southbound traffic on Route 3A and eastbound traffic on St. George Street.



Location:
Cove Street & Washington Street (Duxbury)

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

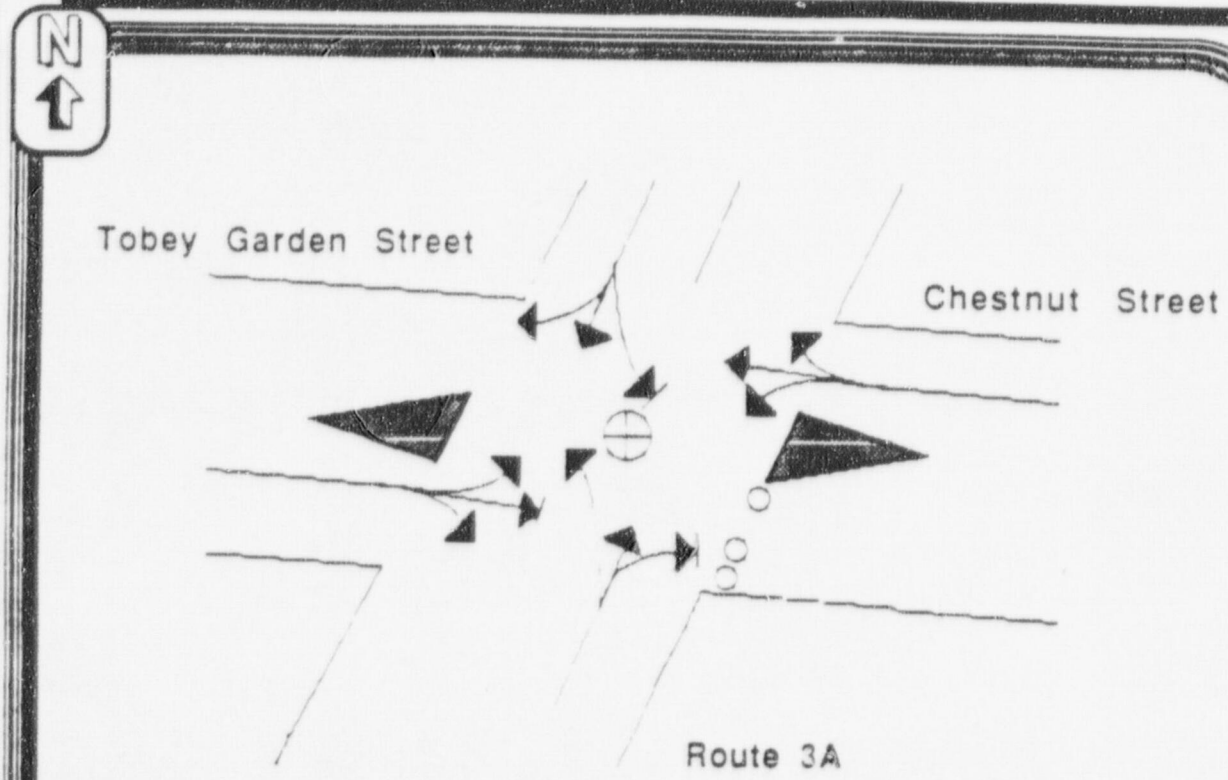
Manpower/Equipment:

1 Traffic Guide
9 Traffic Cones

Description:

Facilitate movement west onto St. George Street. Discourage southbound traffic on Washington Street, eastbound traffic on Powder Point Avenue, and northbound traffic on Cove Street.

Point No. D-T-05



Location:
Route 3A & Chestnut Street (Duxbury)

Priority: 3

KEY

——►	Movement facilitated
——►|	Movement discouraged
⊕	Traffic guide
○	Traffic cone
×	Traffic barricade

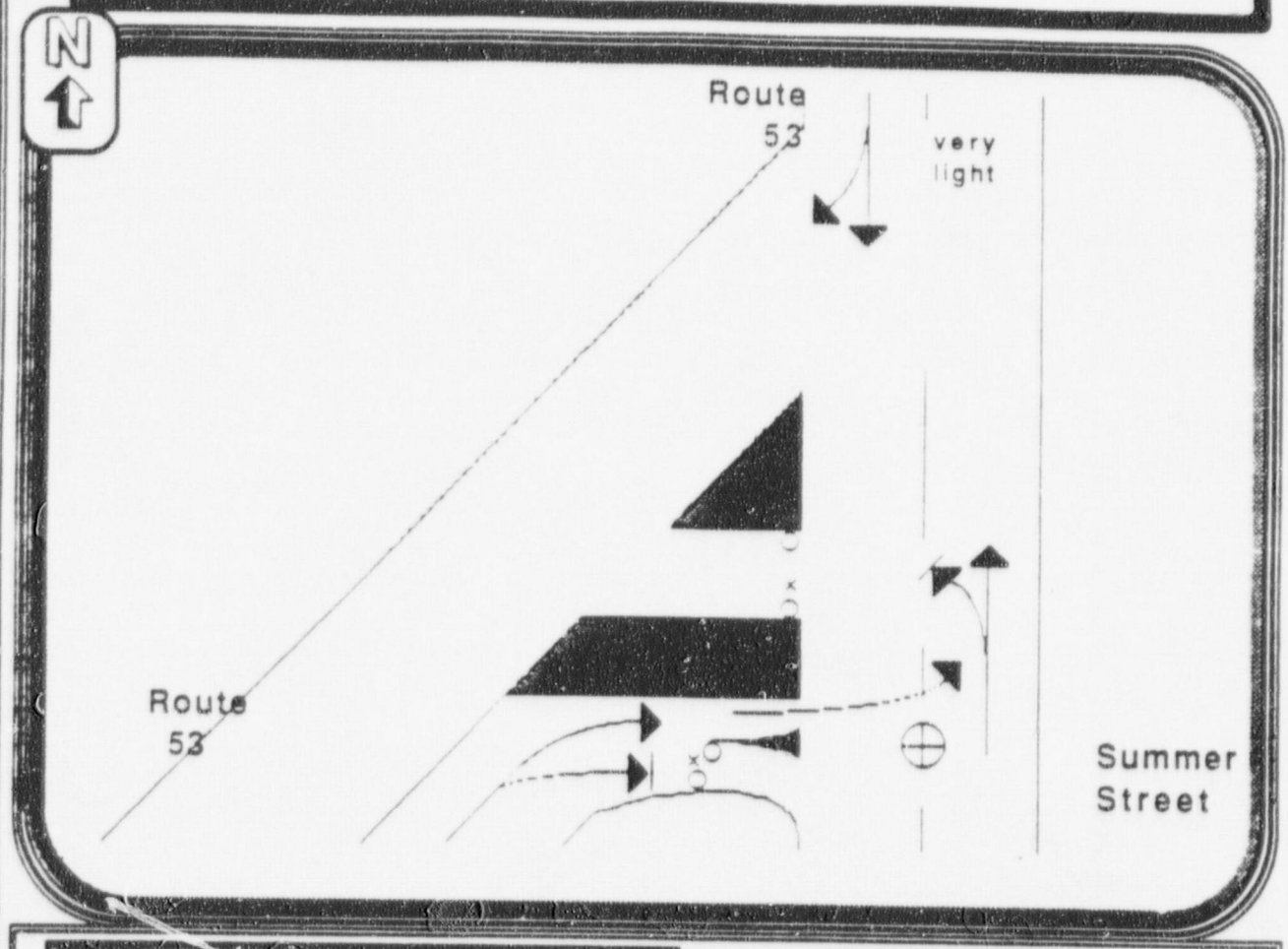
Manpower/Equipment:

1 Traffic Guide

3 Traffic Cones

Description:

Facilitate traffic movement on Route 3A. Direct all traffic west of Route 3A south. Direct all traffic east of Route 3A north.



Location:
Route 53 & Summer Street (Duxbury)

Priority: 3

KEY

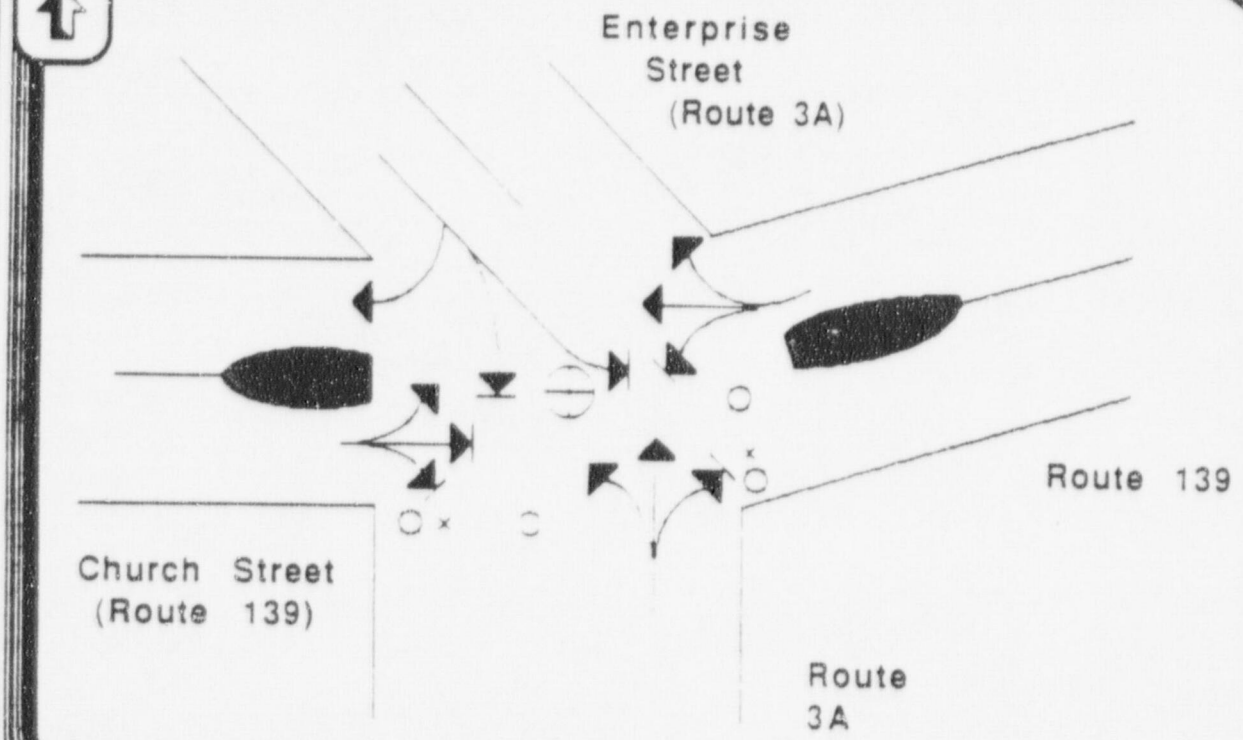
- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

1 Traffic Guide
4 Traffic Cones
2 Traffic Barricade

Description:

Facilitate northbound traffic on Route 53



Location:
Church Street & Route 3A (Duxbury)

Priority: 2

KEY

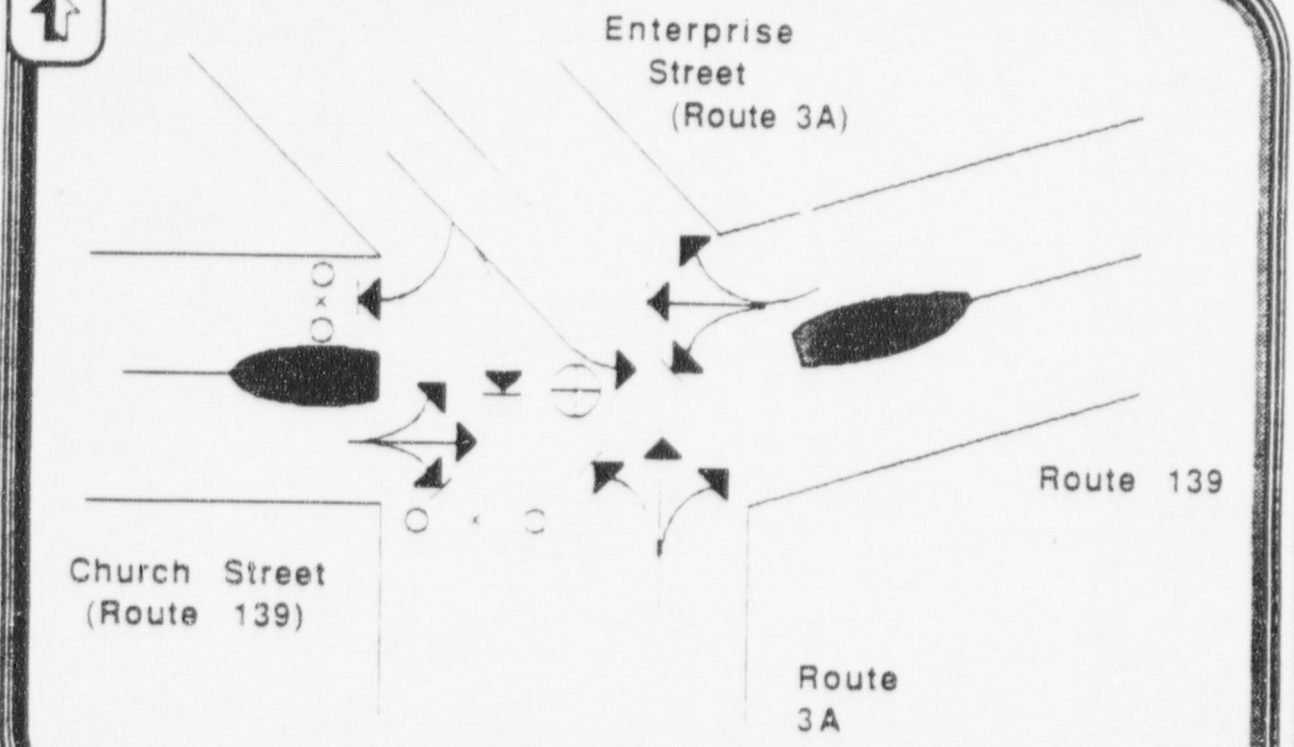
- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

1 Traffic Guide
4 Traffic Cones
2 Traffic Barricades

Description:

Facilitate northbound traffic on Route 3A and traffic moving west on Church Street. Discourage southbound traffic and traffic moving east onto Route 139.



Location:
Church Street & Route 3A (Duxbury)

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

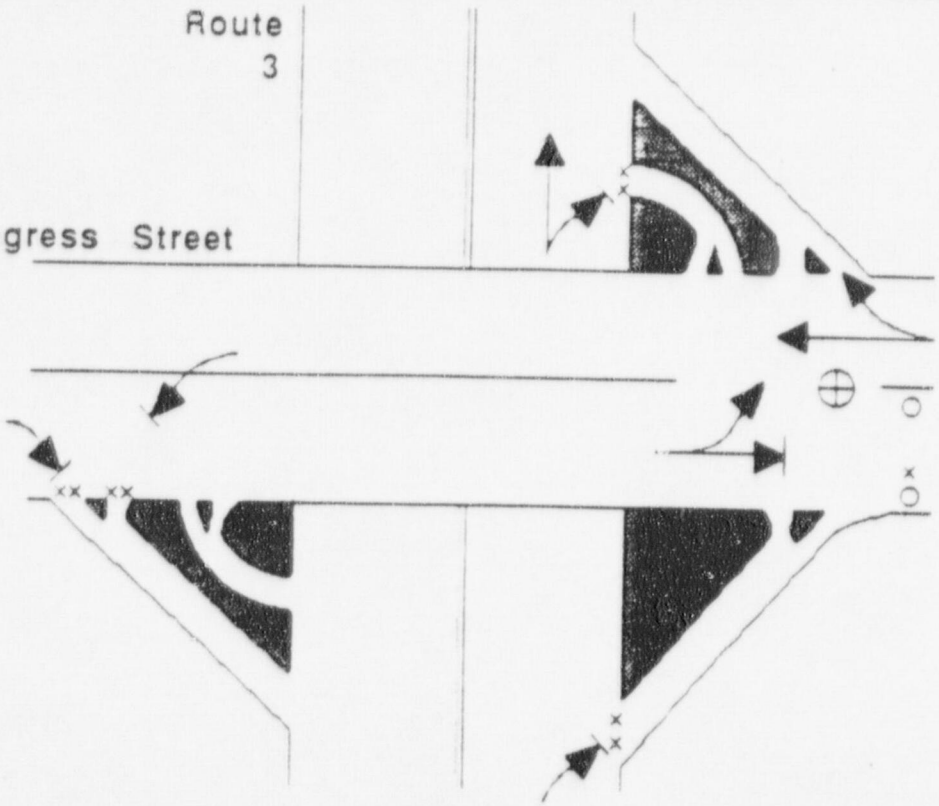
Manpower/Equipment:

1 Traffic Guide
4 Traffic Cones
2 Traffic Barricades

Description:

Discourage southbound traffic and traffic moving west onto Church St.

Point No. D-AT-38



Location:
Route 3 & Congress Street (Duxbury), Exit 11

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

1 Traffic Guide
2 Traffic Cones
9 Traffic Barricades

Description:

Facilitate entry onto northbound Route 3. Discourage entry onto southbound Route 3 and eastbound on Congress Street.

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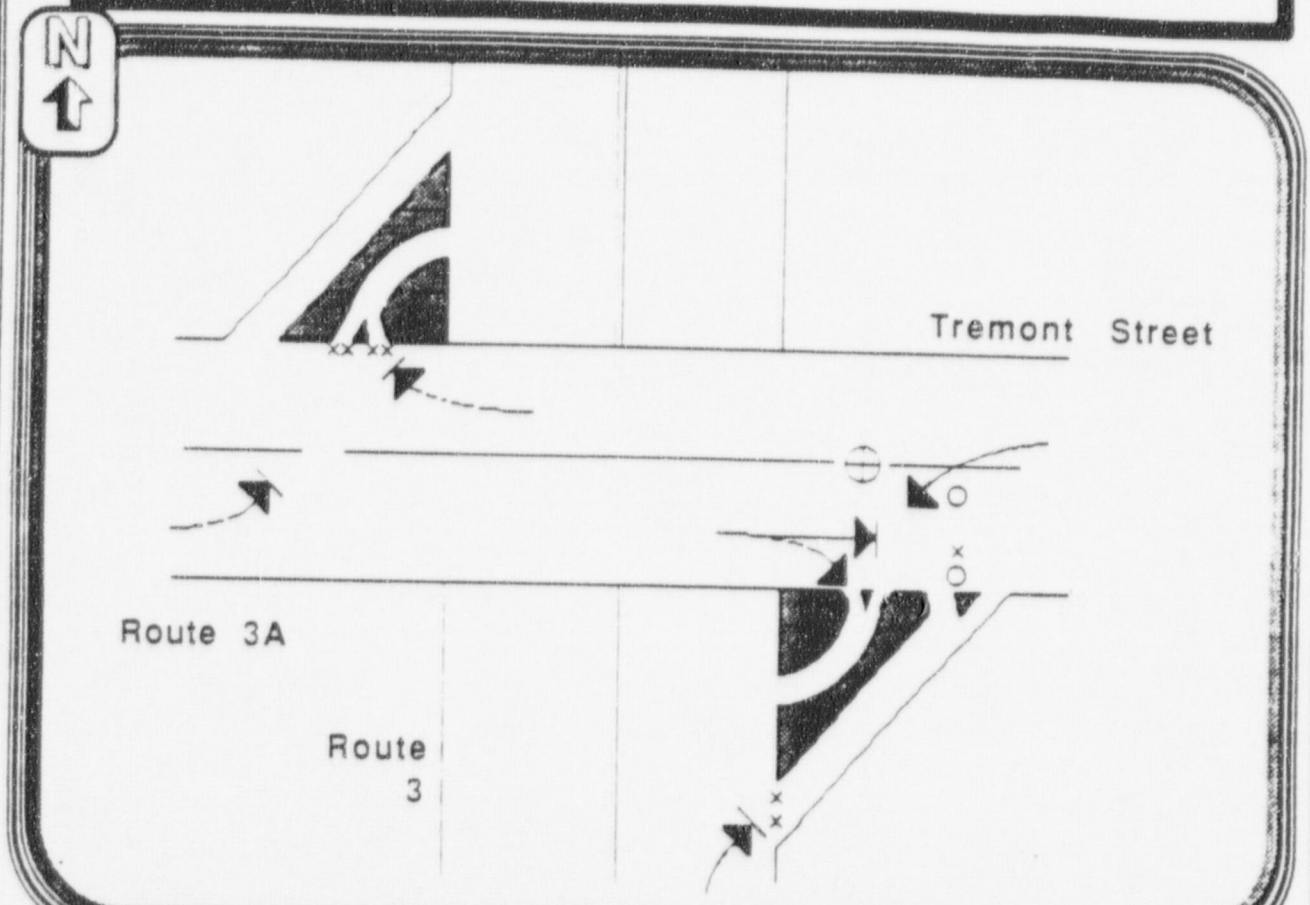
Form No. D-AT-238



Location:
Route 3 & Tremont Street (Duxbury), Exit 10

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

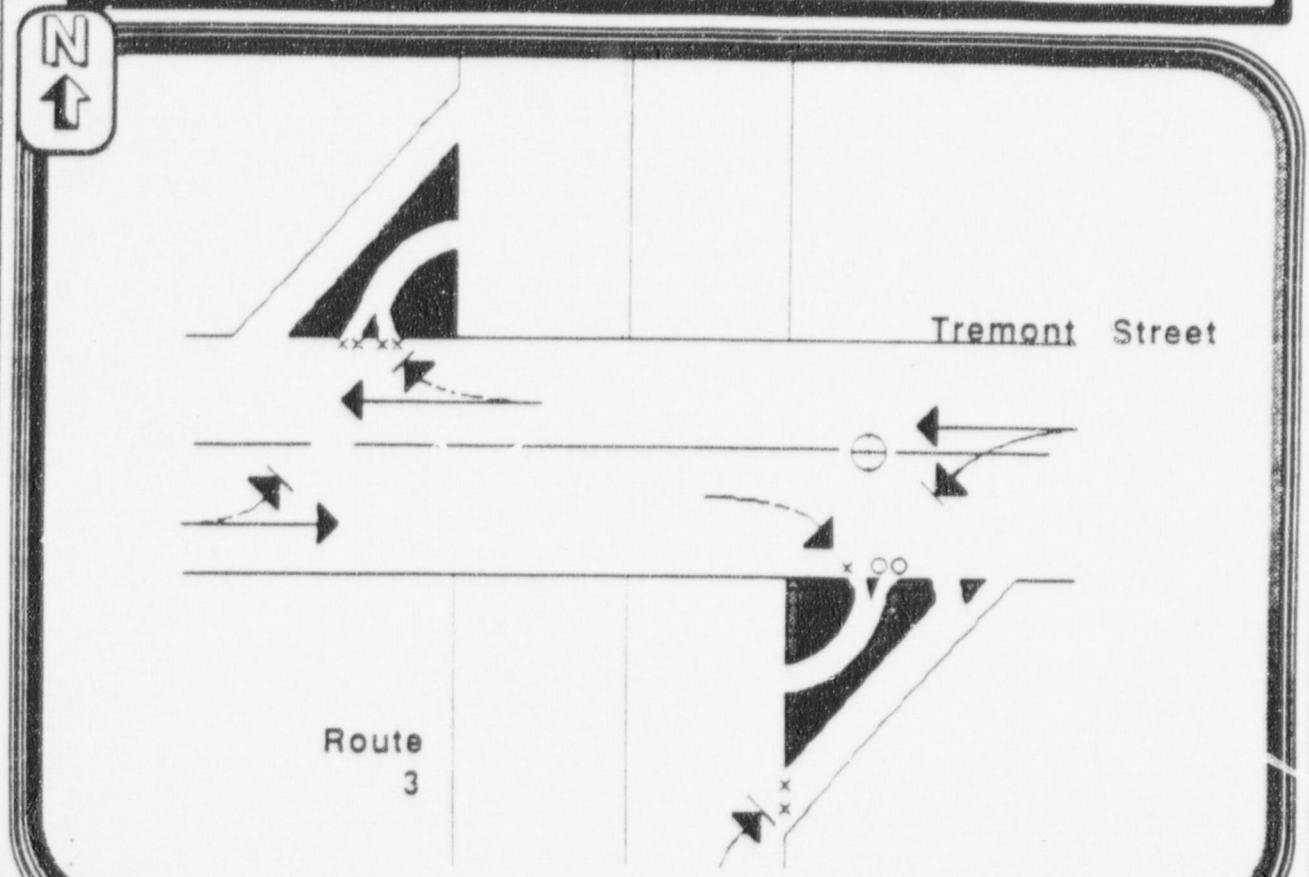
Manpower/Equipment:

1 Traffic Guide
2 Traffic Cones
7 Traffic Barricades

Description:

Facilitate entry onto northbound Route 3. Discourage traffic entering southbound Route 3 and eastbound traffic on Tremont Street.

Plan No. D-AT-38D



Location:
Route 3 & Tremont Street (Duxbury), Exit 10

Priority: 1

KEY

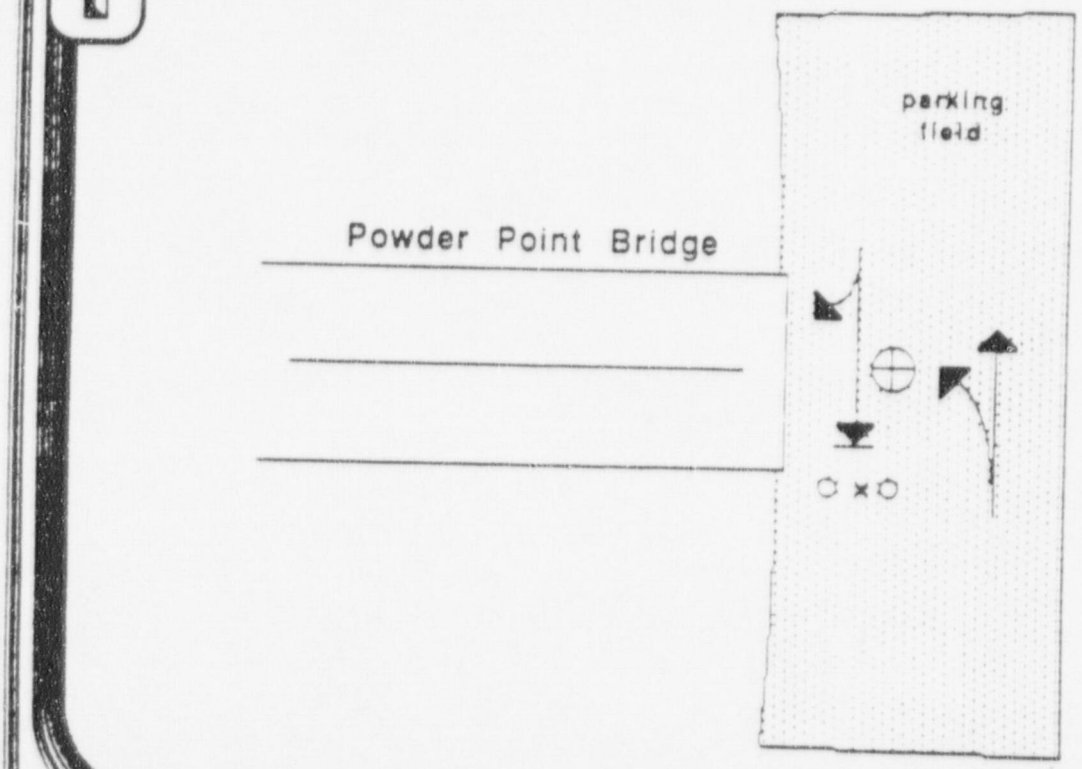
- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

1 Traffic Guide
2 Traffic Cones
7 Traffic Barricades

Description:

Discourage entry onto northbound Route 3. Discourage traffic entering southbound Route 3.



Location:
Duxbury beach east of Powder Point Bridge
(Duxbury)

Priority: 2 (summer); 4 (winter)

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

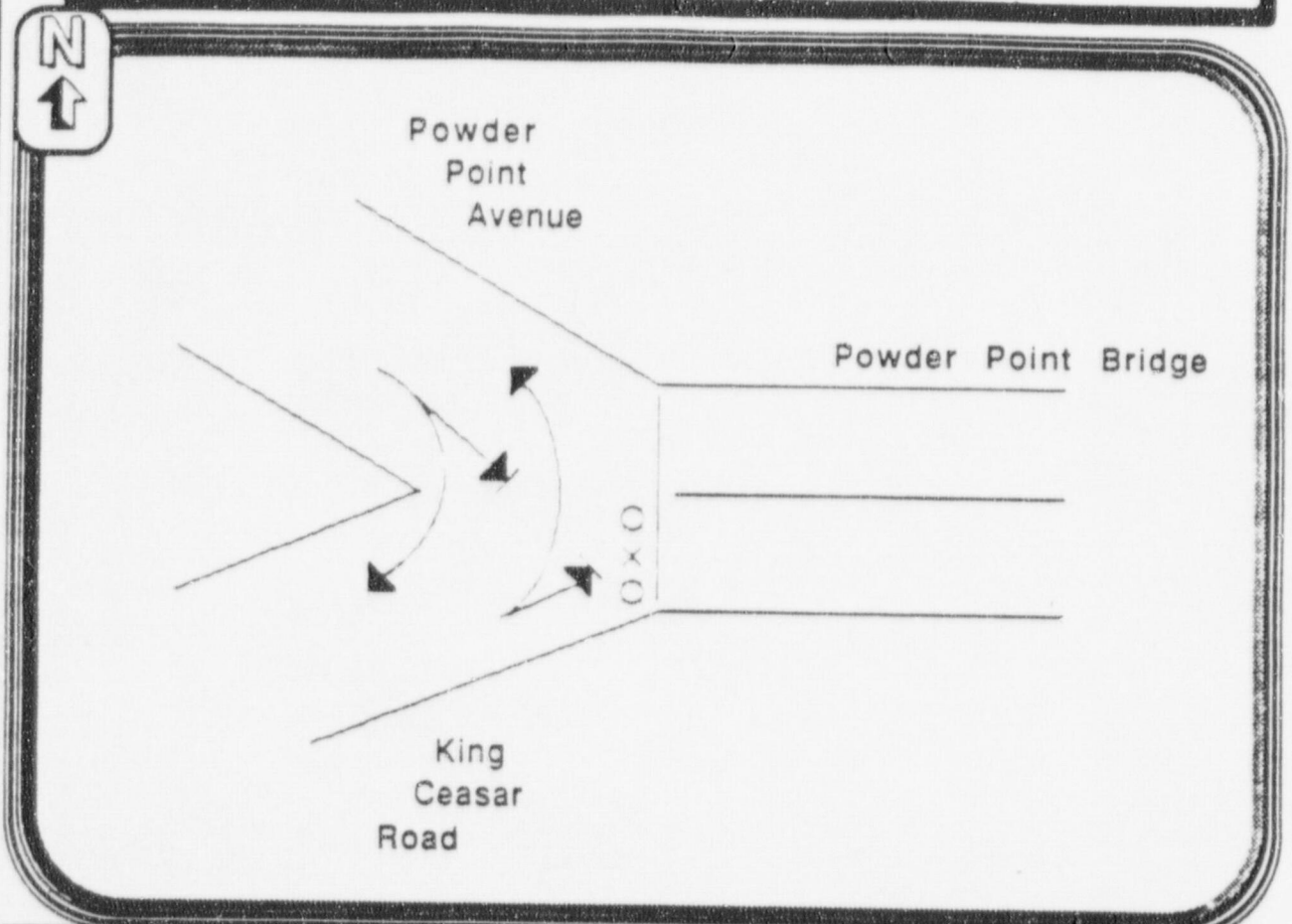
Manpower/Equipment:

1 Traffic Guide
2 Traffic Cones
1 Traffic Barricade

Description:

Discourage southbound traffic on Duxbury Beach.

Point No. D A-11



Location:
Powder Point Bridge (Duxbury)

Priority: 4

KEY

——►	Movement facilitated
——►|	Movement discouraged
⊕	Traffic guide
○	Traffic cone
×	Traffic barricade

Manpower/Equipment:

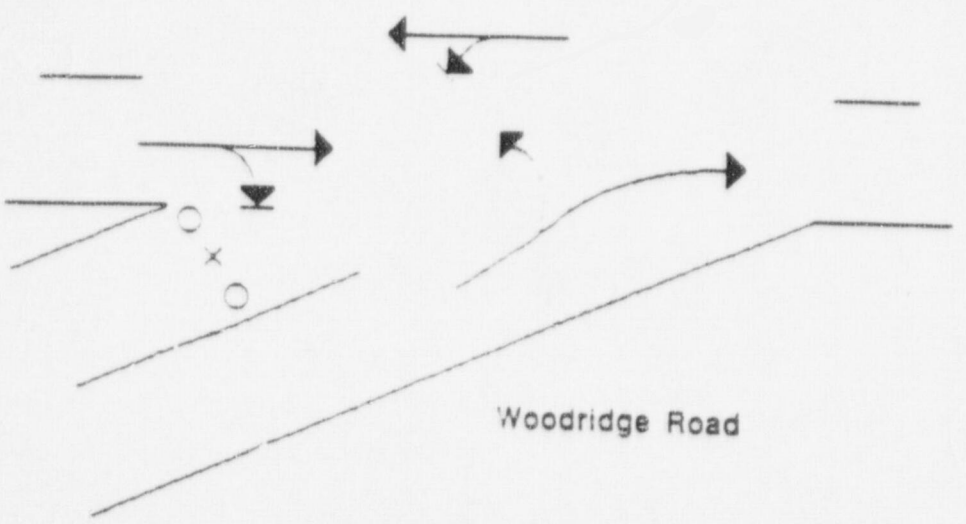
2 Traffic Cones

1 Traffic Barricade

Description:

Prevent eastbound traffic across Powder Point Bridge.

Detail No. D-A-12



Location:
Tremont Street & Woodridge Road (Duxbury)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

2 Traffic Cones
1 Traffic Barricade

Description:

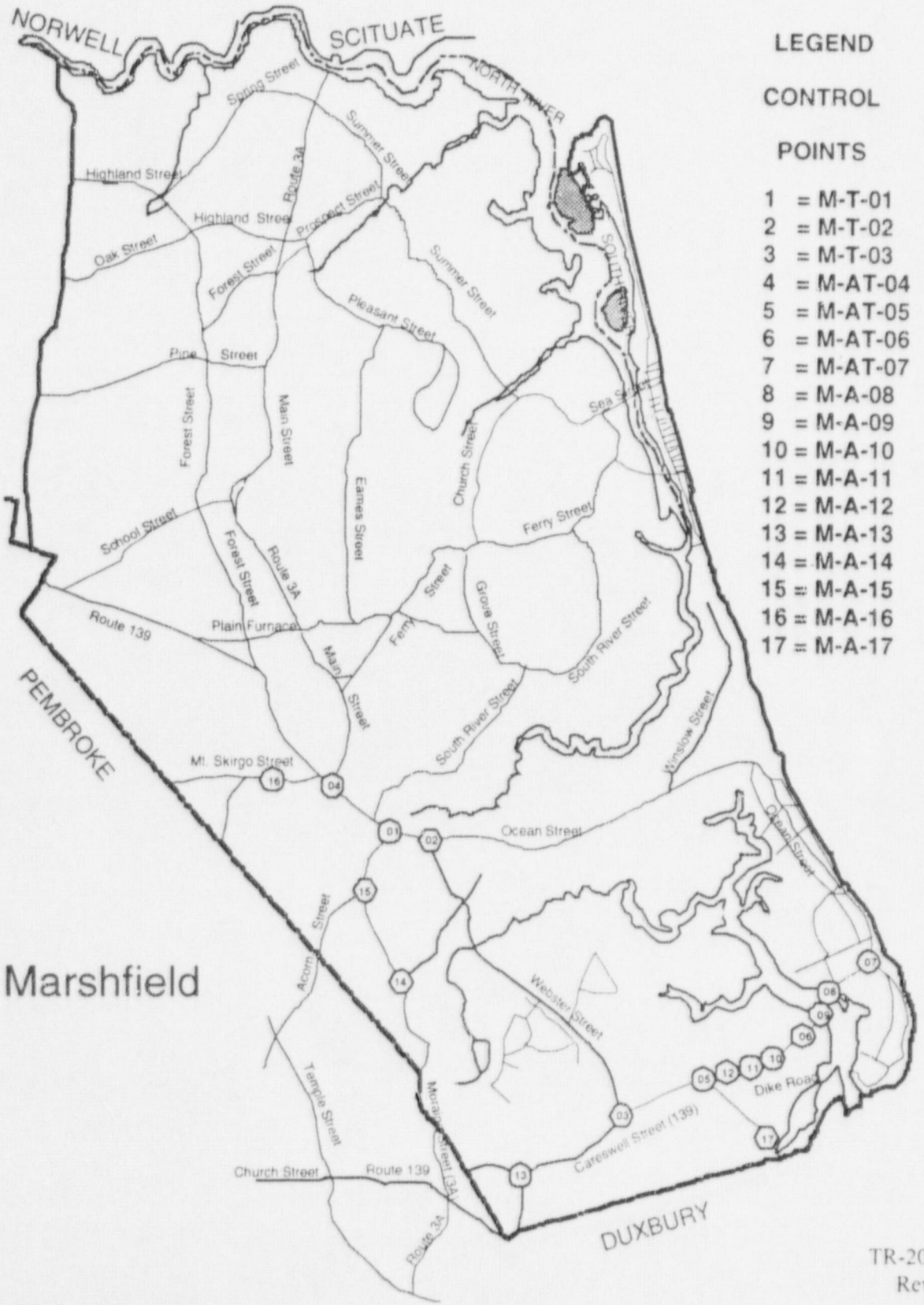
Discourage westbound traffic on Woodridge Road.

MARSHFIELD

I-M-1

Figure I-M-1

Marshfield Traffic and Access Control Points



TR-203A
Rev. 4

Table I-M-1. Location, Manpower, and Equipment Requirements for All Traffic and Access Control Points

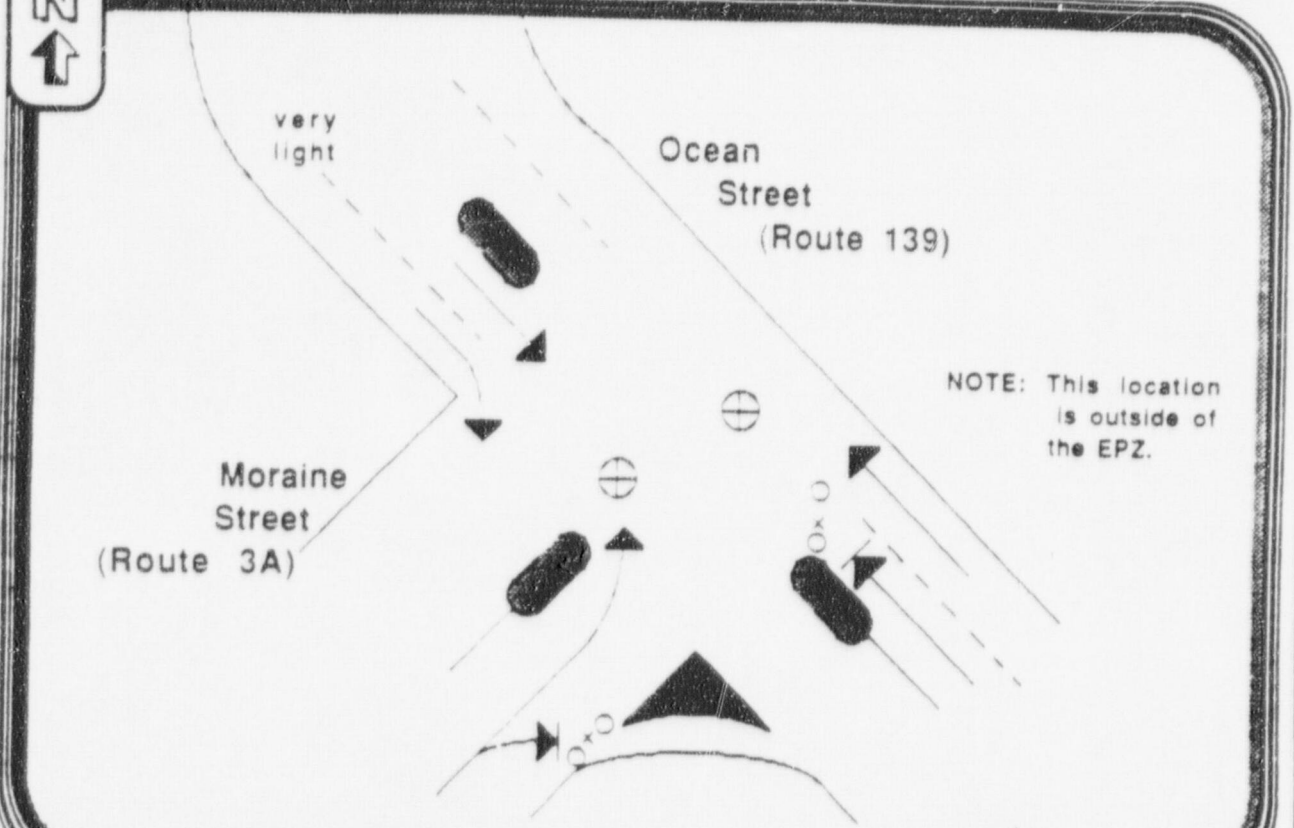
TOWN: Marshfield

ACP	Location	Agency Priority	Guides	Cones	Barricades	Lights
M-T-01	Rte. 3A & Rte. 139	S-1	2	4	2	2
M-T-02	Webster St. & Ocean St.	M-1	1	2	1	1
M-T-03	Careswell St. & Webster St.	M-1	1	4	2	2
M-AT-04	Main St. (Rte. 3A) & Rte. 139	S-1	1	2	1	1
M-AT-05	Careswell St. & Canal St.	M-2	1	4	2	2
M-AT-06	Careswell St. & Beach St.	M-1	1	2	1	1
M-AT-07	Rte. 139 & Island St.	M-2	1	2	1	1
M-A-08	Dike Rd. (Rte. 139) & Careswell St.	M-4		2	1	1
M-A-09	Dike Rd. (Rte. 139) & Landing Rd.	M-4		2	1	1
M-A-10	Careswell St. (Rte. 139) & Temple Rd.	M-4		2	1	1
M-A-11	Careswell St. (Rte. 139) & Edward Rd.	M-4		2	1	1
M-A-12	Careswell St. (Rte. 139) & McCarthy Rd.	M-4		2	1	1
M-A-13	Careswell St. (Rte. 139) & Duck Hill La.	M-4		2	1	1
M-A-14	Moraine St. (Rte. 3A) & Walnut St.	M-4		4	2	2
M-A-15	Moraine St. (Rte. 3A) & Acorn St.	M-4		2	1	1
M-A-16	Cross St. & Old Ocean St.	M-4		2	1	1
M-A-17	Canal St., Bay Ave, & Gurnet Rd.	M-4	1	2	0	1

Table I-M-2. Allocation of Access Control Points to Towns

TOWN: Marshfield

ACCESS CONTROL POINT	ACTIVATED FOR FOLLOWING REGIONS:
M-AT-04	17, 18, 19, 20, 22
M-AT-05	17, 18, 19, 20, 22
M-AT-06	17, 18, 19, 20, 22
M-AT-07	17, 18, 19, 20, 22
M-A-08	17, 18, 19, 20, 22
M-A-09	17, 18, 19, 20, 22
M-A-10	17, 18, 19, 20, 22
M-A-11	17, 18, 19, 20, 22
M-A-12	17, 18, 19, 20, 22
M-A-13	17, 18, 19, 20, 22
M-A-14	17, 18, 19, 20, 22
M-A-15	17, 18, 19, 20, 22
M-A-16	17, 18, 19, 20, 22
M-A-17	13, 14, 15, 16



Location:
Route 3A and Route 139 (Marshfield)

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- ⊕ Traffic guide
- ○ Traffic cone
- × Traffic barricade

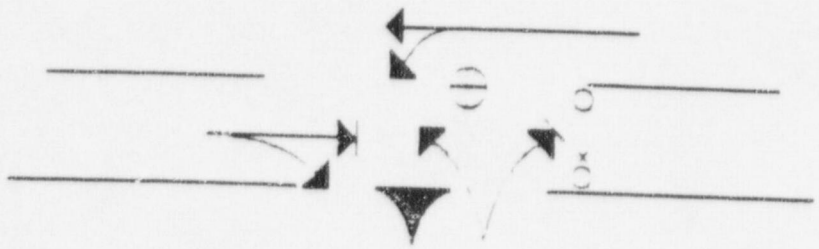
Manpower/Equipment:

2 Traffic Guides
4 Traffic Cones
2 Traffic Barricades

Description:

Facilitate northbound traffic on Route 3A and westbound traffic on Route 139. Discourage traffic on Route 3A from turning east onto Route 139 (Ocean Street).

Patrol No. M-T-02



NOTE: This location is outside of the EPZ.

Location:
Webster Street & Ocean Street (Marshfield)

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

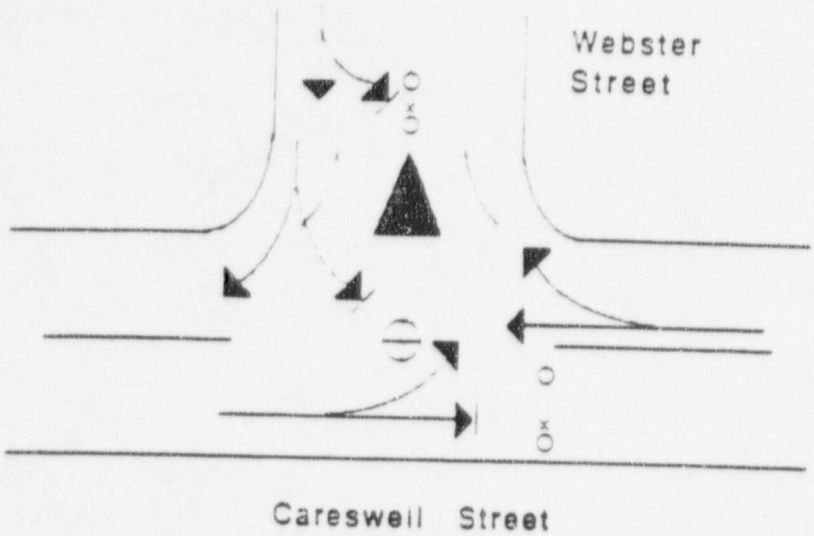
Manpower/Equipment:

1 Traffic Guide
2 Traffic Cones
1 Traffic Barricade

Description:

Facilitate northbound traffic on Webster Street and westbound traffic on Ocean Street. Discourage eastbound traffic.

Point No. M-T-[illegible]



Location:
Careswell Street & Webster Street (Marshfield)

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

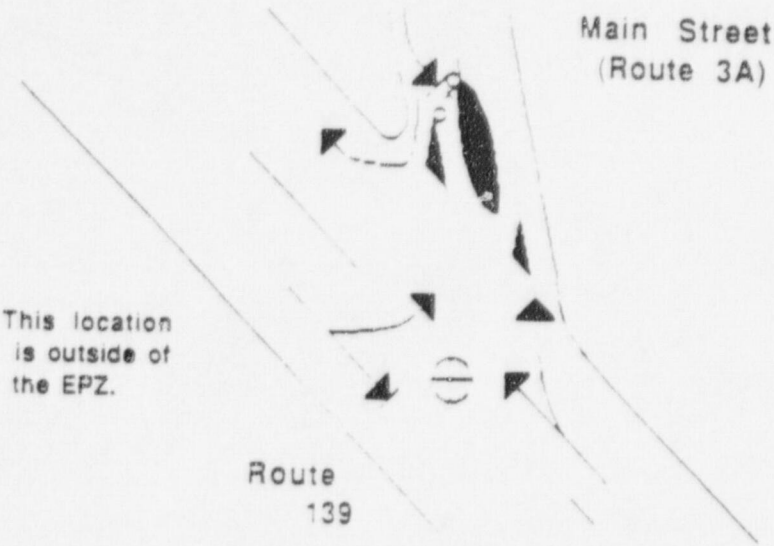
Manpower/Equipment:

1 Traffic Guide
4 Traffic Cones
2 Traffic Barricades

Description:

Facilitate westbound movement on Careswell Street.
Discourage eastbound traffic on Careswell Street.

Point No. M-AT-04



Location:
Main Street & Route 139 (Marshfield)

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

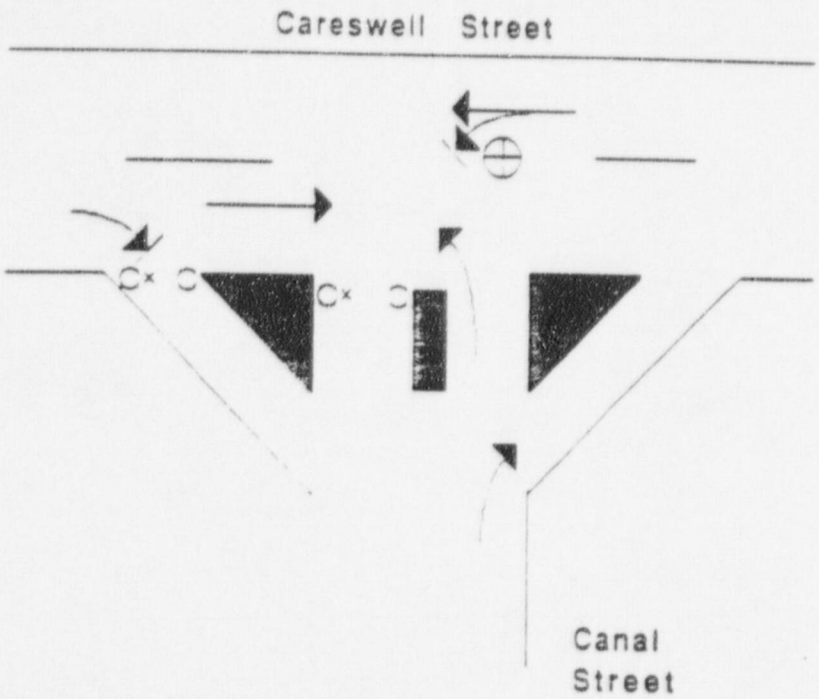
Manpower/Equipment:

1 Traffic Guide
2 Traffic Cones
1 Traffic Barricade

Description:

Facilitate northbound evacuation traffic on Main Street and Route 139.

Point No. M-AT-05



Location:
Careswell Street & Canal Street (Marshfield)

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

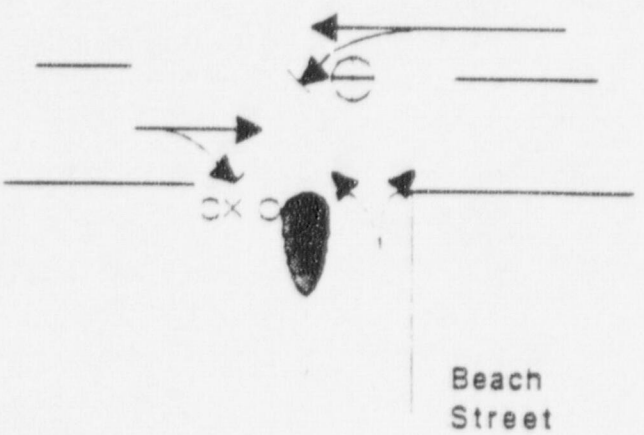
Manpower/Equipment:

1 Traffic Guide
4 Traffic Cones
2 Traffic Barricades

Description:

Facilitate westbound traffic on Careswell Street (Route 139). Facilitate traffic turning west onto Careswell Street from Canal Street. Discourage southbound traffic on Canal Street.

Plan No. M-AT-03



Location:
Careswell Street & Beach Street (Marshfield)

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

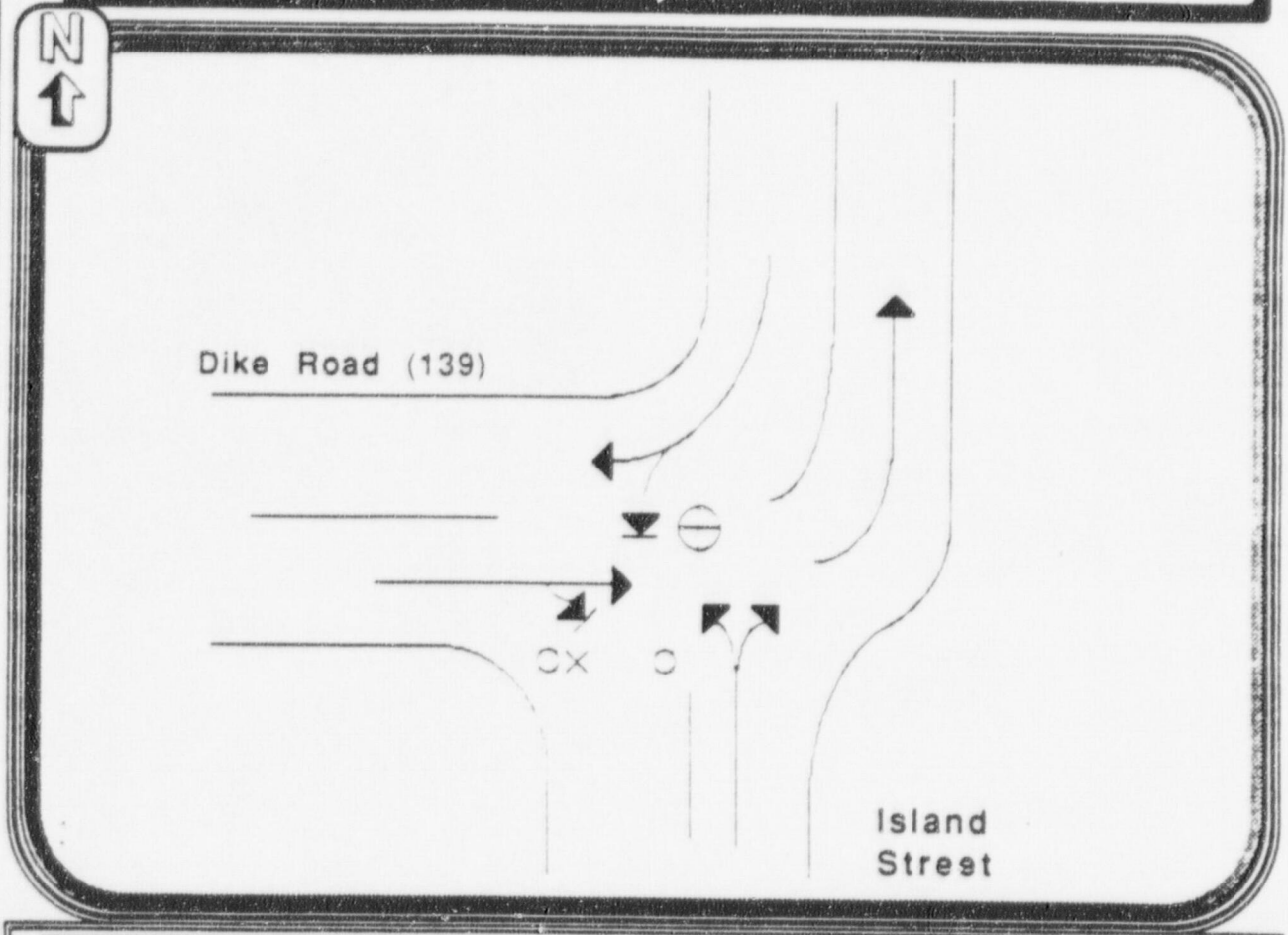
Manpower/Equipment:

1 Traffic Guide
2 Traffic Cones
1 Traffic Barricade

Description:

Facilitate northbound movement from Beach Street and all movements on Careswell Street. Discourage southbound movements on Beach Street.

Plan No. M-AT-37



Location:
Route 139 & Island Street (Marshfield)

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

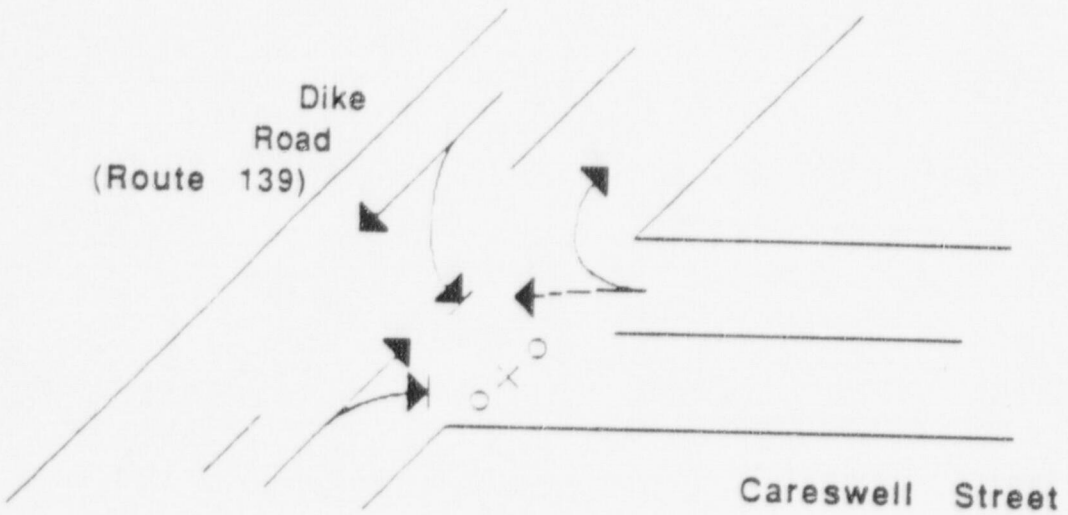
Manpower/Equipment:

1 Traffic Guide
2 Traffic Cones
1 Traffic Barricade

Description:

Facilitate all traffic on Route 139. Discourage southbound traffic on Island Street.

Point No. M-A-08



Location:
Dike Road (Route 139) & Careswell Street
(Marshfield)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

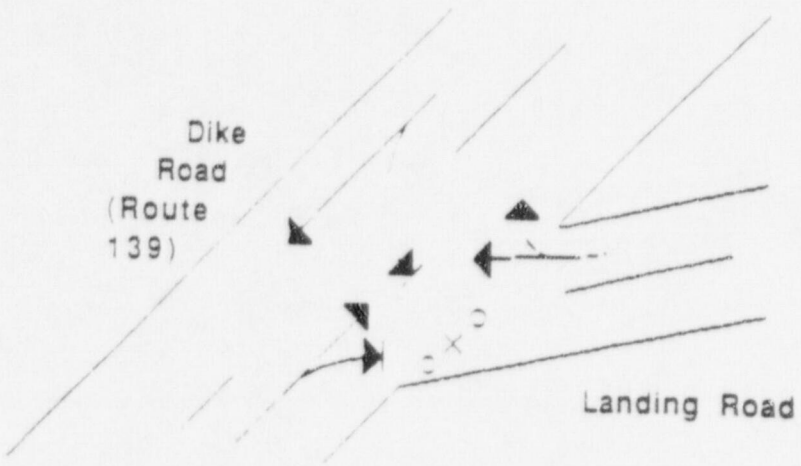
Manpower/Equipment:

2 Traffic Cones
1 Traffic Barricade

Description:

Discourage eastbound traffic on Careswell Street.

Point No. M-A-[illegible]



Location:
Dike Road (Route 139) & Landing Road
(Marshfield)

Priority: 4

KEY

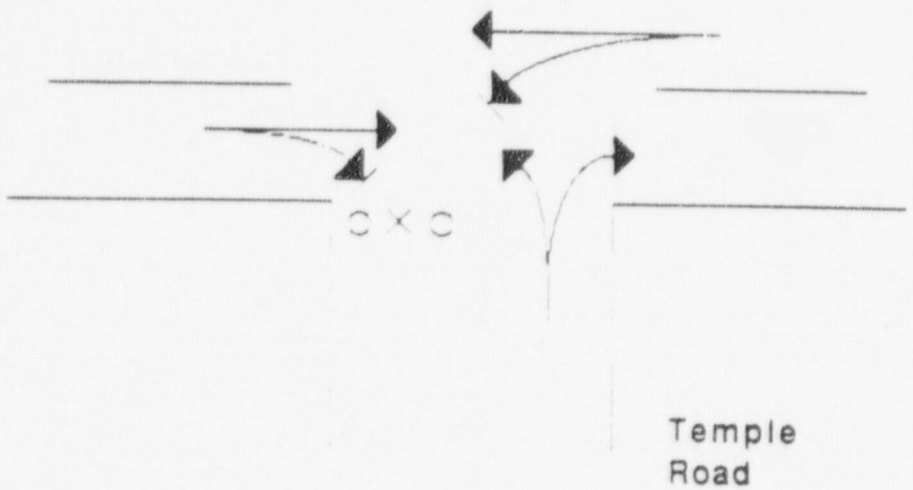
- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

2 Traffic Cones
1 Traffic Barricade

Description:

Discourage eastbound traffic on Landing Road.



Location:
Careswell Street (Route 139) & Temple Road
(Marshfield)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

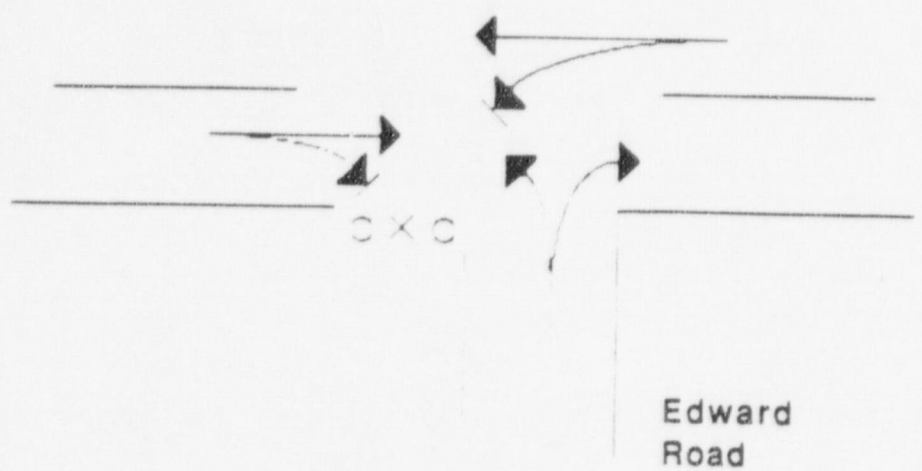
Manpower/Equipment:

2 Traffic Cones

1 Traffic Barricade

Description:

Discourage southbound traffic on Temple Road.



Location:
Careswell Street (Route 139) & Edward Road
(Marshfield)

Priority: 4

KEY

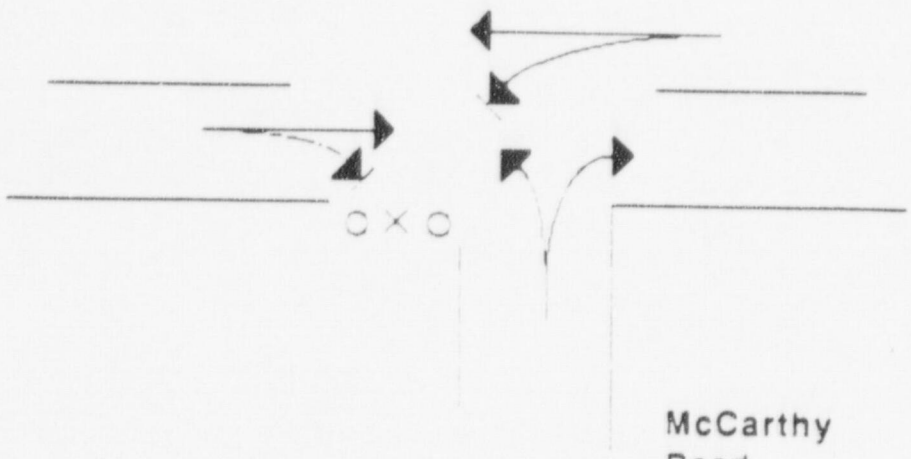
- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

2 Traffic Cones
1 Traffic Barricade

Description:

Discourage southbound traffic on Edward Road.



Location:
Careswell Street (Route 139) & McCarthy Road
(Marshfield)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

2 Traffic Cones

1 Traffic Barricade

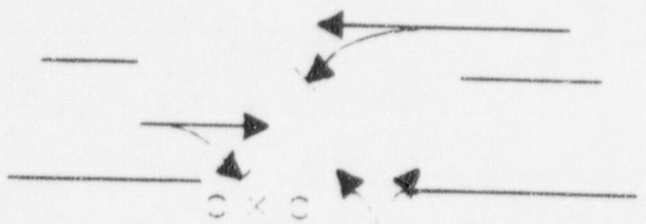
Description:

Discourage southbound traffic on McCarthy Road.

Point No. M-A-13

N

Route 139 (Careswell Avenue)



Duckhill/
Lane

Colby
Hewitt
Lane

Location:
Route 139 & Duckhill Lane (Marshfield)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

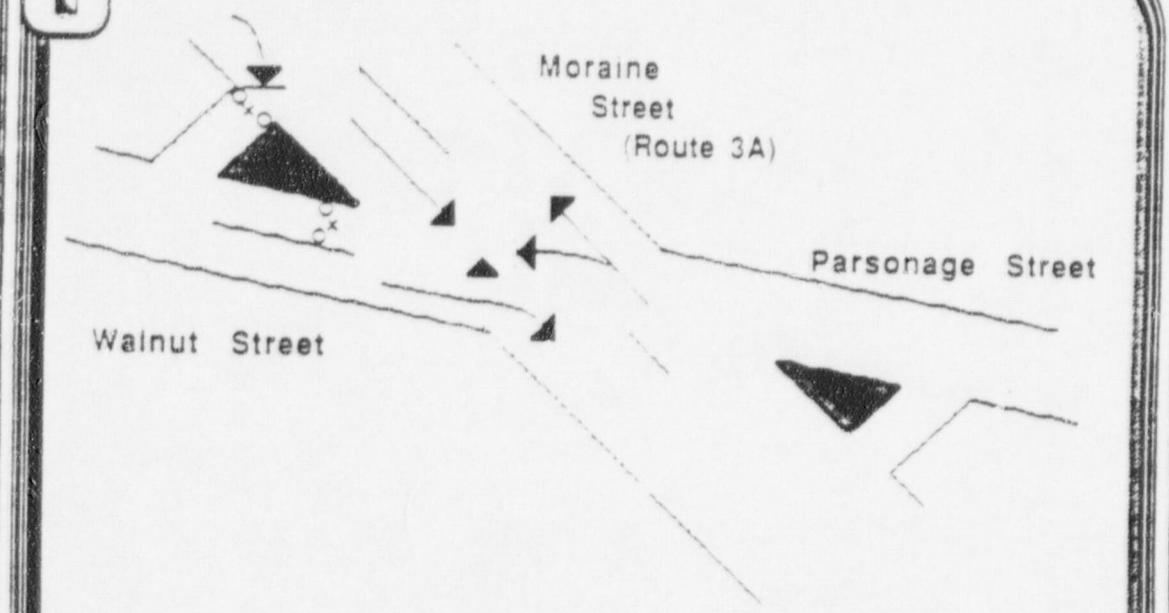
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage southbound traffic on Duckhill Lane.

Point No. [illegible]



Location:
Moraine Street (Route 3A) & Walnut Street
Marshfield

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

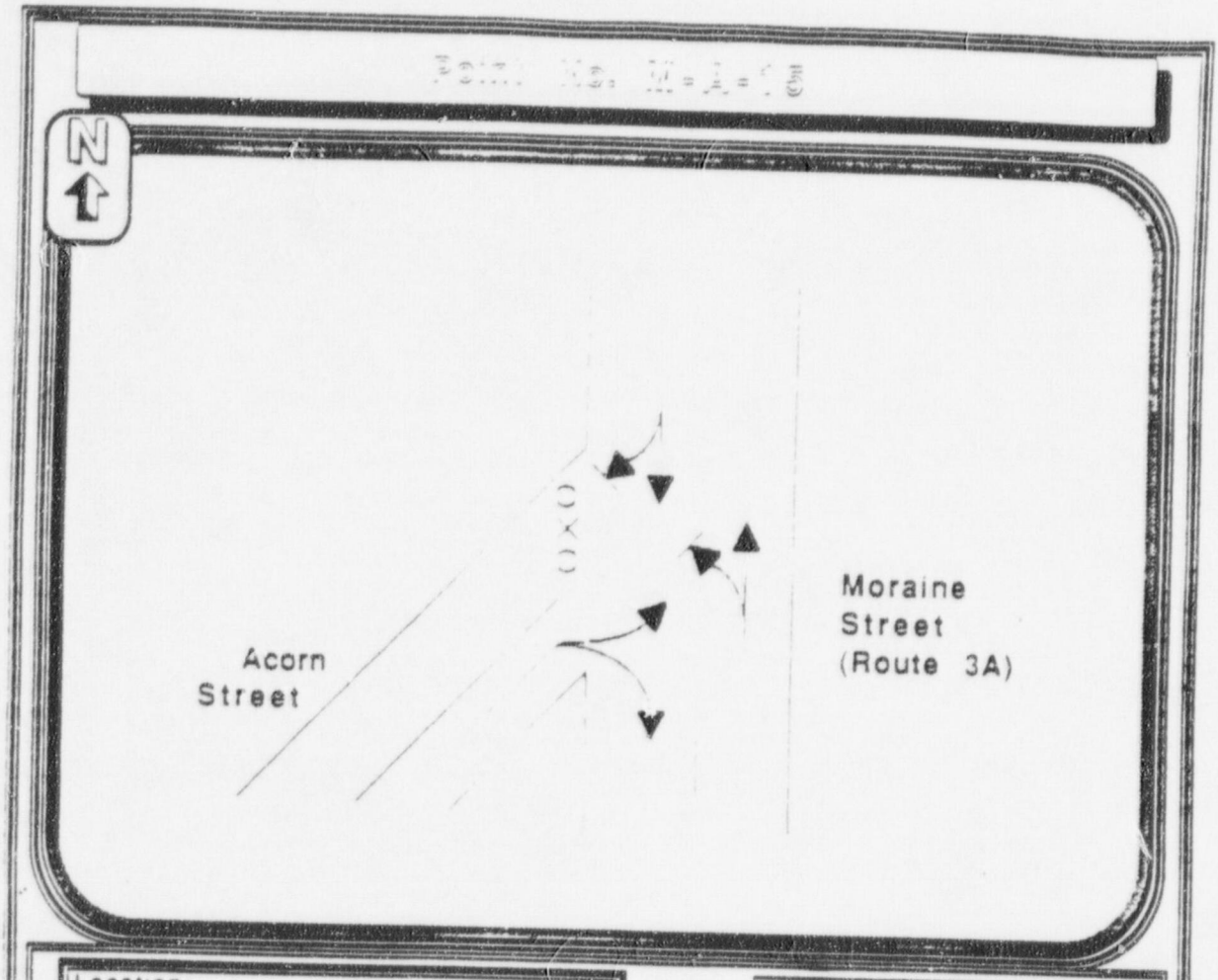
Manpower/Equipment:

4 Traffic Cones

2 Traffic Barricades

Description:

Discourage westbound travel on Walnut Street.



Location:
Moraine Street (Route 3A) & Acorn Street
(Marshfield)

Priority: 4

KEY

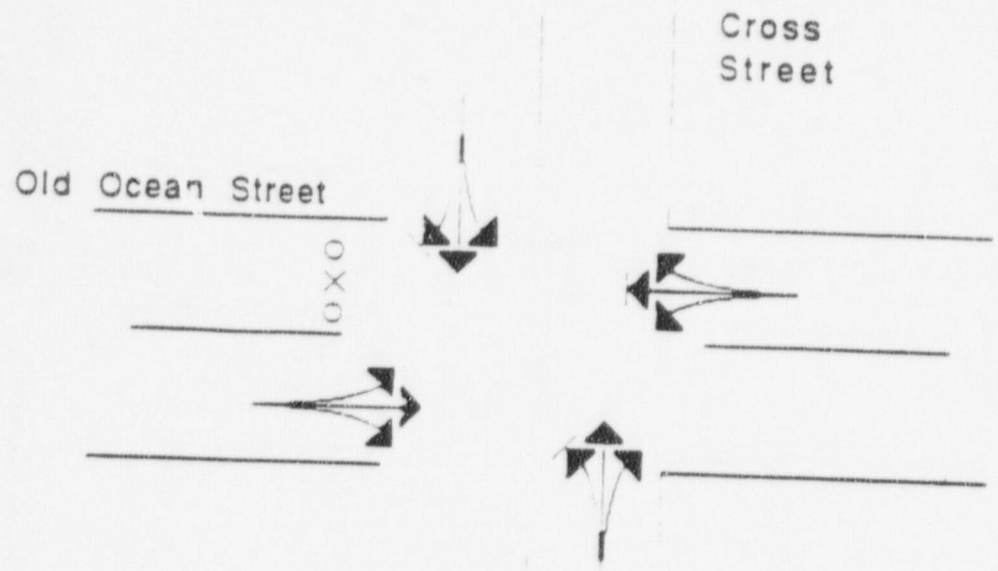
- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

2 Traffic Cones
1 Traffic Barricade

Description:

Discourage westbound traffic on Acorn Street.



Location:
Cross Street & Old Ocean Street (Marshfield)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

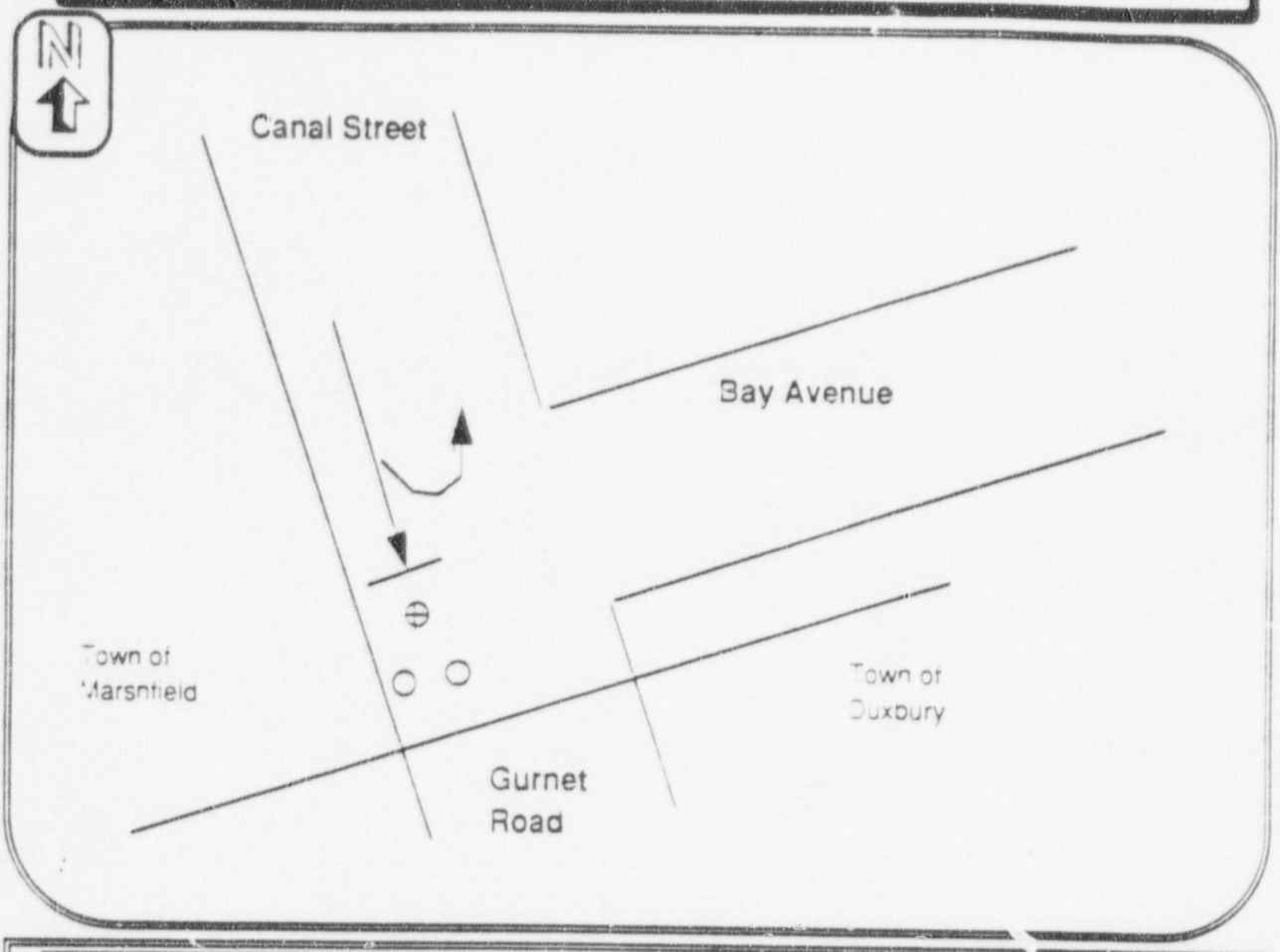
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage westbound traffic on Old Ocean Street.

Point No.



Location: Canal Street, Bay Avenue and Gurnet Road (Marshfield).

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

1 Traffic Guide

2 Traffic Cones

Description: Discourage southbound traffic on Gurnet Road.

Route 3 Traffic & Access Control

Table I-RT3-1. Location, Manpower, and Equipment Requirements for All Traffic and Access Control Points

ACP	Location	Agency Priority	Guides	Cones	Barricades	Lights	Signs
Weymouth							
WY-T-01[1]	Rte. 3 & Rte. 18, Exit 16	S-1	2	10	4	4	2
Hingham							
HG-AT-01	Rte. 3 & Oak St. Exit 15	S-1	1	0	4	4	
Rockland							
RK-AT-05[2]	Rte. 3 & Rte. 228, Hingham St. Exit 14	S-1	1	0	4	4	
Hanover							
HA-AT-01	Rte. 3 & Rte. 53, Exit 13	S-1	2	0	4	4	

---

[1] ACP WY-T-01 is duplicated in the Reception Center Traffic Management Plan.

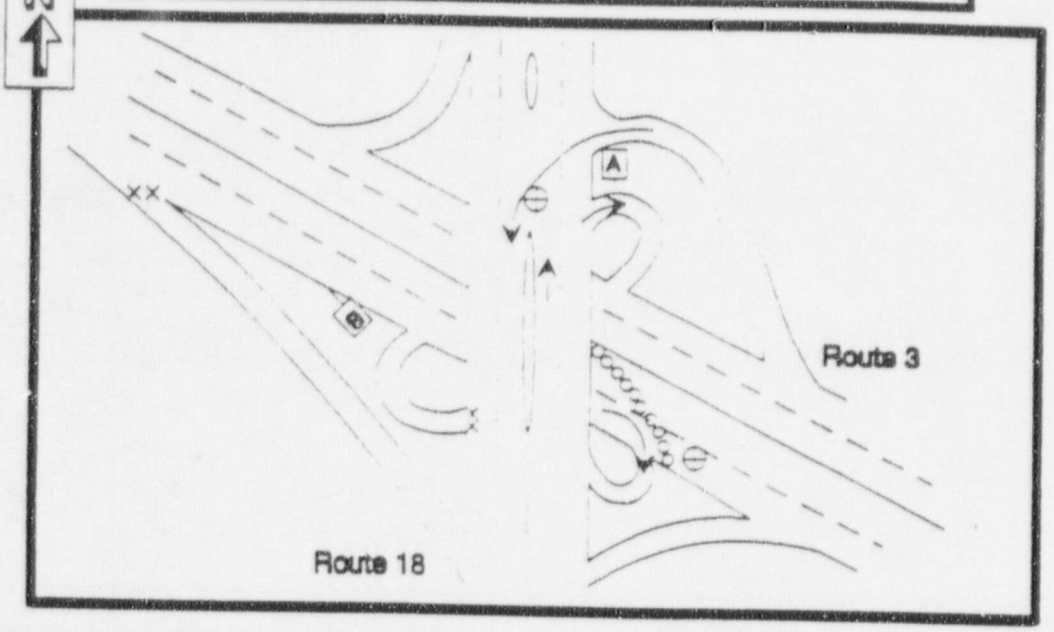
[2] Rockland Traffic Control Points 1 through 4 are contained in the Massachusetts State Police Traffic Management Plan.

Table I-RT3-2. Allocation of Access Control Points to Towns

TOWN: Weymouth, Hingham, Rockland, Hanover

ACCESS CONTROL POINT	ACTIVATED FOR FOLLOWING REGIONS:
WY-T-01	All Regions
HG-AT-01	All Regions
RK-AT-05	All Regions
HA-AT-01	All regions

WY-T-01



LOCATION:

Route 3 & Route 18

MANPOWER/EQUIPMENT:

2 Traffic Guides
10 Traffic Cones
4 Traffic Barricades
2 Traffic Signs

PRIORITY: 1

SIGNS:

A. To Reception Center →

B. Road Closed

KEY:

→ Movement facilitated

→| Movement discouraged

⊕ Traffic guide

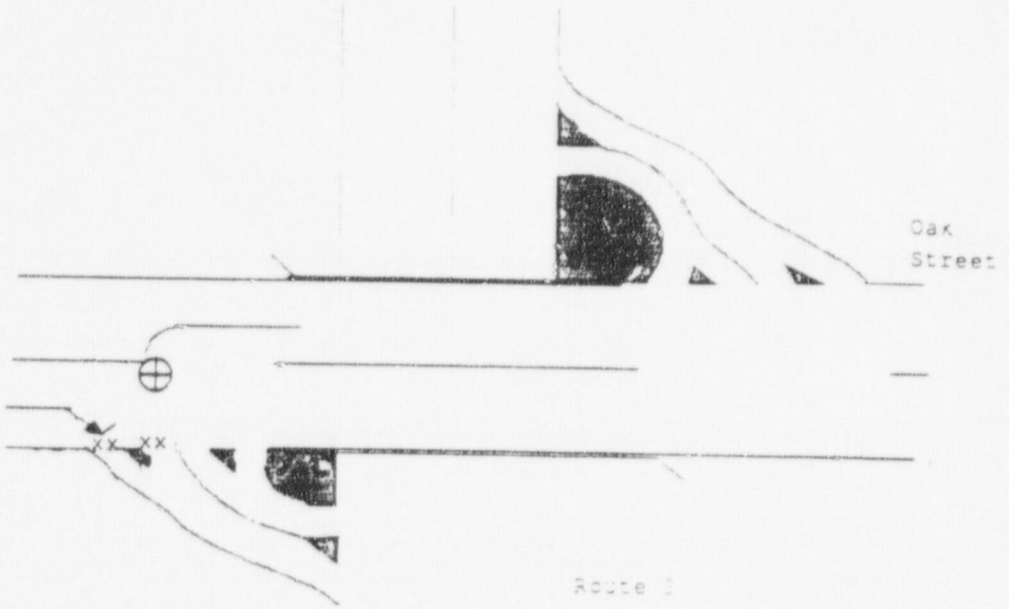
○ Traffic cone

✕ Traffic barricade

DESCRIPTION:

Direct Reception Center traffic to northbound Route 3.
Close Route 3 southbound.

Point No. EG-AT-01



Location:
Route 3 and Oak Street, Hingham, Exit 15

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- ⊕ Traffic guide
- ○ Traffic cone
- × Traffic barricade

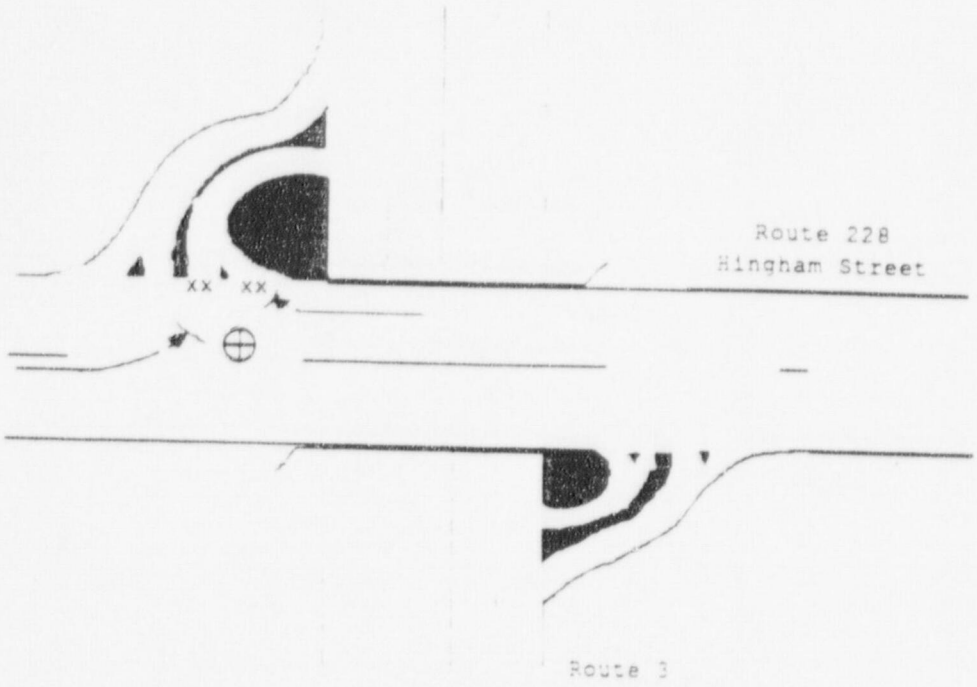
Manpower/Equipment:

- Traffic Guide
- Traffic Barricade

Description:

Discourage traffic entering southbound Route 3.

Point No. RX-AT-05



Location:
Route 3 and Route 228 (Hingham St.)
Rockland, Exit 14

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

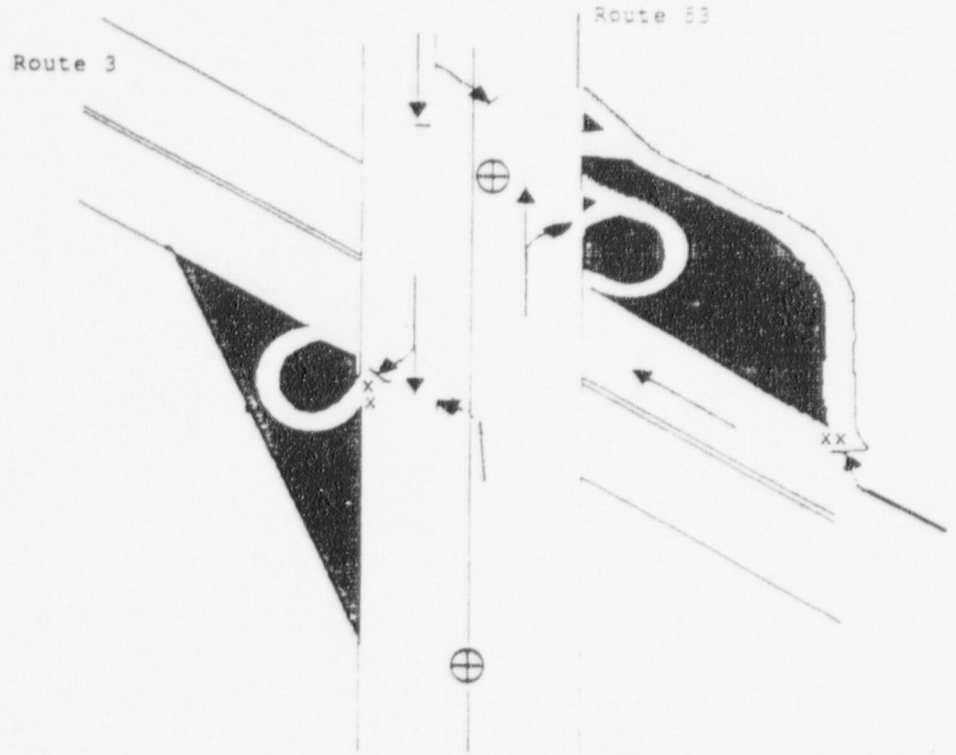
Manpower/Equipment:

1 Traffic Guide
4 Traffic Barricade

Description:

Discourage traffic entering southbound Route 3. (Note:Rockland traffic control points numbered 1 through 4 are contained in the peripheral town traffic management plan.)

Point No. EA-AT-01



Location:
Route 3 and Route 52 (Hanover), Exit 13

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

2 Traffic Guide

4 Traffic Barricade

Description:
Discourage traffic entering southbound Route 3.

PEMBROKE

I-PE-1

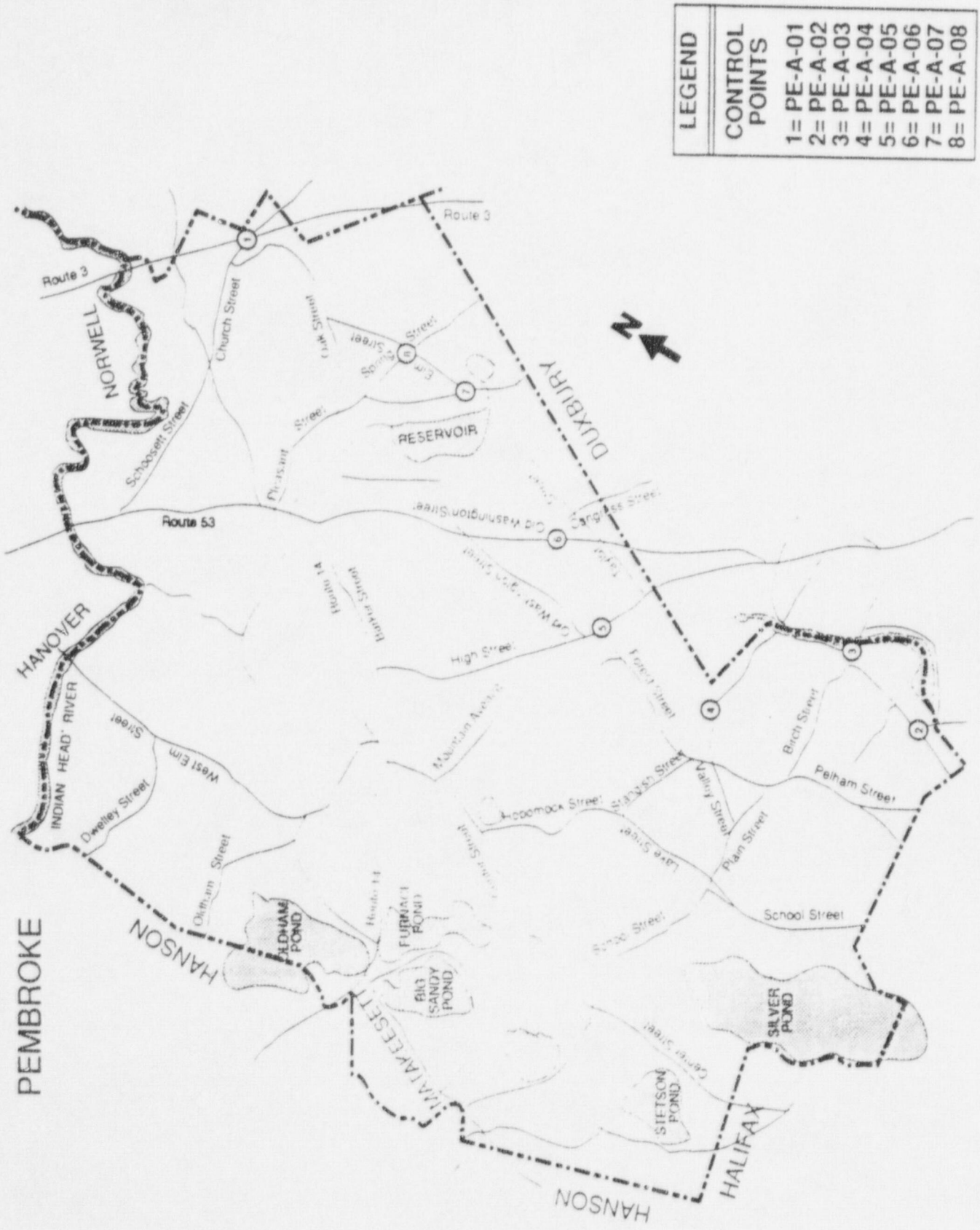


Figure I-PE-1 Traffic and Access Control Points
Pembroke

Rev. 5

Table I-PE-1. Location, Manpower, and Equipment Requirements for All Traffic and Access Control Points

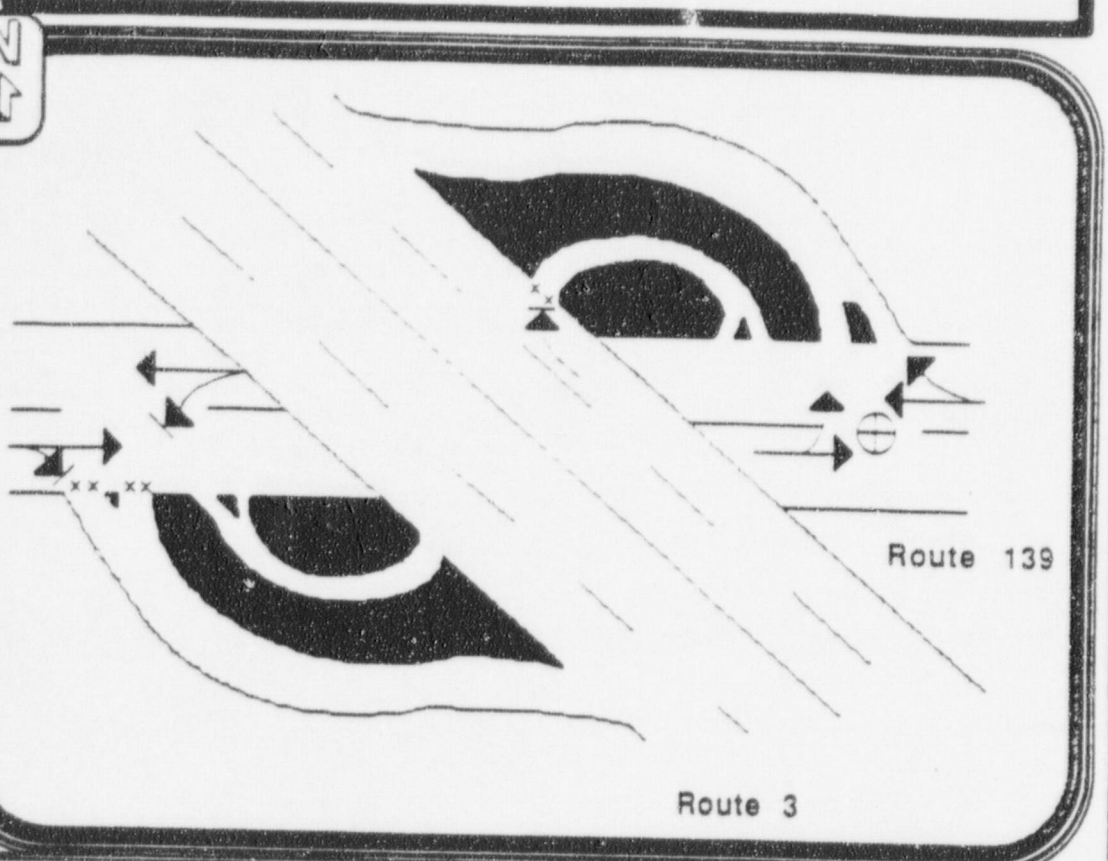
TOWN: Pembroke

ACP	Location	Agency Priority	Guides	Cones	Barricades	Lights
PE-A-01	Rte. 3 & Rte. 139	S-1	1		6	6
PE-A-02	Chapel St. & Pine St.	PE-4		2	1	1
PE-A-03	Birch St. & Harvard St.	PE-4		2	1	1
PE-A-04	Valley St. & Cypress Rd.	PE-4		2	1	1
PE-A-05	High St. & Forest St.	PE-3	1	2	1	1
PE-AT-06	Rte. 53 & Rte. 14	S-2	1	4	2	2
PE-A-07	Elm St. & Pleasant St.	PE-4		2	1	1
PE-A-08	Elm St. & Spring St.	PE-4		2	1	1

Table I-PE-2. Allocation of Access Control Points to Towns

TOWN: Pembroke

ACCESS CONTROL POINT	ACTIVATED FOR FOLLOWING REGIONS:
PE-A-01	All Regions Except 11
PE-A-02	13, 14, 15, 16, 17, 18, 19, 22
PE-A-03	13, 14, 15, 16, 17, 18, 19, 22
PE-A-04	13, 14, 15, 16, 17, 18, 19, 22
PE-A-05	13, 14, 15, 16, 17, 18, 19, 22
PE-AT-06	13, 14, 15, 16, 17, 18, 19, 22
PE-A-07	13, 14, 15, 16, 17, 18, 19, 22
PE-A-08	13, 14, 15, 16, 17, 18, 19, 22



Location:
Route 3 & Route 139 (Pembroke), Exit 12

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

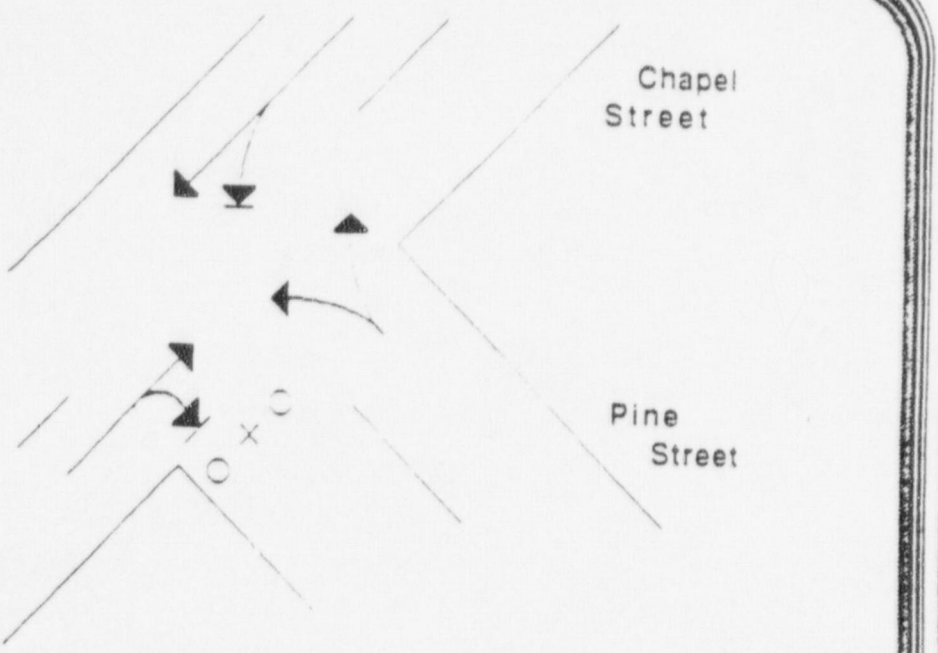
1 Traffic Guide

5 Traffic Barricades

Description:

Facilitate entry onto northbound Route 3. Discourage entry onto southbound Route 3.

Point No. PE-A-12



Location:
Chapel Street & Pine Street (Pembroke)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- ⊕ Traffic guide
- ○ Traffic cone
- × Traffic barricade

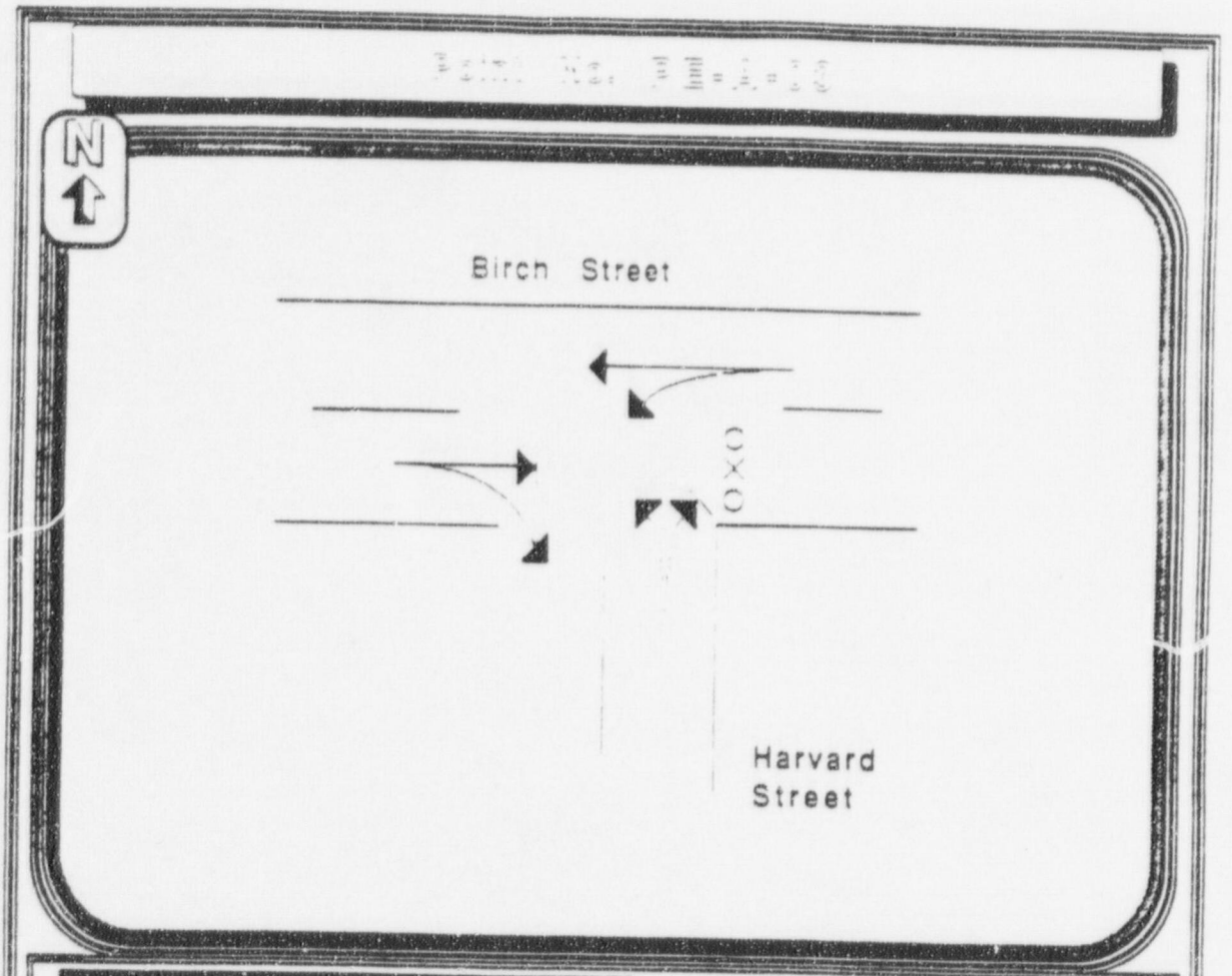
Manpower/Equipment:

2 Traffic Cones

1 Traffic Barricade

Description:

Discourage southbound traffic on Pine Street.



Location:
Birch Street & Harvard Street (Pembroke)

Priority: 4

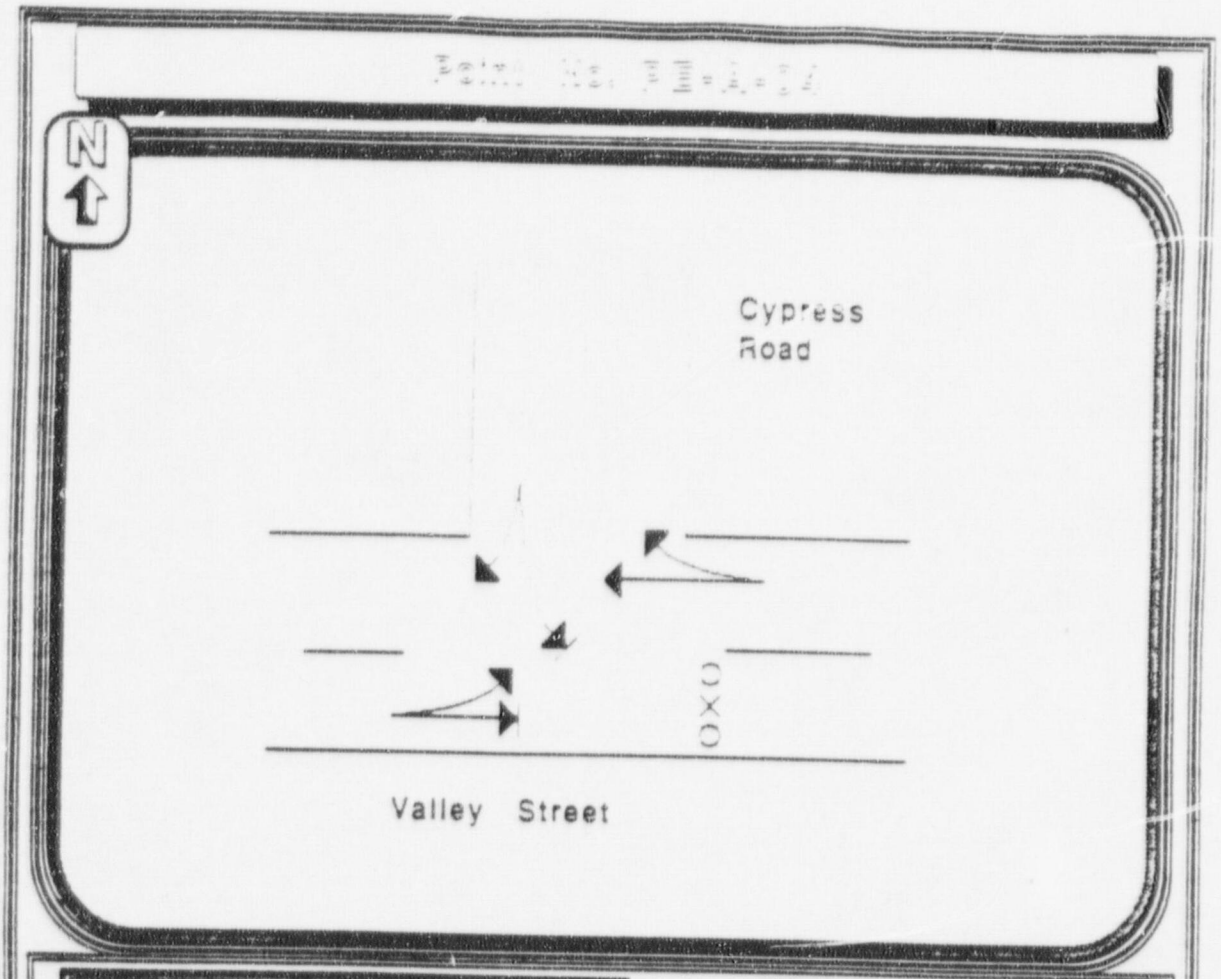
KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

2 Traffic Cones
1 Traffic Barricade

Description:
Discourage eastbound traffic on Birch Street.



Location:
Valley Street & Cypress Road (Pembroke)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

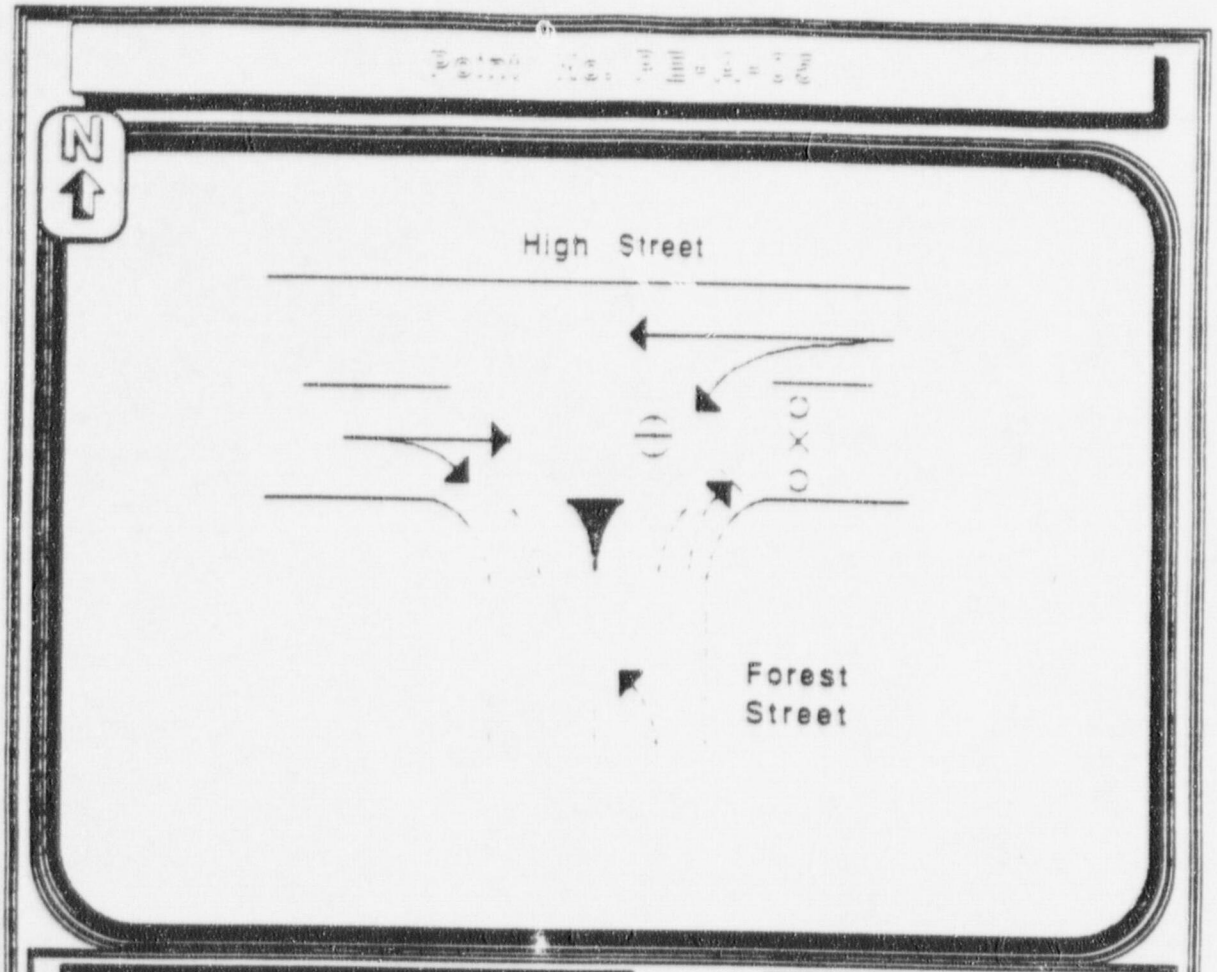
Manpower/Equipment:

2 Traffic Cones

1 Traffic Barricade

Description:

Discourage eastbound traffic on Valley Street.



Location:
High Street & Forest Street (Pembroke)

Priority: 3

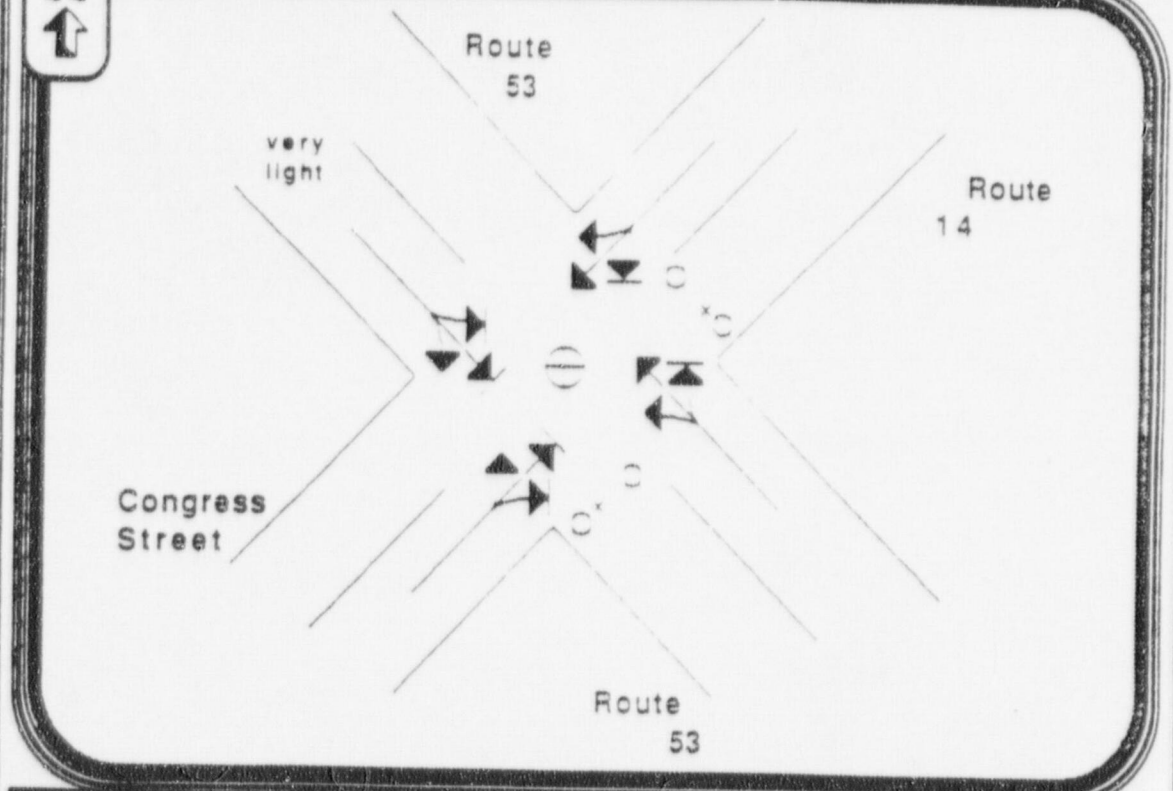
KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

1 Traffic Guide
2 Traffic Cones
1 Traffic Barricade

Description:
Discourage eastbound traffic on High Street.



Location:
Route 53 & Route 14 (Pembroke)

Priority: 2

KEY

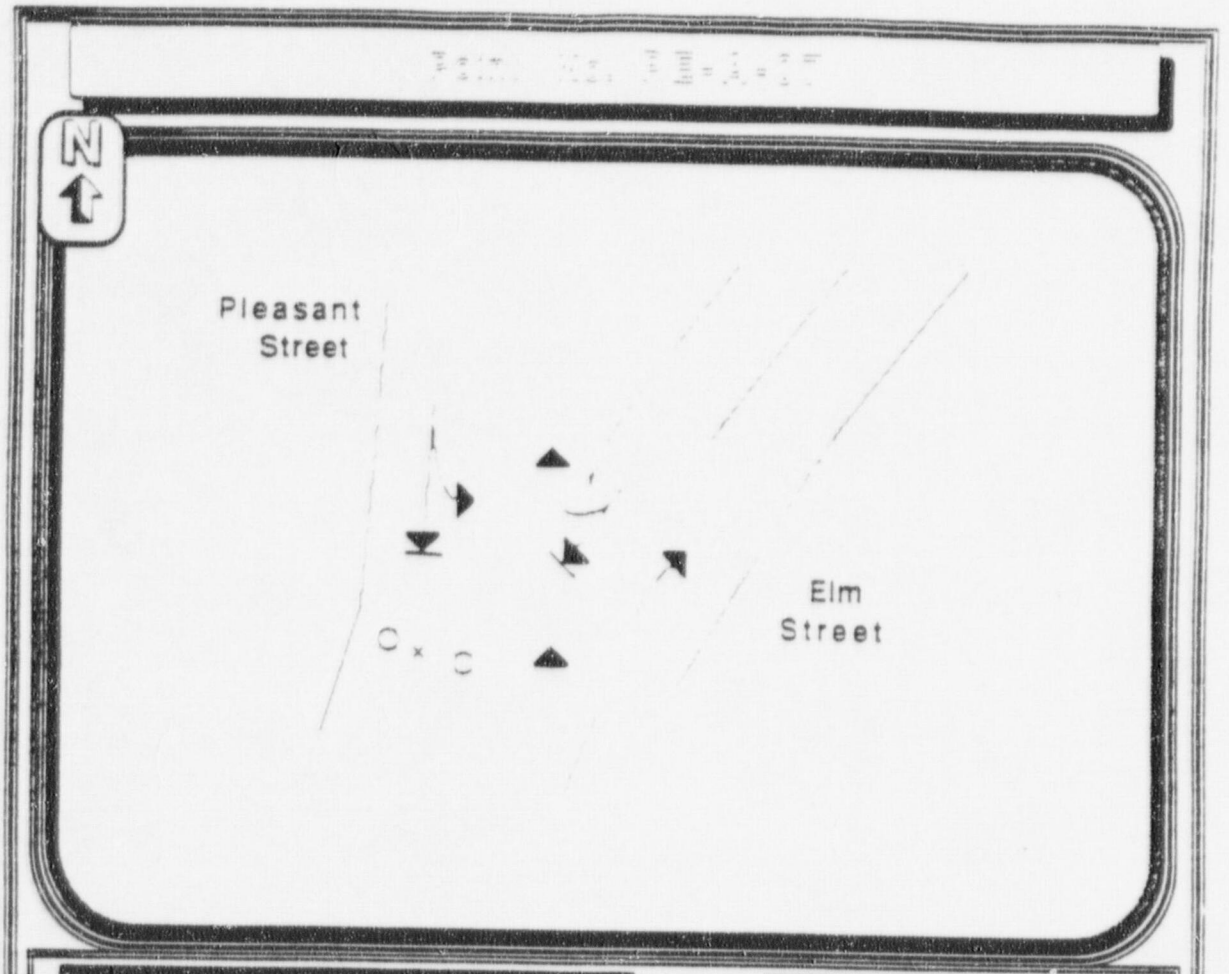
- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

1 Traffic Guide
4 Traffic Cones
2 Traffic Barricades

Description:

Facilitate westbound traffic on Route 14 and northbound traffic on Route 53. Discourage all eastbound and southbound traffic.



Location:
Elm Street & Pleasant Street (Pembroke

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

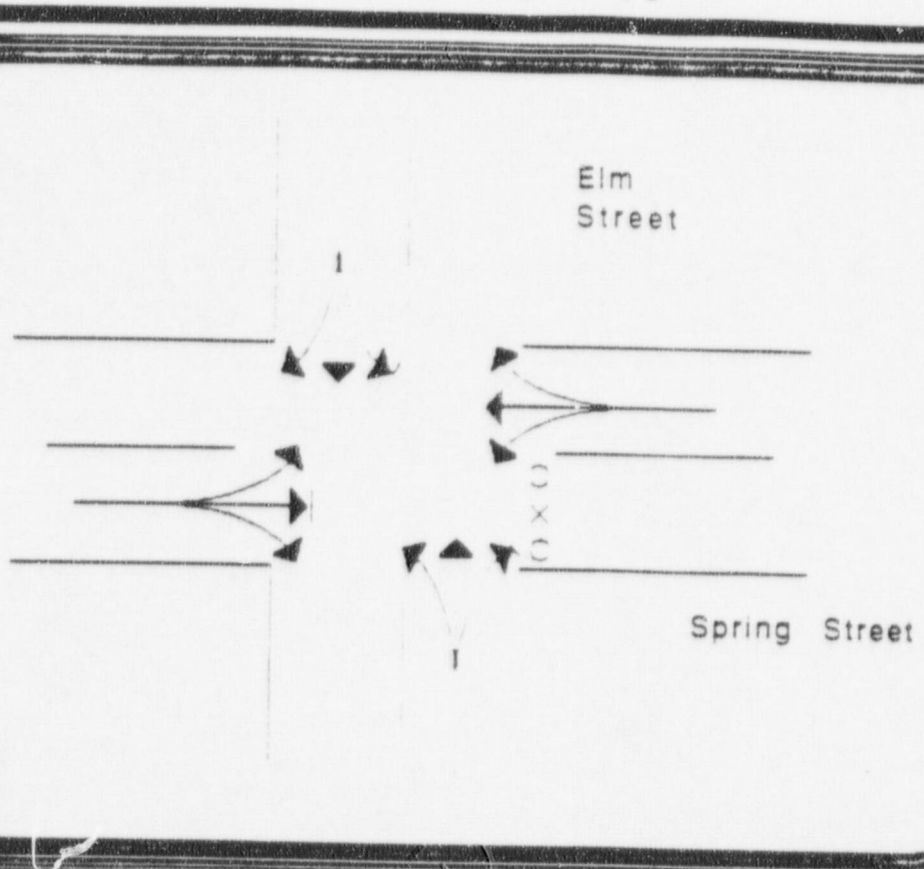
Manpower/Equipment:

2 Traffic Cones

1 Traffic Barricade

Description:

Discourage southbound traffic on Elm Street.



Location:
Elm Street & Spring Street (Pembroke)

Priority: 2

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

2 Traffic Cones
1 Traffic Barricade

Description:
Discourage eastbound traffic on Spring Street.

PLYMPTON

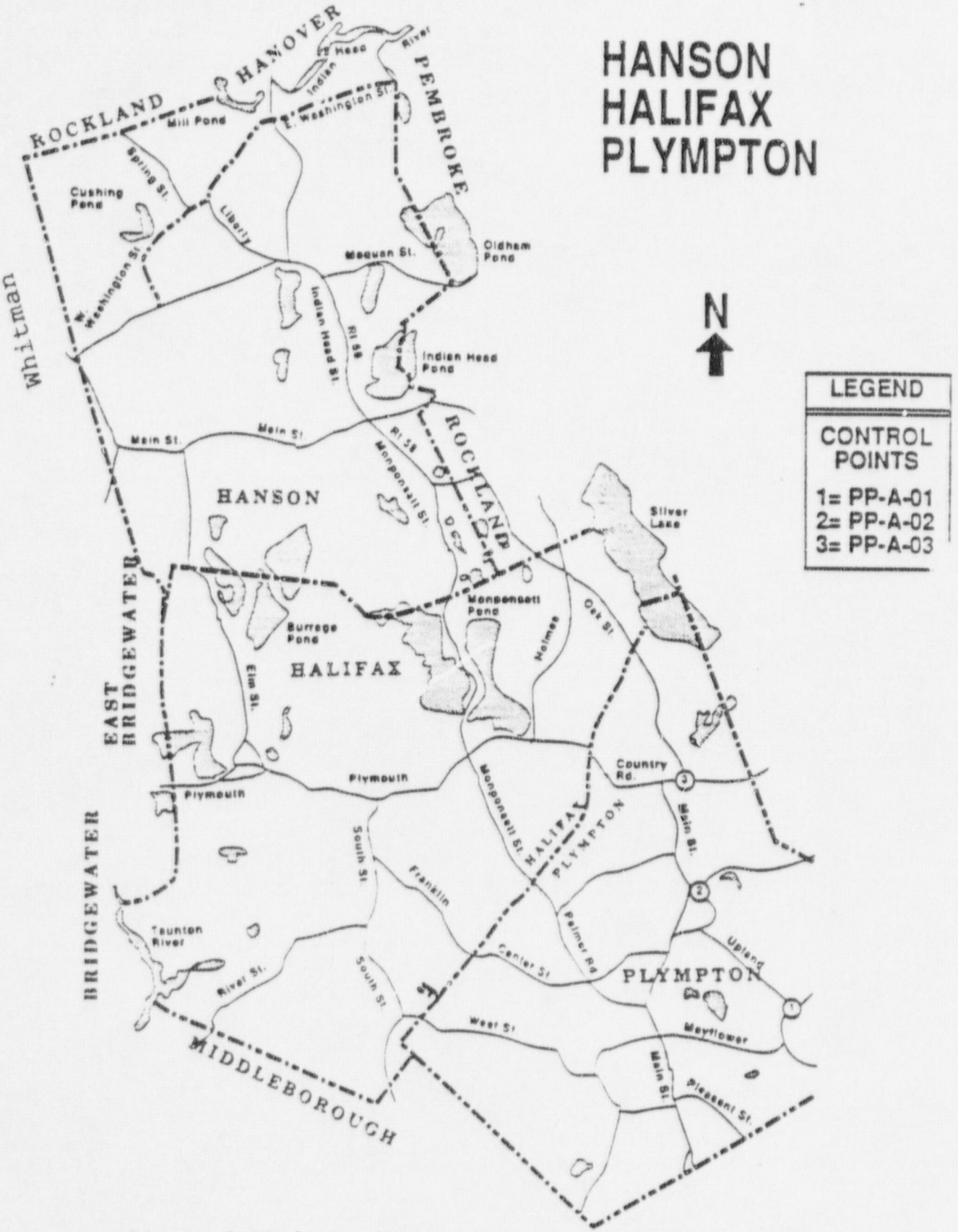


Figure I-PP-1. Traffic and Access Control Points
Hanson

Table I-PP-1. Location, Manpower, and Equipment Requirements for All Traffic and Access Control Points

TOWN: Plympton

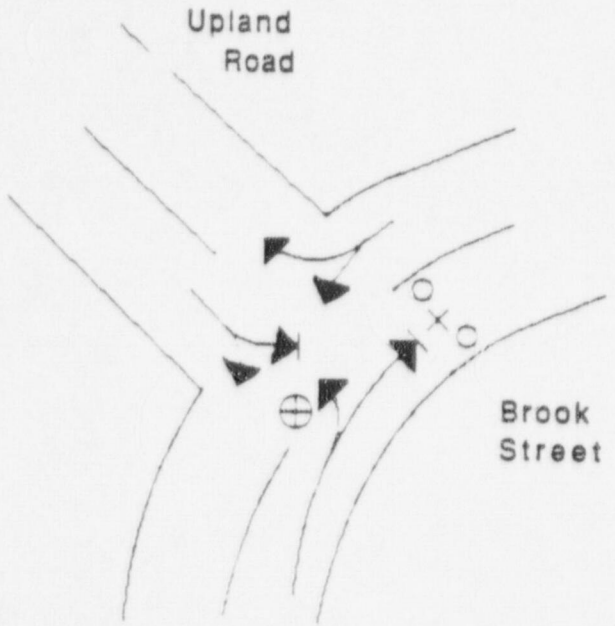
ACP	Location	Agency Priority	Guides	Cones	Barricades	Lights
PP-A-01	Brook St. & Upland Rd.	PP-3	1	2	1	1
PP-A-02	Ring Rd. & Crescent St.	PP-4		2	1	1
PP-A-03	Rte. 106 & Lake St.	PP-3	1	2	1	1

Table I-PP-2. Allocation of Access Control Points to Towns

TOWN: Plympton

ACCESS CONTROL POINT	ACTIVATED FOR FOLLOWING REGIONS:
PP-A-01	8, 10, 11, 13, 14, 15, 16, 17, 18, 20, 22
PP-A-02	13, 14, 15, 16, 17, 18, 22
PP-A-03	13, 14, 15, 16, 17, 18, 22

Point No. PP-A-01



Location:
Brook Street & Upland Road (Plympton)

Priority: 3

KEY

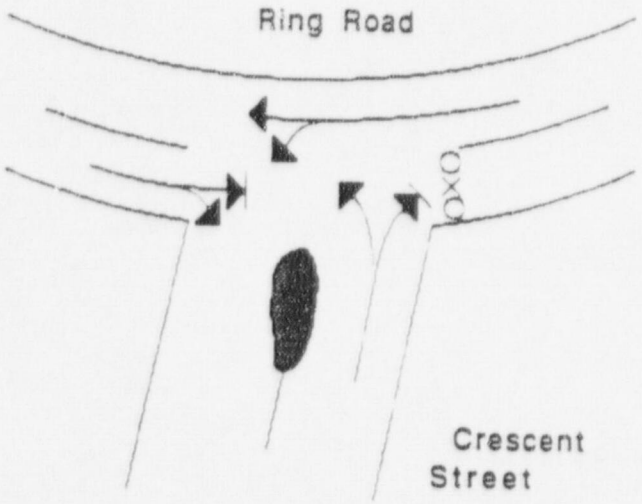
- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

1 Traffic Guide
2 Traffic Cones
1 Traffic Barricade

Description:
Discourage eastbound traffic on Brook Street.

Point No. PP-A-12



Location:
Ring Road & Crescent Street (Plympton)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

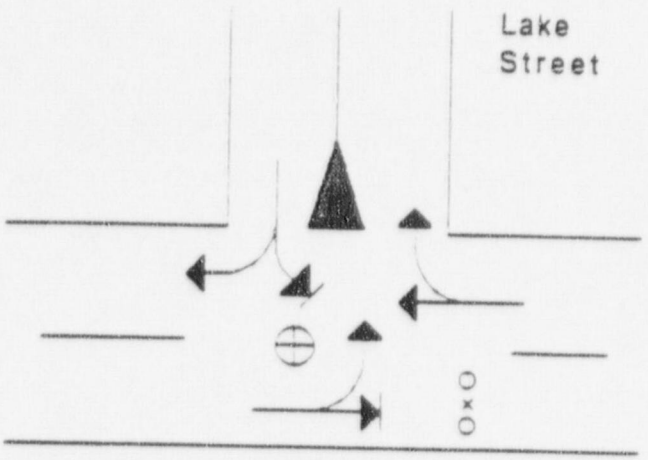
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage eastbound traffic on Ring Road.

Point No. PP-1-13



Route 106

Location:
Route 106 & Lake Street (Plympton)

Priority: 3

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

1 Traffic Guide
2 Traffic Cones
1 Traffic Barricade

Description: Discourage eastbound traffic on Route 106.

WAREHAM

I-WA-1

Rev. 5

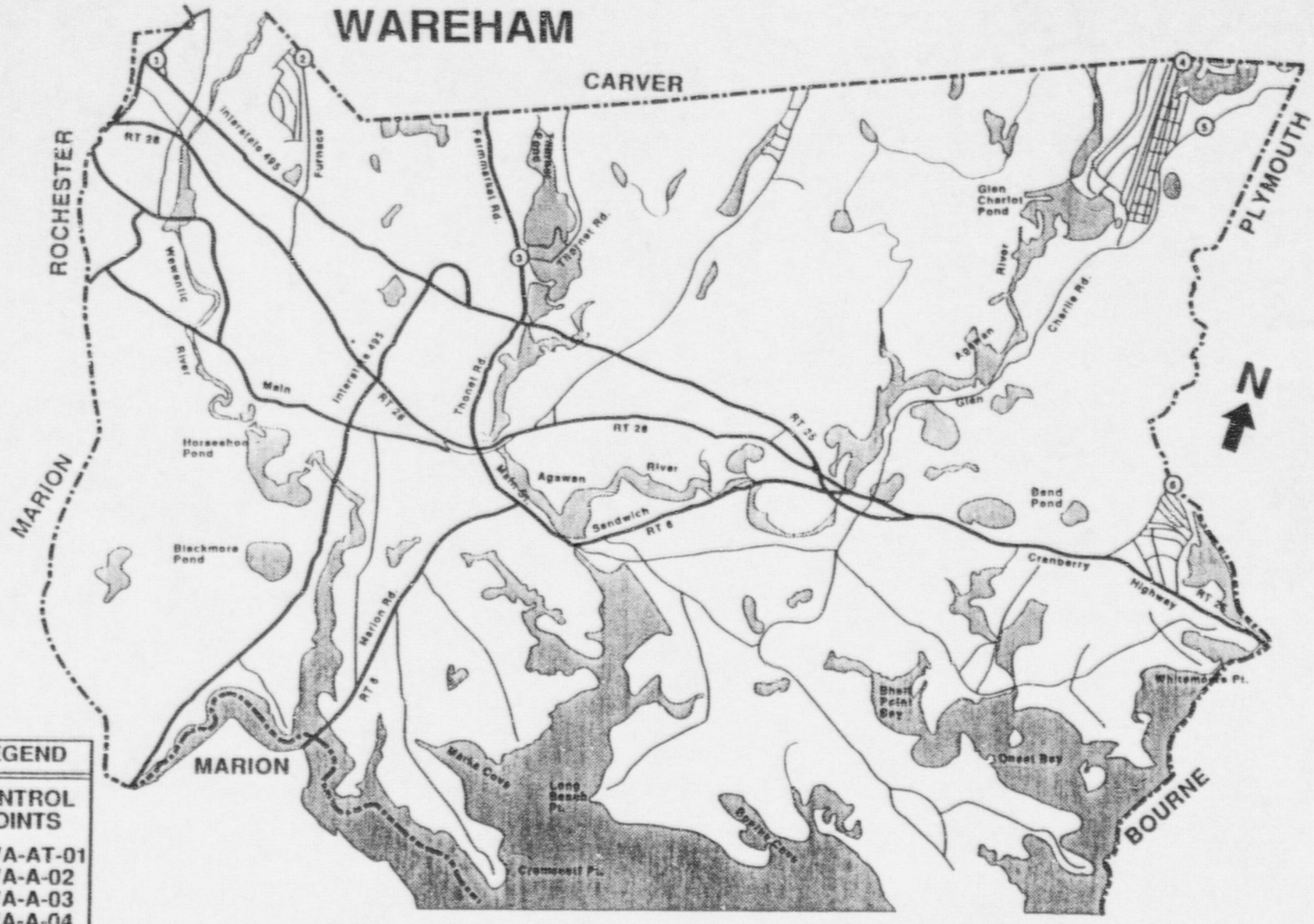


Figure I-WA-1. Traffic and Access Control Points
Wareham

Table I-WA-1. Location, Manpower, and Equipment Requirements for All Traffic and Access Control Points

TOWN: Wareham

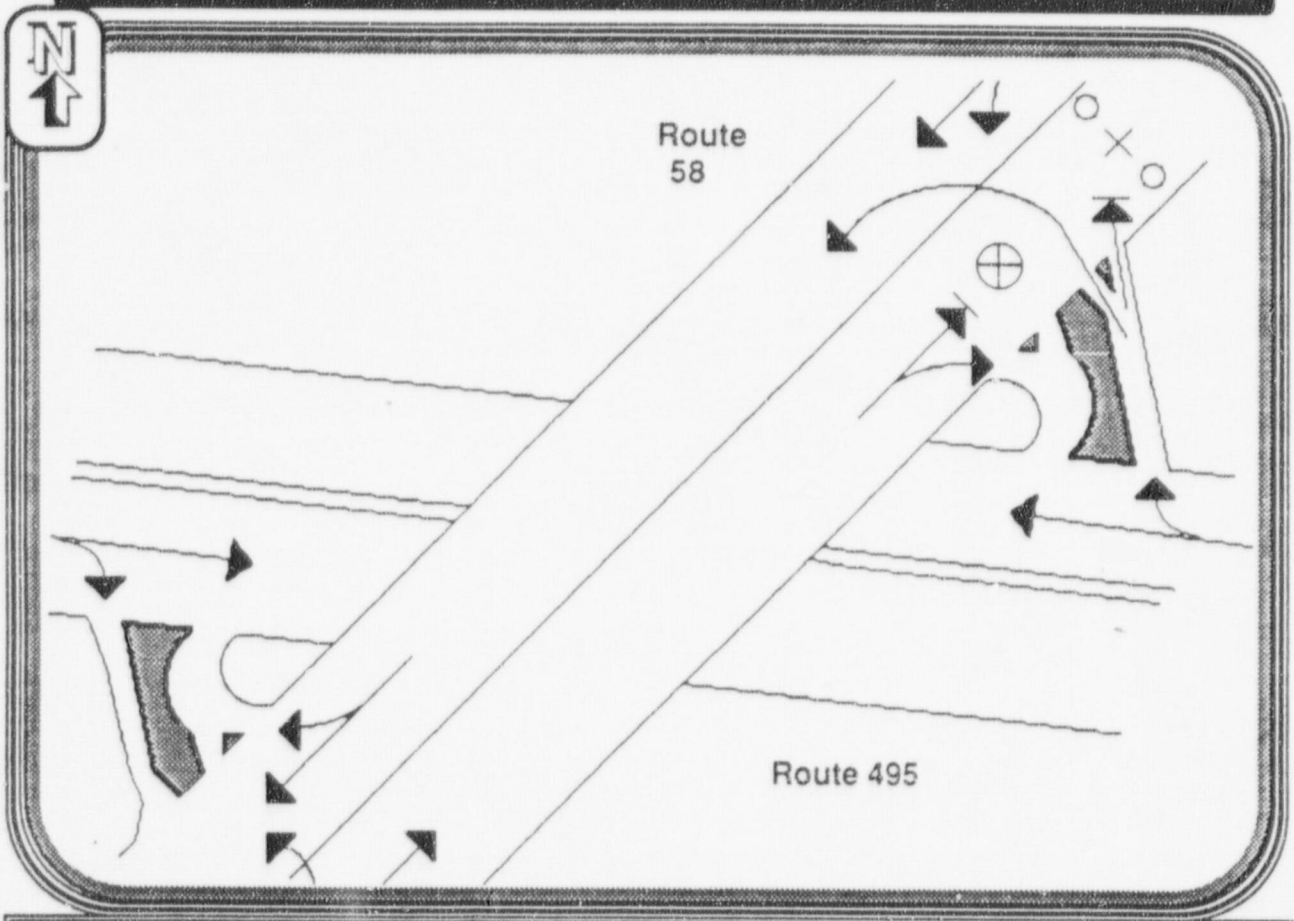
ACP	Location	Agency Priority	Guides	Cones	Barricades	Lights
WA-AT-01	Rte. 58 & Rte. 495/Rte.25	S-1	1	2	1	1
WA-A-02	Wareham St. & Cummequid Rd.	WA-4		2	1	1
WA-A-03	Tihonet Rd. & Farm to Market Rd.	WA-4		2	1	1
WA-A-04	Wareham Rd. & Plymouth Ave.	WA-3	1	2	1	1
WA-A-05	Barker Rd. & Blackberry Rd.	WA-4		2	1	1
WA-A-06	Red Brook Rd. & Gitche Gumee Rd.	WA-3	1	2	1	1

Table I-WA-2. Allocation of Access Control Points to Towns

TOWN: Wareham

ACCESS CONTROL POINT	ACTIVATED FOR FOLLOWING REGIONS:
WA-AT-01	8, 9, 10, 11, 12, 13, 14, 22
WA-A-02	8, 9, 10, 11, 12, 13, 14, 22
WA-A-03	7, 8, 9, 10, 11, 12, 13, 14, 22
WA-A-04	7, 8, 9, 22
WA-A-05	7, 8, 9, 22
WA-A-06	7, 8, 9, 22

Point No. WA-AT-01



Location:
Route 58 & Route 495 / Route 25 (Wareham)

Priority: 1

KEY

——▶	Movement facilitated
——▶|	Movement discouraged
⊕	Traffic guide
○	Traffic cone
×	Traffic barricade

Manpower/Equipment:

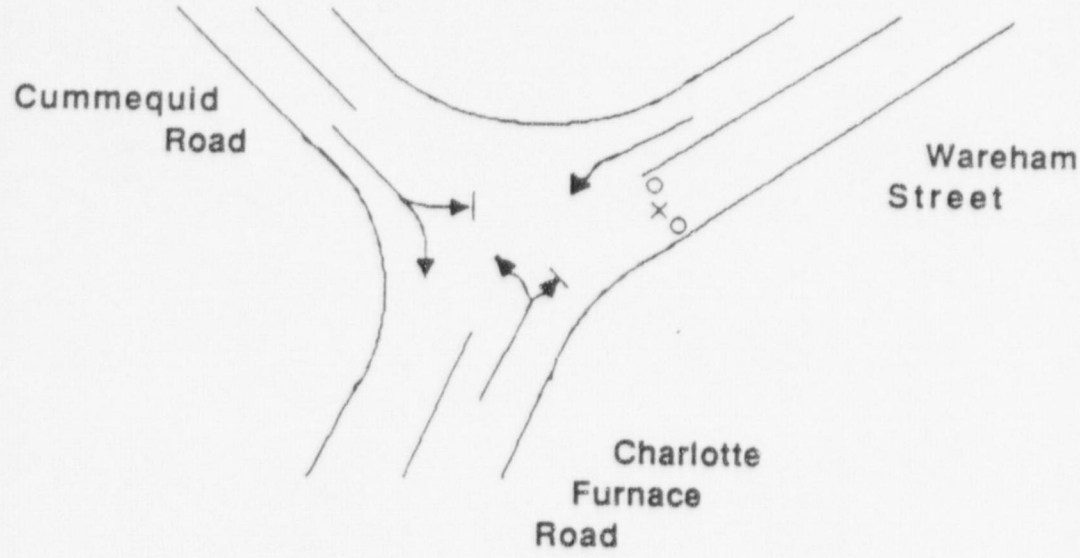
1 Traffic Guide
2 Traffic Cones
1 Traffic Barricade

Description:

Facilitate southbound traffic on Route 58 and traffic entering westbound Route 495. Discourage northbound traffic on Route 58.

WAR-ACP-WA-A-01	072688	
Wareham Access Control Point #01	1 of 1	38

Point No. WA-A-02



Location:
Wareham Street & Cummequid Road (Wareham)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

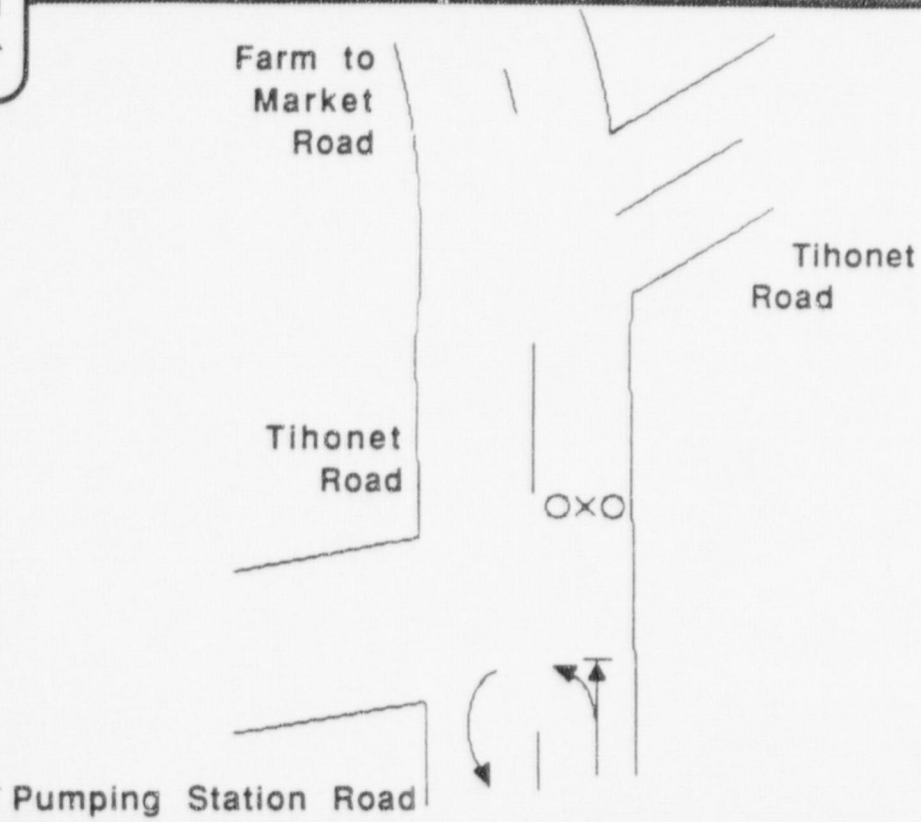
2 Traffic Cones

1 Traffic Barricade

Description:
Discourage northbound traffic on Wareham Street.

WAR-ACP-WA-A-02	072688	
Warham Access Control Point #02	1 of 1	SA

Point No. WA-A-03



Location:
Tihonet Road and Farm to Market Road
(Wareham)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

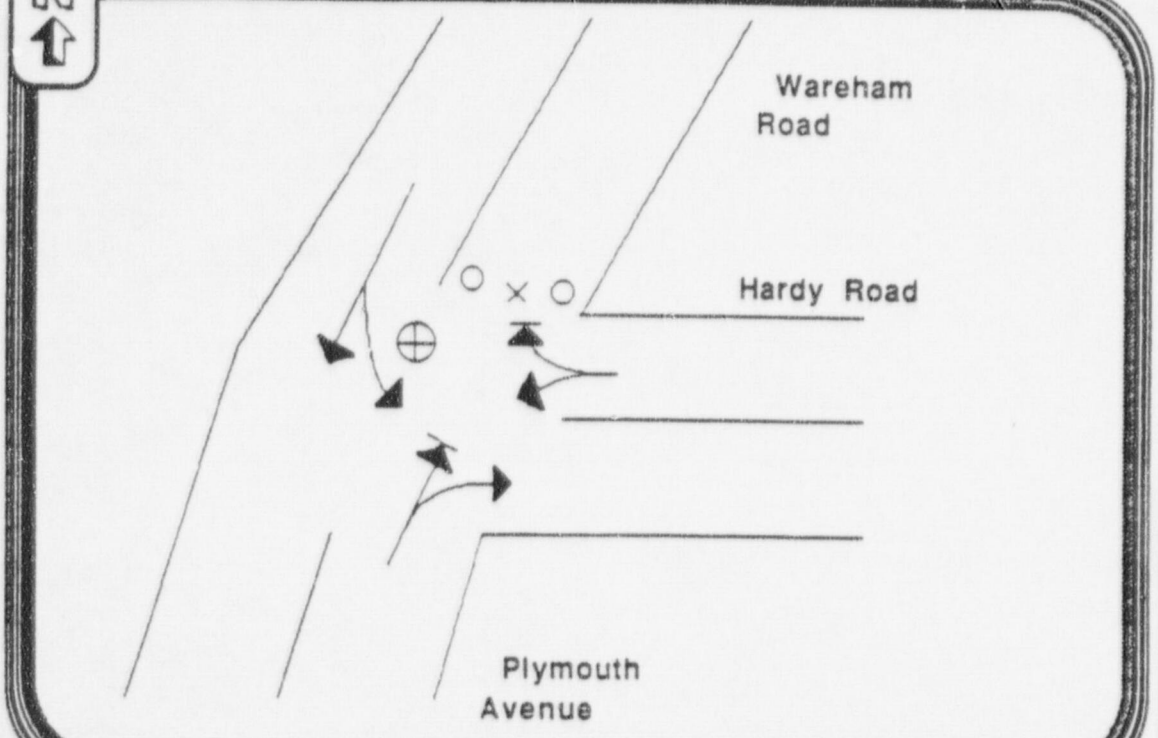
2 Traffic Cones

1 Traffic Barricade

Description: Discourage northbound traffic on Tihonet Road

WAR.ACP.WA-A-03	072598	
Wareham Access Control Point #03	1 of 1	38

Point No. WA-A-04



Location:
Warenam Road & Plymouth Avenue (Wareham)

Priority: 3

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

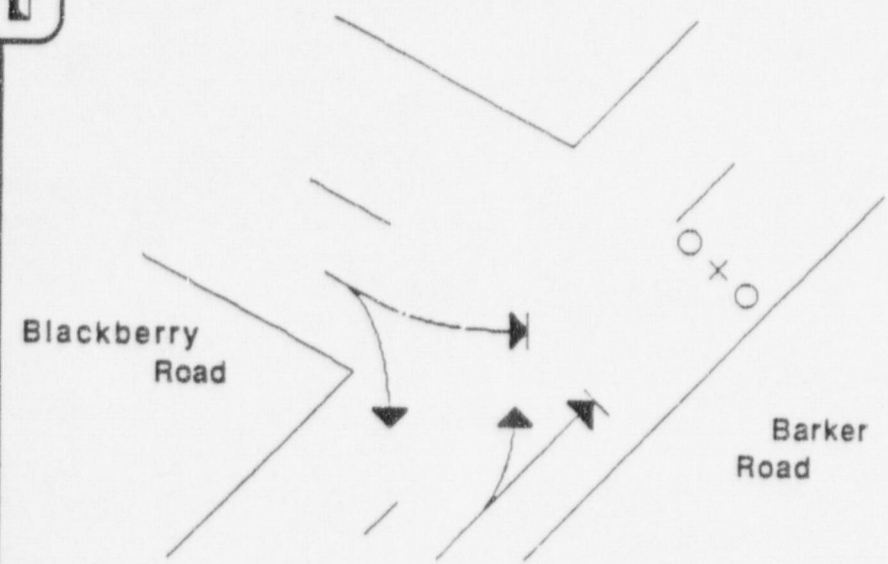
Manpower/Equipment:

1 Traffic Guide
2 Traffic Cones
1 Traffic Barricade

Description:

Discourage northbound traffic on Wareham Road.

Point No. WA-A-9



Location:
Barker Road & Blackberry Road (Warenam)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

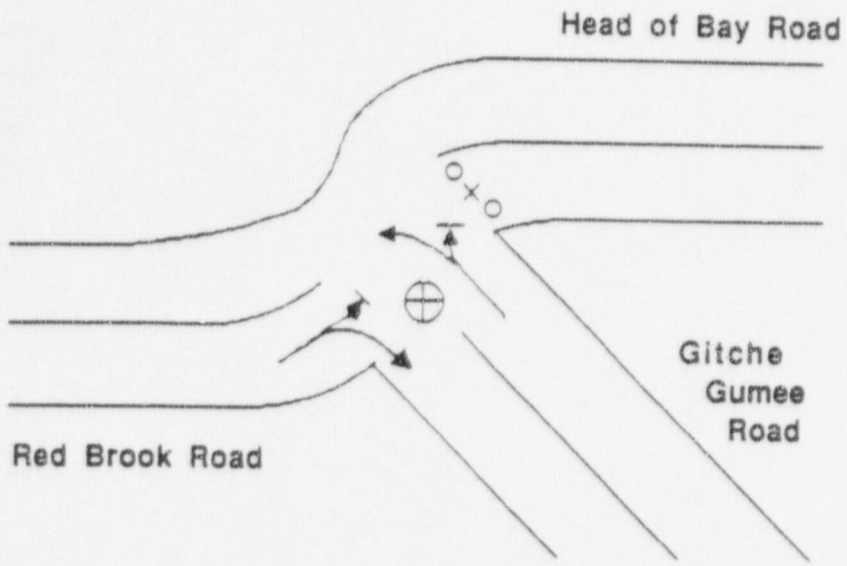
2 Traffic Cones

1 Traffic Barricade

Description:

Discourage eastbound traffic on Barker Road.

Point No. WA-A-06



Location:
Red Brook Road & Gitche Gumee Road (Warenam)

Priority: 3

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

1 Traffic Guide
2 Traffic Cones
1 Traffic Barricade

Description: Discourage northbound traffic onto Head of Bay Road

WAR-ACP-WA-A-06

BOURNE

I-BO-1

Rev. 5

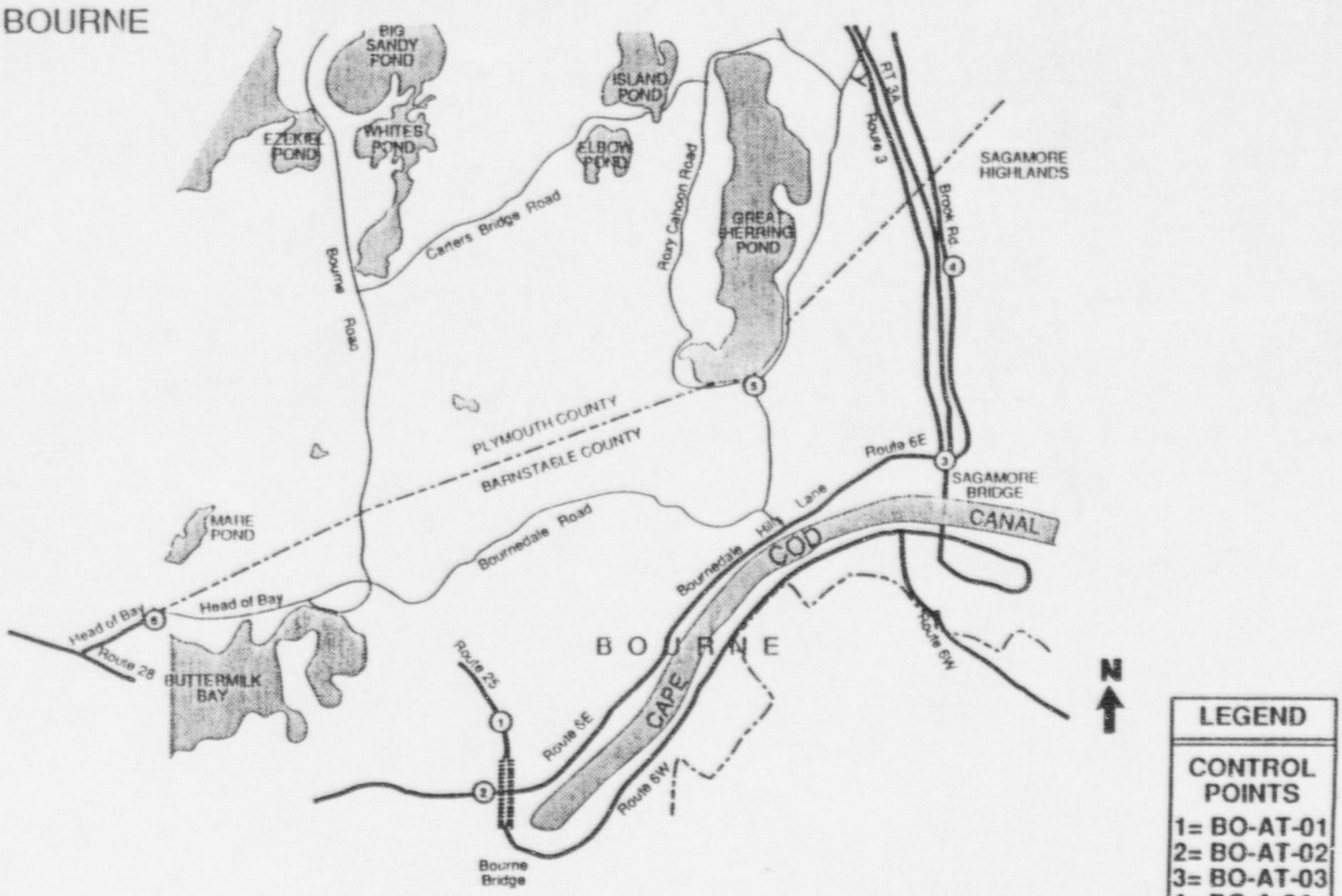


Figure I-BO-1. Traffic and Access Control Points
Bourne

Table I-BO-1. Location, Manpower, and Equipment Requirements for All Traffic and Access Control Points

TOWN: Bourne

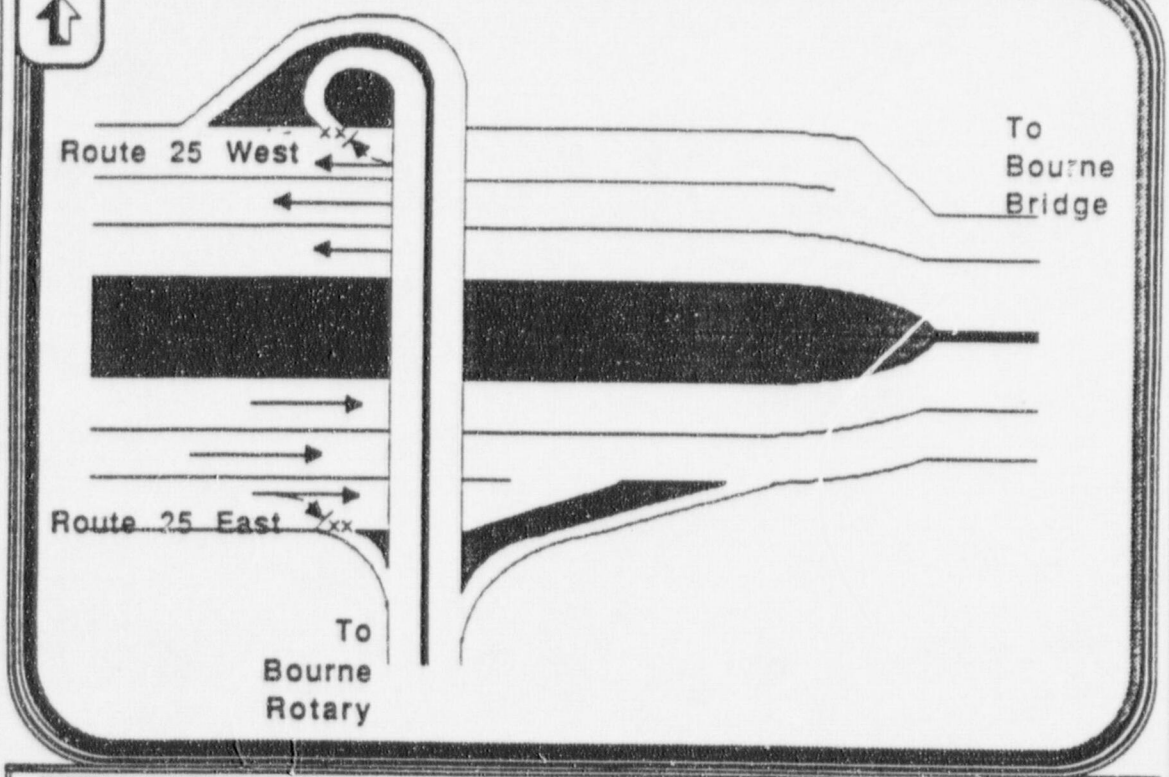
ACP	Location	Agency Priority	Guides	Cones	Barricades	Lights
BO-AT-01	Bourne Rotary & Rte. 25	S-1			4	4
BO-AT-02	Bourne Rotary	S-1	2	2	2	2
BO-AT-03	Sagamore Rotary	S-1	2	2	5	5
BO-A-04	Brook Rd. & Manomet Rd.	BO-4		2	1	1
BO-A-05	Little Sandy Pond Rd. & Herring Pond Rd.	BO-4		4	2	2
BO-A-06	Bourne Rd. & Head of Bay Rd.	BO-4		2	1	1

Table I-BO-2. Allocation of Access Control Points to Towns

TOWN: Bourne

ACCESS CONTROL POINT	ACTIVATED FOR FOLLOWING REGIONS:
BO-AT-01	All regions except 15, 16, & 17
BO-AT-02	All regions except 15, 16, & 17
BO-AT-03	All regions except 15, 16, & 17
BO-A-04	7, 8, 9, 22
BO-A-05	7, 8, 9, 22
BO-A-06	7, 8, 9, 22

Point No. BO-AT-01



Location:
Route 25 & Bourne Rotary (Bourne)

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

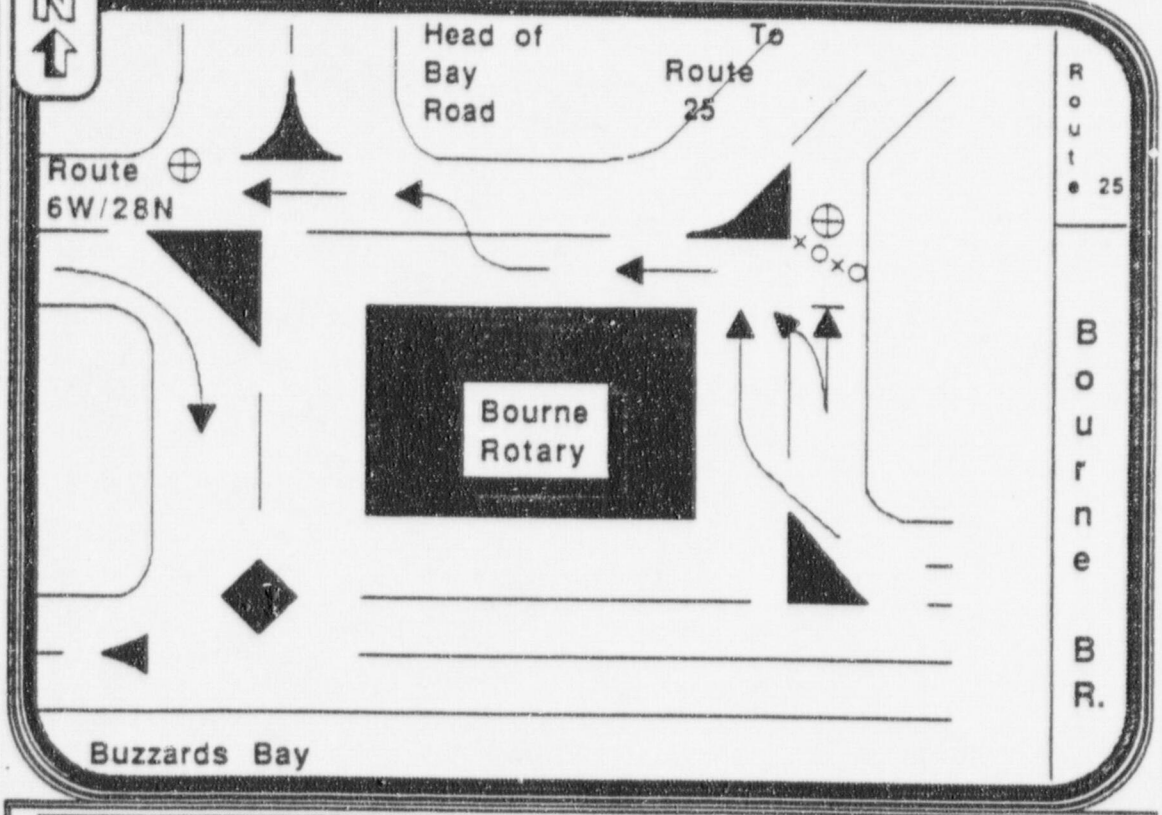
Manpower/Equipment:

4 Traffic Barricades

Description:

Discourage traffic exiting off Route 25 onto the Bourne Rotary.

BO-AT-02



Location:
Bourne Rotary

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- ⊕ Traffic guide
- ○ Traffic cone
- × Traffic barricade

Manpower/Equipment:

2 Traffic Guides

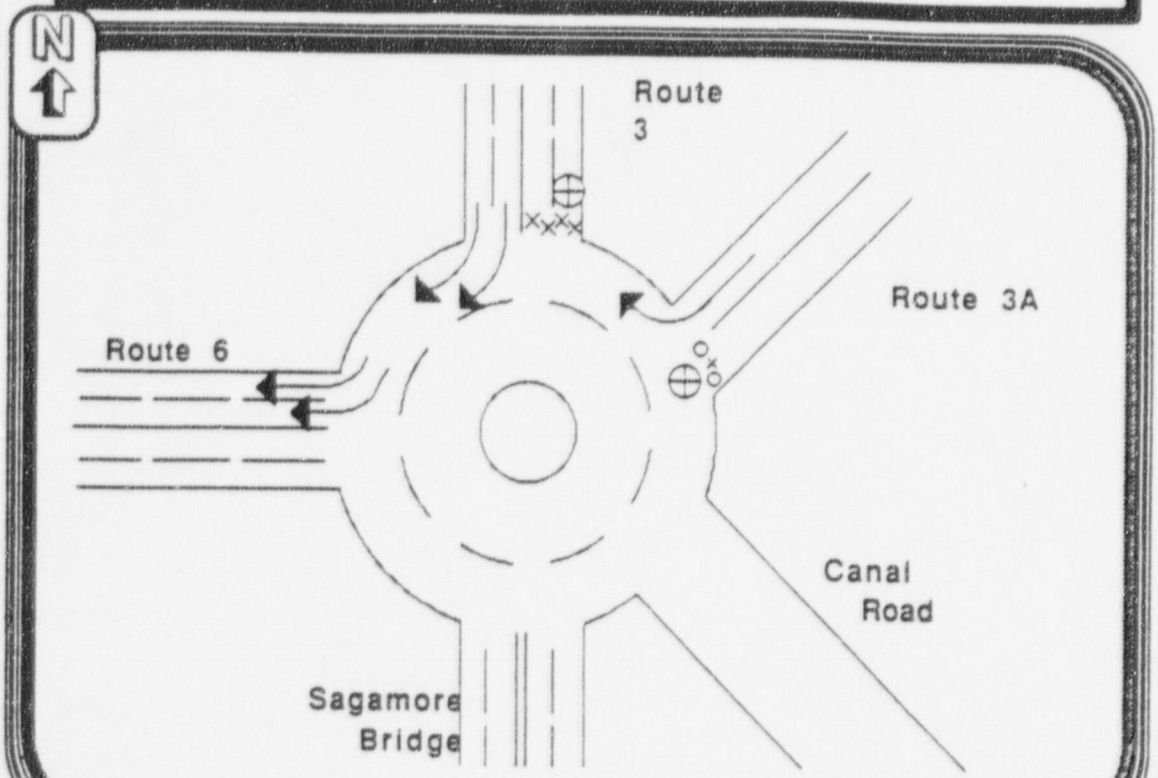
2 Traffic Cones

2 Traffic Barricades

Description:

Facilitate westbound traffic on Route 6W. Discourage traffic to Route 25 and the Bourne Bridge.

Point No. BO-AT-03



Location:
Rotary, North of Sagamore Bridge (Bourne)

Priority: 1

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

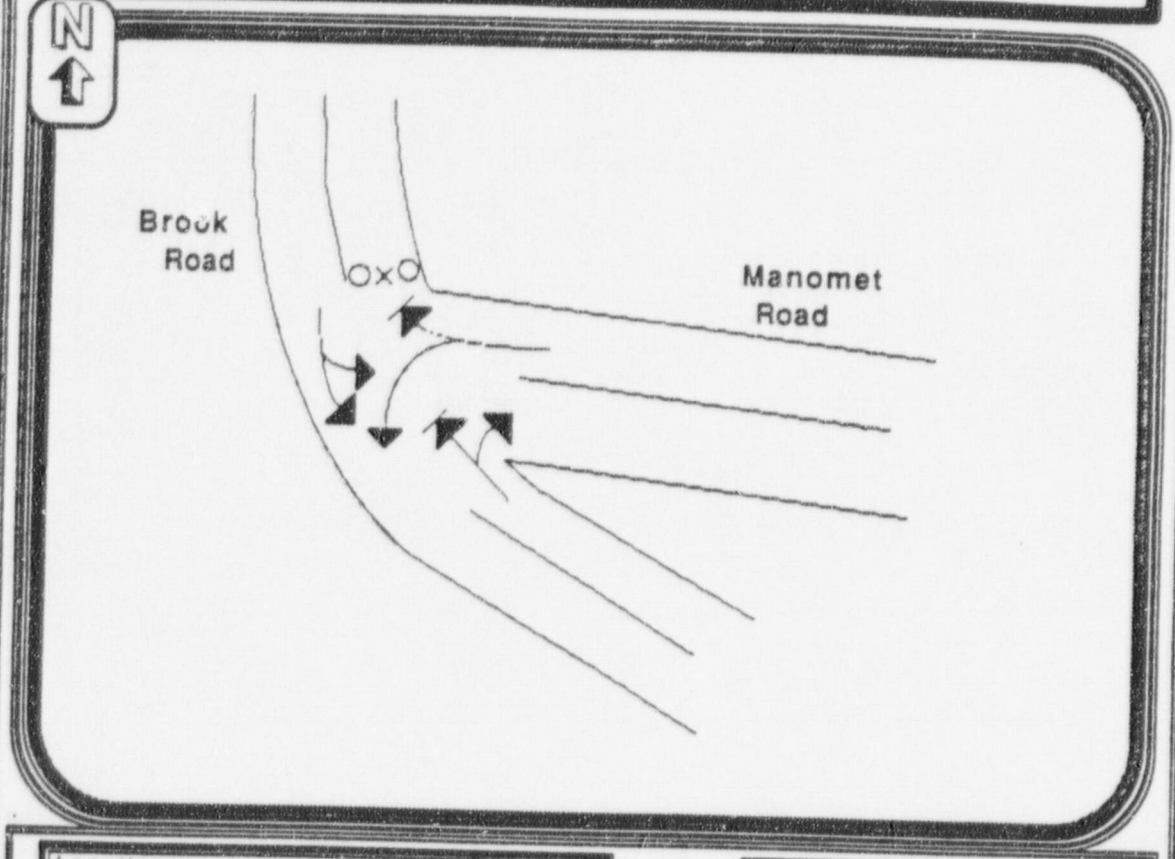
Manpower/Equipment:

2 Traffic Guides
2 Traffic Cones
5 Traffic Barricades

Description:

Facilitate traffic moving onto Route 6 west. Discourage northbound traffic on Routes 3 and 3A.

Point No. BO-A-04



Location:
Brook Road & Manomet Road (Bourne)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

2 Traffic Cones

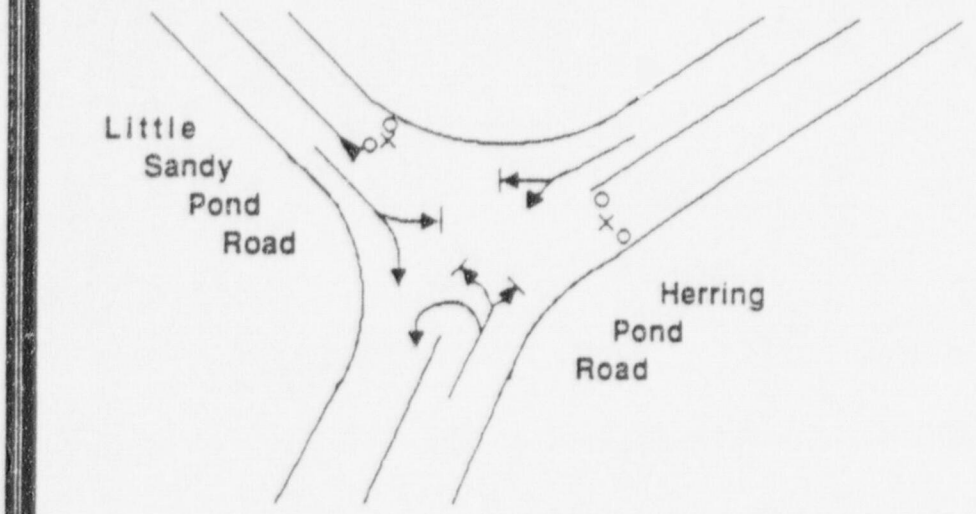
1 Traffic Barricade

Description:

Discourage northbound traffic on Brook Road.

BOU-ACP-BO-A-04

Point No. BO-A-05



Location:
Little Sandy Pond Road & Herring Pond Road
(Bourne)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

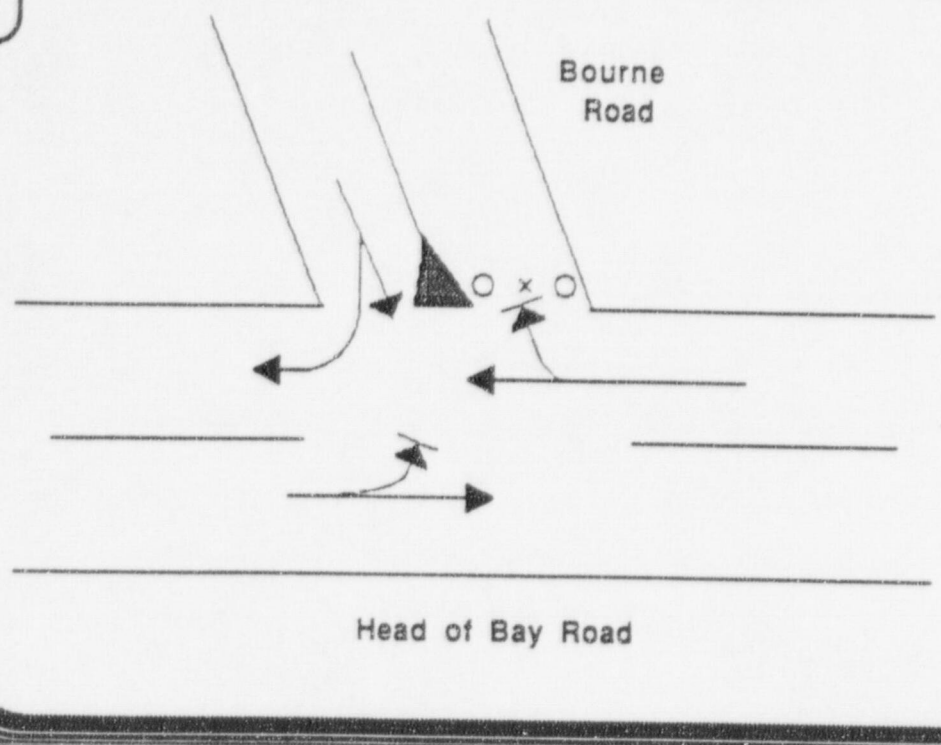
4 Traffic Cones

2 Traffic Barricades

Description:

Discourage northbound traffic on Herring Pond Road and Little Sandy Pond Road.

Point No. BO-A-06



Location:
Bourne Road & Head of Bay Road (Bourne)

Priority: 4

KEY

- Movement facilitated
- Movement discouraged
- Traffic guide
- Traffic cone
- Traffic barricade

Manpower/Equipment:

2 Traffic Cones

1 Traffic Barricade

Description:

Discourage northbound traffic on Bourne Road.

BOU-ACP-BO-A-06

I-BO-10
END

SANDWICH

I-SA-1

Table I-SA-1. Location, Manpower, and Equipment Requirements for All Traffic and Access Control Points

TOWN: Sandwich

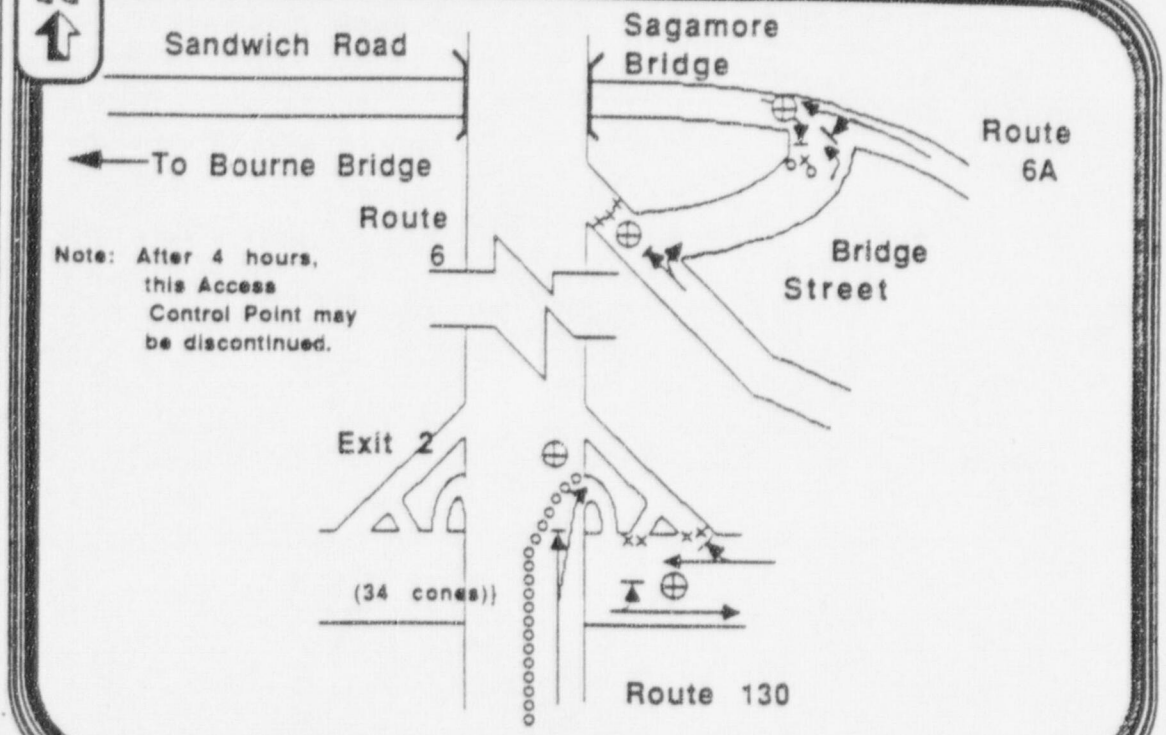
ACP	Location	Agency Priority	Guides	Cones	Barricades	Lights
SA-A-01	Sagamore Bridge Approaches	SA-1 (May-Sept) SA-3 (Oct-Apr)	4	36	8	19

Table I-SA-2. Allocation of Access Control Points to Towns

TOWN: Sandwich

ACCESS CONTROL POINT	ACTIVATED FOR FOLLOWING REGIONS:
SA-A-01	All regions

Point No. SA-A-01



Location:
Sagamore Bridge approaches (Sandwich)

Priority: 1 (May-Sept.) 3 (Oct.-Apr.)

KEY

- Movement facilitated
- Movement discouraged
- ⊕ Traffic guide
- ○ Traffic cone
- × Traffic barricade

Manpower/Equipment:

4 Traffic Guides
36 Traffic Cones
8 Traffic Barricades

Description:

The Sagamore Bridge should be closed for 4 hours after an order to evacuate is issued. Discourage traffic from proceeding north on Route 6 at Exit 2 (Route 130). Direct traffic east on Route 130 to Route 6A and then to the Bourne Bridge on Sandwich Rd. Discourage traffic approaching the Sagamore Bridge from Bridge Street and the Route 6A access road.

APPENDIX J

Description of Evacuation Routes

Evacuation Routes to Taunton High School Reception Center
From Subareas 1,2,3,5,6

SUBAREAS 1, 2, 3 OR 5 - ALL IN PLYMOUTH:

(or if you have school children at school in Plymouth)

Take Route 3 or 3A South to Route 6 (Cranberry Highway) West, to Route 25/495. Follow Route 25/495 West to Route 24 South. Follow Route 24 South to Route 140 North. Go North on Route 140 to Williams Street. Turn right on Williams Street. Follow Williams Street to the Owen Riverway. Turn left and follow the Owen Riverway to the **Taunton High School Reception Center**.

SUBAREA 6 - PLYMOUTH:

(or if you have school children at school in Plymouth)

Take Route 44 West to Route 24 South to Route 140 North. Go North on Route 140 to Williams Street. Turn right on Williams Street. Follow Williams Street to the Owen Riverway. Turn left and follow the Owen Riverway to the **Taunton High School Reception Center**.

Or, take Route 44 West to Route 58 South to Route 495 North. Follow Route 495 North to Route 24 South. Follow Route 24 South to Route 140 North. Go North on Route 140 to Williams Street. Turn right on Williams Street. Follow Williams Street to the Owen Riverway. Turn left and follow the Owen Riverway to the **Taunton High School Reception Center**.

Evacuation Routes to Bridgewater State College Reception Center From Subareas 7,8,11

SUBAREA 7 - PLYMOUTH:

Note: If you are in Subarea 7 and have children at school in Plymouth, follow directions for Subarea 6 to the Taunton High School. If you do not have children at school in Plymouth, use the following directions:

Take Route 44 West to Route 58. Turn right and follow Route 58 North to Route 106 West. Turn left and follow Route 106 West to Route 104 West. Turn left and follow Route 104 West to Great Hill Drive. Turn left on Great Hill Drive and follow signs to the **Bridgewater State College Reception Center**.

Or, take Route 3 North to Route 53 North. Follow Route 53 North to Route 123 West. Follow Route 123 West to Route 18 South. Follow Route 18 South to East Street in East Bridgewater. Turn left on East Street to Hayward Street to Whitman Street. Turn left on Whitman Street to Route 104 West. Turn right on Route 104 West to Great Hill Drive. Turn left on Great Hill Drive and follow signs to the **Bridgewater State College Reception Center**.

Evacuation Routes to Bridgewater State College Reception Center From Subareas 7,8,11
(Concluded)

SUBAREA 8 - KINGSTON:

Take Route 106 West to Route 104 West. Turn left and follow Route 104 West to Great Hill Drive. Turn left on Great Hill Drive and follow signs to the **Bridgewater State College Reception Center**.

Or, take Brook Street to Elm Street West to Brook Street in Plympton. Follow Brook Street to Colchester Road. Turn right on Colchester Road to Mayflower Road West to Route 58 North to Route 106 West. Follow Route 106 West to Route 104 West to Great Hill Drive. Turn left on Great Hill Drive and follow signs to the **Bridgewater State College Reception Center**.

Or, take Route 27 North to Route 14 West to Route 18 South. Follow Route 18 South to East Street in East Bridgewater. Turn left on East Street to Hayward Street to Whitman Street. Turn left on Whitman Street to Route 104 West. Turn right on Route 104 West to Great Hill Drive. Turn left on Great Hill Drive and follow signs to the **Bridgewater State College Reception Center**.

SUBAREA 11 - CARVER:

Take Route 58 North to Route 106 West. Take Route 106 West to Route 104 West. Follow Route 104 West to Great Hill Drive. Turn left on Great Hill Drive and follow signs to the **Bridgewater State College Reception Center**.

Or, take Route 58 South to Route 495 North to Exit 5 to Route 18 North. Continue on Route 18 North to Flagg Street. Turn right on Flagg Street and proceed across Summer Street where Flagg Street becomes Auburn Street. Proceed on Auburn Street to Laurel Street. Turn left on Laurel Street to Water Street. Turn right on Water Street to Wood Street. Turn left on Wood Street to Route 104 West. Turn left and follow Route 104 West to Great Hill Drive. Turn left on Great Hill Drive and follow signs to the **Bridgewater State College Reception Center**.

Evacuation Routes to Braintree High School Reception Center From Subareas 4, 9, and 10

Subarea # 4 - Duxbury Beach, Saquish Neck, Gurnet Point, Clark's Island:

Take Route 3A North to Route 123 West to Route 53 South. Turn left on Route 53 South to Route 3 North. Turn right on Route 3 North to Exit 20, Route I-93 South (Rt.. 128 North). Take I-93 South (Rt.. 128 North) to Exit 6 (Route 37, Braintree). Turn right on Route 37 past South Shore Plaza and proceed towards Braintree Five Corners. Bear right at Braintree Five Corners onto Granite Street. Turn left onto Town Street at Granite Plaza to the **Braintree Reception Center at Braintree High School**.

Subarea # 9 - Duxbury:

Take Route 3 North to Exit 20, Route I-93 South (Rt. 128 North). Take I-93 South (Rt.. 128 North) to Exit 6 (Route 37, Braintree). Turn right on Route 37 past South Shore Plaza and proceed towards Braintree Five Corners. Bear right at Braintree Five Corners onto Granite Street. Turn left onto Town Street at Granite Plaza to the **Braintree Reception Center at Braintree High School**.

Subarea # 10 - Marshfield:

Take Route 3A North to Route 139. Turn left onto Route 139 West and proceed to Route 3 North. Alternatively, proceed west on Route 139 to Route 58. Turn right (north) on Route 58 and proceed to Route 18 North. Take Route 18 north to Route 3. Take Route 3 North to Exit 20, Route I-93 South (Rt. 128 North). Take I-93 South (Rt.. 128 North) to Exit 6 (Route 37, Braintree). Turn right on Route 37 past South Shore Plaza and proceed towards Braintree Five Corners. Bear right at Braintree Five Corners onto Granite Street. Turn left onto Town Street at Granite Plaza to the **Braintree Reception Center at Braintree High School**

Notes on Evacuation Routing

The evacuation routes identified in this Appendix represents a set of **major** evacuation routes leaving the EPZ. It is recognized that other evacuation routes exist and will be used by people who live in the area. For example, Kingston residents along Parting Ways Road could proceed west to Route 58, then north to Route 106 where they may join a major evacuation route to Bridgewater. The traffic modeling and resultant ETE estimation is based upon the use of both major and minor evacuation routes.

APPENDIX K

Evacuation Route Maps

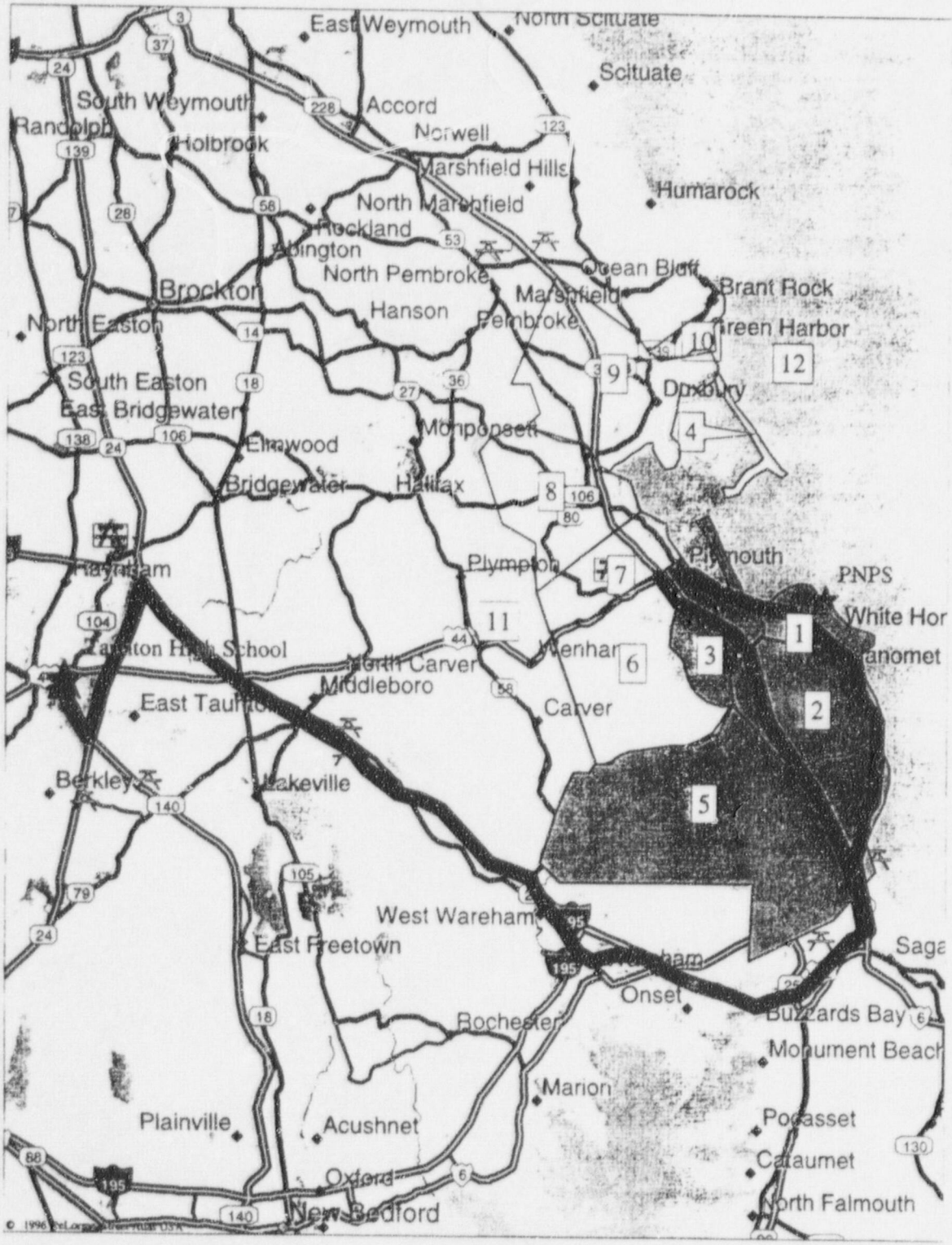


Figure K-1. Evacuation Route Map for
Plymouth Subareas 1, 2, 3, 5



Figure K-2. Evacuation Route Map for
Plymouth Subarea 6

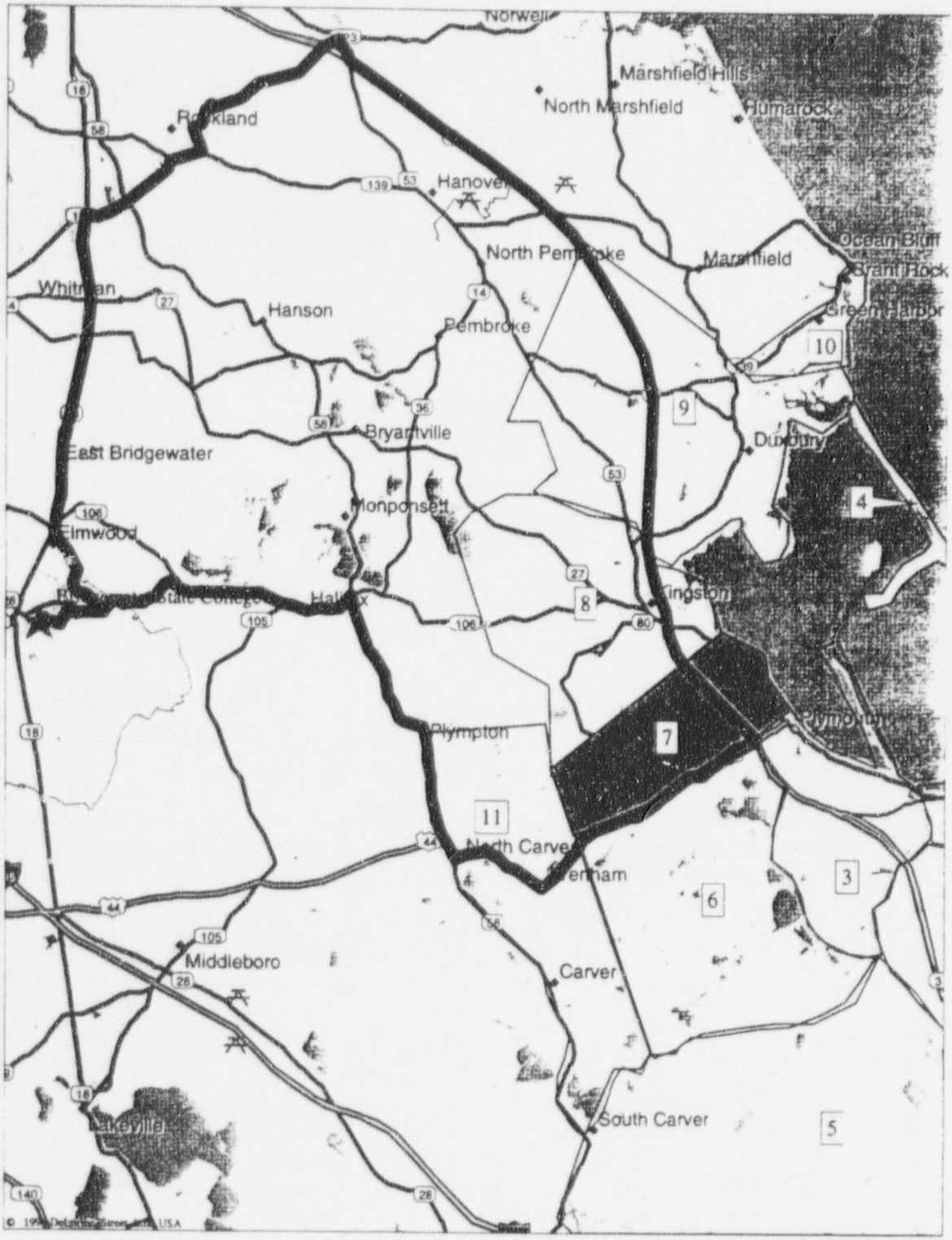


Figure K-3. Evacuation Route Map for
Plymouth Subarea 7

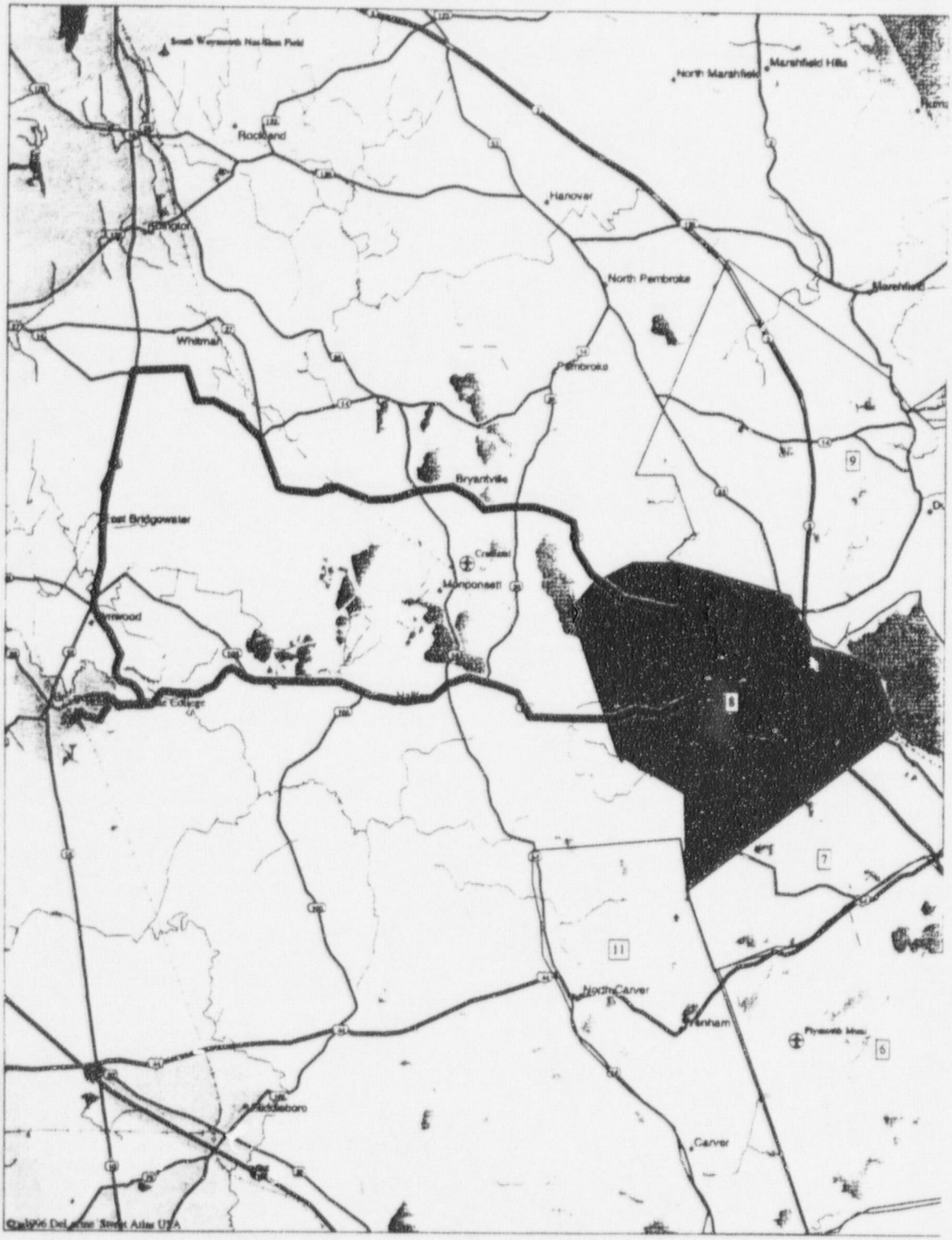


Figure K-4. Evacuation Route Map for
Kingston Subarea 8

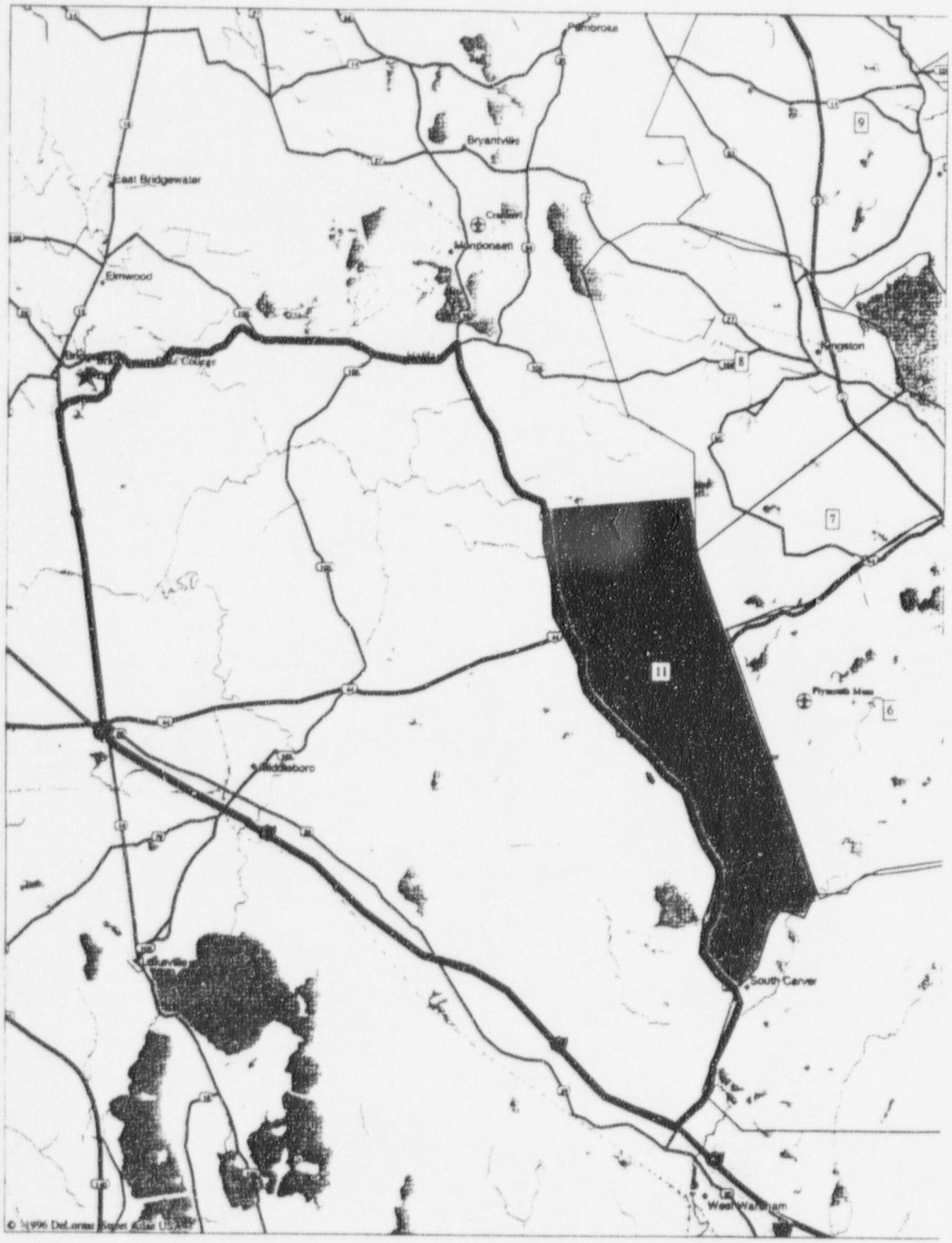


Figure K-5. Evacuation Route for
Carver Subarea 11

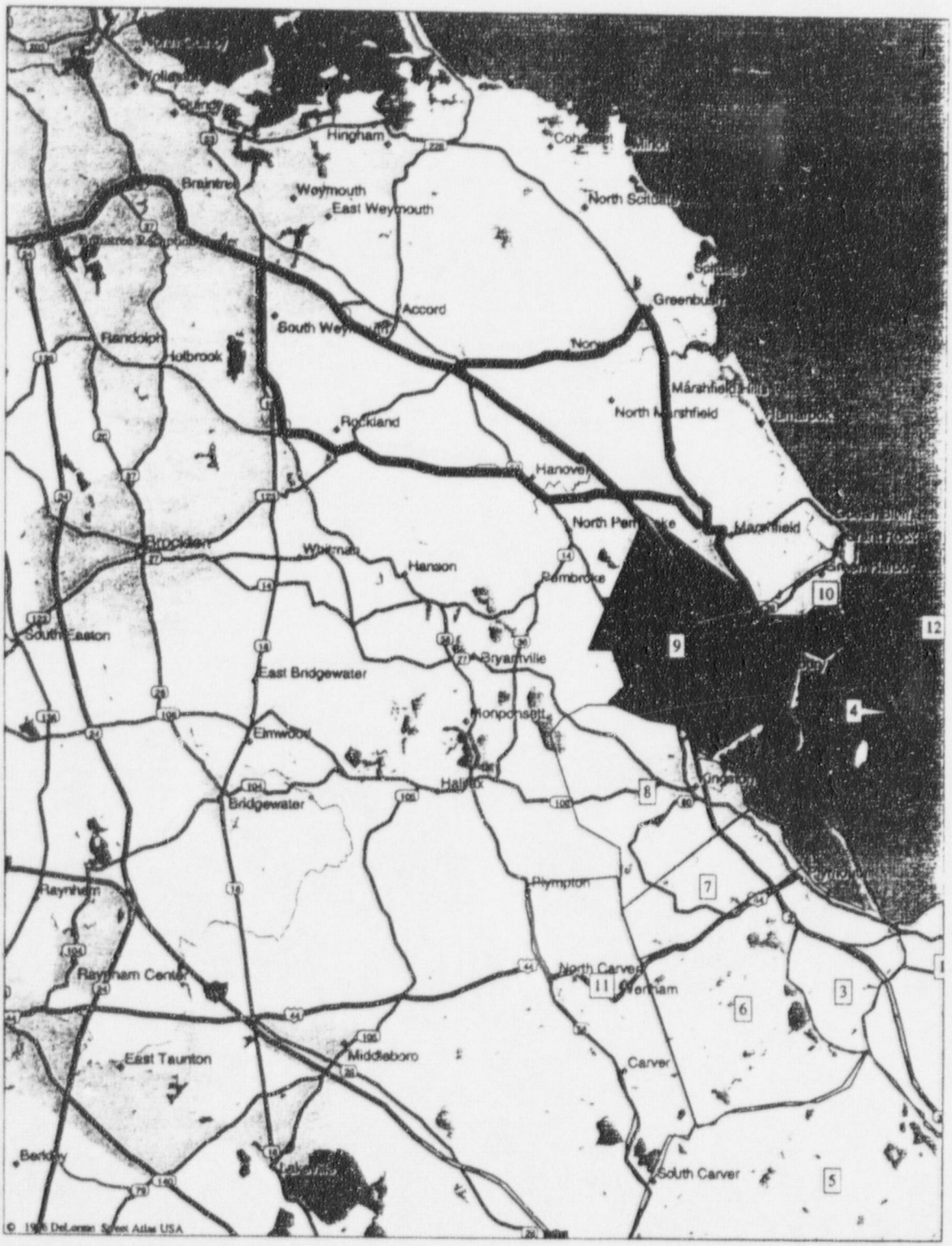


Figure K-6. Evacuation Route Map for
Gurnet Point, Clark's Island, Duxbury Subareas 4,9

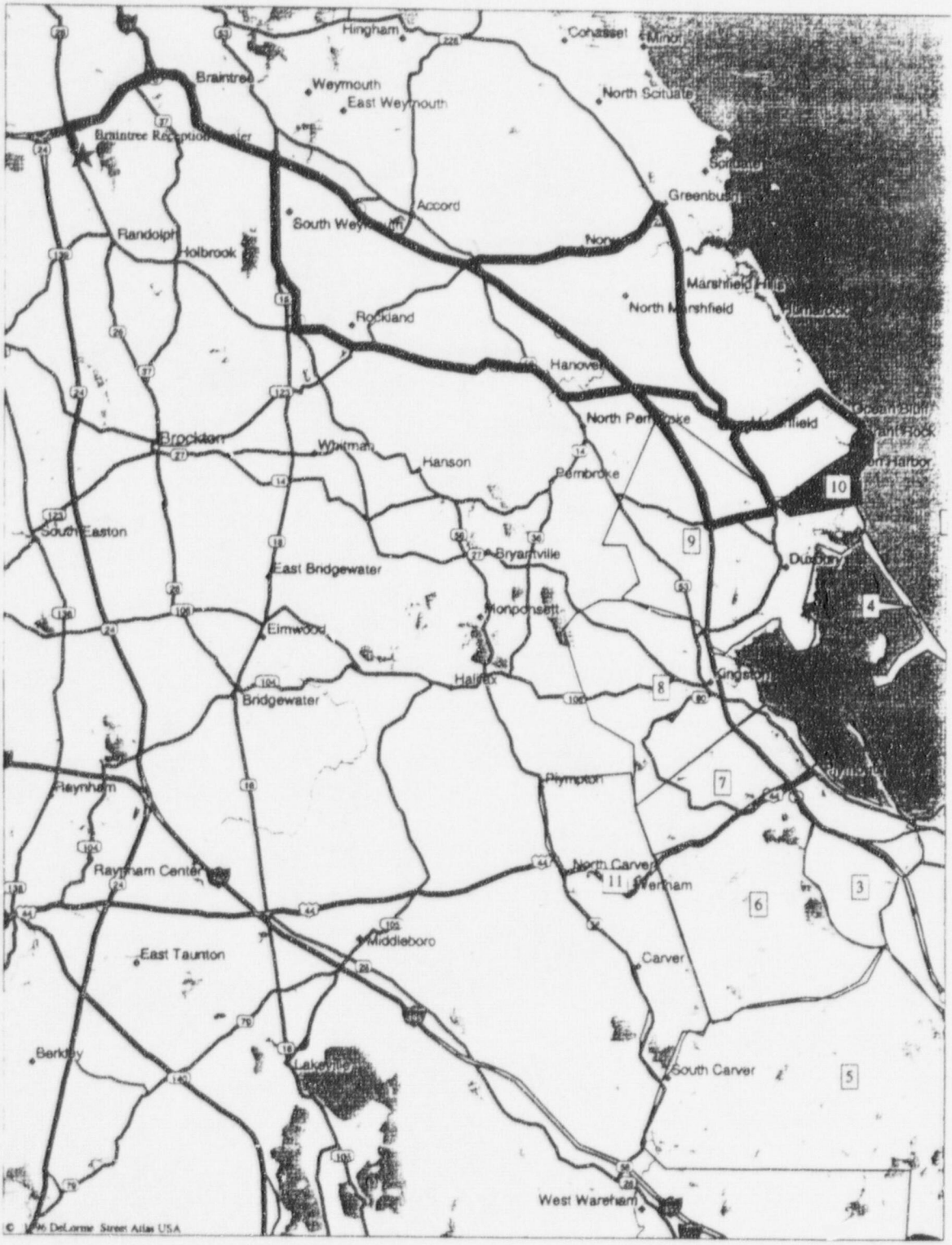


Figure K-7. Evacuation Route Map for
Marshfield Subarea 10

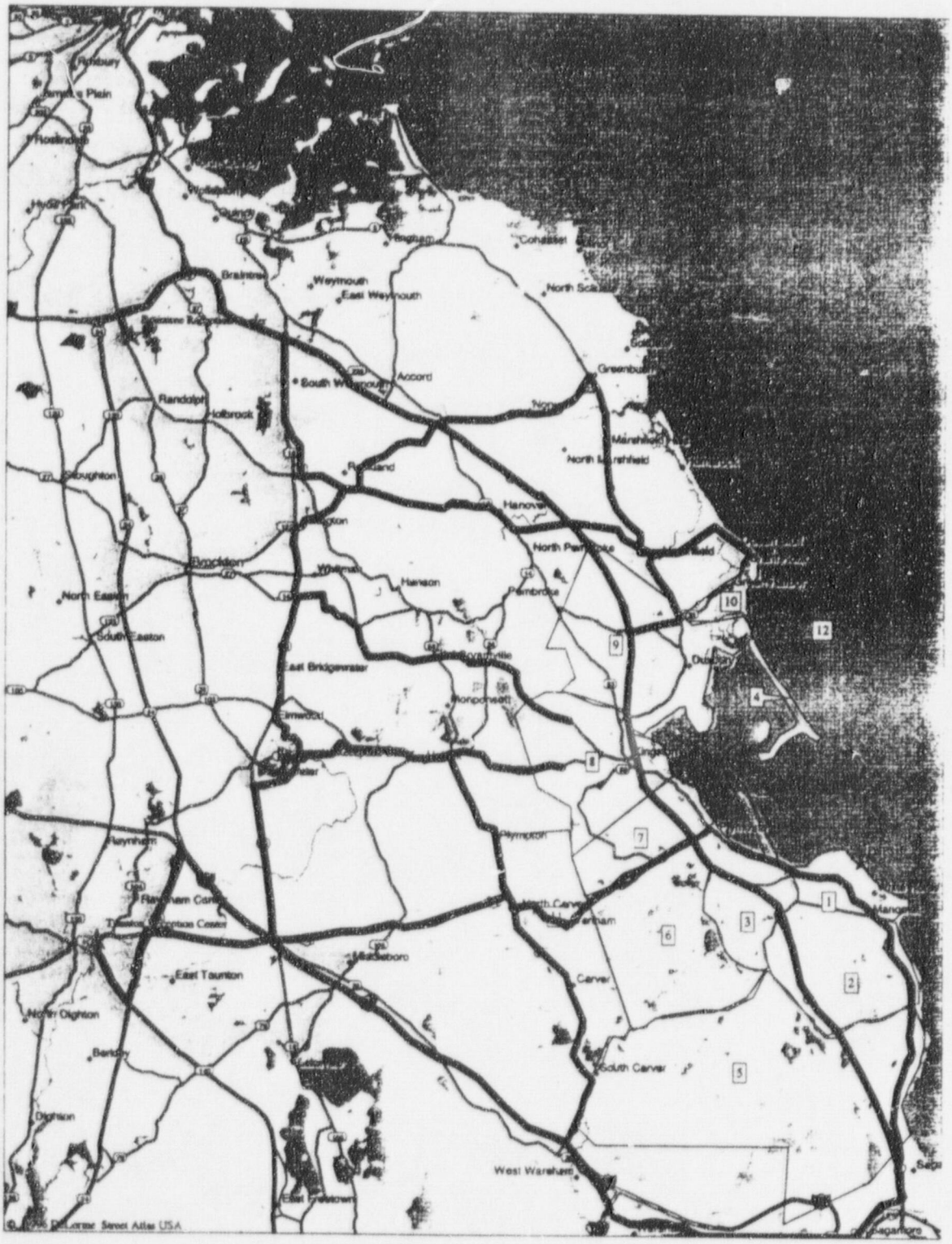


Figure K-8. Summary Evacuation Route Map

APPENDIX L

ACCESS CONTROL ACTIVATION

Access Control Point Activation

Region	Communities										
	Bourne	Carver	Duxbury	Route 3	Kingston	Marshfield	Plymouth	Pembroke	Plympton	Sandwich	Wareham
1	BO-AT-01		D-AT-08	Weymouth	K-AT-05A		P-AT-13A	PE-A-01		SA-A-01	
	BO-AT-02		D-AT-09A	WY-T-01	K-AT-06A		P-AT-16A				
	BO-AT-03						P-AT-19A				
				Hingham			P-AT-20				
				HG-AT-01			P-AT-21A				
							P-AT-22A				
				Rockland			P-AT-24				
				RK-AT-05			P-AT-25				
							P-AT-27				
				Hanover			P-A-28				
				HA-AT-01			P-A-29				
							P-A-30				
							P-A-31				
							P-A-32				
							P-A-33				
							P-A-34				
							P-A-35				
							P-A-37				
							P-A-38				

Access Control Point Activation

Region	Communities										
	Bourne	Carver	Duxbury	Route 3	Kingston	Marshfield	Plymouth	Pembroke	Plympton	Sandwich	Wareham
2	BO-AT-01 BO-AT-02 BO-AT-03		D-AT-08 D-AT-09A	Weymouth WY-T-01 Hingham HG-AT-01 Rockland RK-AT-05 Hanover HA-AT-01	K-AT-05A K-AT-06A		P-AT-13A P-AT-16A P-AT-19A P-AT-20 P-AT-21A P-AT-22A P-AT-23B P-AT-25 P-AT-26 P-AT-27 P-A-36A P-A-37 P-A-38 P-A-39 P-A-40 P-A-41 P-A-42 P-A-43 P-A-44 P-A-45	PE-A-01		SA-A-01	

Access Control Point Activation

Region	Communities										
	Bourne	Carver	Duxbury	Route 3	Kingston	Marshfield	Plymouth	Pembroke	Plympton	Sandwich	Wareham
3	BO-AT-01		D-AT-08	Weymouth	K-AT-05A		P-AT-13A	PE-A-01		SA-A-01	
	BO-AT-02		D-AT-09A	WY-T-01	K-AT-06A		P-AT-16A				
	BO-AT-03						P-AT-17				
				Hingham			P-AT-18				
				HG-AT-01			P-AT-19A				
							P-AT-20				
				Rockland			P-AT-21A				
				RK-AT-05			P-AT-22A				
							P-AT-23A				
				Hanover			P-AT-25				
				HA-AT-01			P-AT-26				
							P-AT-27				
							P-A-39				
							P-A-40				
							P-A-41				
							P-A-42				
							P-A-43				
							P-A-44				
							P-A-45				
							P-A-49				
							P-A-50				
							P-A-51				
							P-A-52				
							P-A-53				
							P-A-54				
							P-A-55				

Access Control Point Activation

Communities

Region	Bourne	Carver	Duxbury	Route 3	Kingston	Marshfield	Plymouth	Pembroke	Plympton	Sandwich	Wareham
4	BO-AT-01		D-AT-08	Weymouth	K-AT-05A		P-AT-13A	PE-A-01		SA-A-01	
	BO-AT-02		D-AT-09A	WY-T-01	K-AT-06A		P-AT-16A				
	BO-AT-03						P-AT-17				
				Hingham			P-AT-18				
				HG-AT-01			P-AT-19A				
							P-AT-20				
				Rockland			P-AT-21A				
				RK-AT-05			P-AT-22A				
							P-AT-23A				
				Hanover			P-AT-24				
				HA-AT-01			P-AT-25				
							P-AT-27				
							P-A-28				
							P-A-29				
							P-A-30				
							P-A-31				
							P-A-32				
							P-A-33				
							P-A-34				
							P-A-35				
							P-A-36B				
							P-A-37				
							P-A-46				
							P-A-47				
							P-A-48				
							P-A-49				
							P-A-50				
							P-A-51				
							P-A-52				
							P-A-53				
							P-A-54				
							P-A-55				

Access Control Point Activation

Region	Communities										
	Bourne	Carver	Duxbury	Route 3	Kingston	Marshfield	Plymouth	Pembroke	Plympton	Sandwich	Wareham
5	BO-AT-01		D-AT-08	Weymouth	K-AT-05A		P-AT-13A	PE-A-01		SA-A-01	
	BO-AT-02		D-AT-09A	WY-T-01	K-AT-06A		P-AT-16A				
	BO-AT-03		D-AT-10				P-AT-17				
			D-AT-11	Hingham			P-AT-18				
				HG-AT-01			P-AT-19A				
							P-AT-20				
				Rockland			P-AT-21A				
				RK-AT-05			P-AT-22A				
							P-AT-23A				
				Hanover			P-AT-24				
				HA-AT-01			P-AT-25				
							P-AT-27				
							P-A-28				
							P-A-29				
							P-A-30				
							P-A-31				
							P-A-32				
							P-A-33				
							P-A-34				
							P-A-35				
							P-A-36B				
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Access Control Point Activation

Communities

Region	Bourne	Carver	Duxbury	Route 3	Kingston	Marshfield	Plymouth	Pembroke	Plympton	Sandwich	Wareham
6	BO-AT-01		D-AT-08	Weymouth	K-AT-05A		P-AT-13A	PE-A-01		SA-A-01	
	BO-AT-02		D-AT-09A	WY-T-01	K-AT-06A		P-AT-16A				
	BO-AT-03		D-AT-10				P-AT-19A				
			D-AT-11	Hingham			P-AT-20				
				HG-AT-01			P-AT-21A				
							P-AT-22A				
				Rockland			P-AT-24				
				RK-AT-05			P-AT-25				
							P-AT-27				
				Hanover			P-A-28				
				HA-AT-01			P-A-29				
							P-A-30				
							P-A-31				
							P-A-32				
							P-A-33				
							P-A-34				
							P-A-35				
							P-A-37				
							P-A-38				

Access Control Point Activation

Region	Communities										
	Bourne	Carver	Duxbury	Route 3	Kingston	Marshfield	Plymouth	Pembroke	Plympton	Sandwich	Wareham
7	BO-AT-01		D-AT-08	Weymouth	K-AT-05A		P-AT-13A	PE-A-01		SA-A-01	WA-A-03
	BO-AT-02		D-AT-09A	WY-T-01	K-AT-06A		P-AT-16A				WA-A-04
	BO-AT-03						P-AT-19A				WA-A-05
	BO-A-04			Hingham			P-AT-20				WA-A-06
	BO-A-05			HG-AT-01			P-AT-21A				
	BO-A-06						P-AT-22A				
				Rockland			P-AT-23B				
				RK-AT-05			P-AT-25				
							P-AT-27				
				Hanover			P-A-36A				
				HA-AT-01			P-A-37				
							P-A-38				
							P-A-56				
							P-A-57				
							P-A-58				
							MS-AT-01				
							MS-AT-02A				
							MS-AT-03A				
							MS-AT-04				
							MS-AT-05A				
							MS-AT-06				
							MS-AT-07				

Access Control Point Activation

	Communities										
Region	Bourne	Carver	Duxbury	Route 3	Kingston	Marshfield	Plymouth	Pembroke	Plympton	Sandwich	Wareham
8	BO-AT-01	C-A-13A	D-AT-08	Weymouth	K-AT-05A		P-AT-13A	PE-A-01	PP-A-01	SA-A-01	WA-AT-01
	BO-AT-02	C-A-14	D-AT-09A	WY-T-01	K-AT-06A		P-AT-15B				WA-A-02
	BO-AT-03	C-A-15					P-AT-16A				WA-A-03
	BO-A-04	C-A-16		Hingham			P-AT-17				WA-A-04
	BO-A-05			HG-AT-01			P-AT-19A				WA-A-05
	BO-A-06						P-AT-20				WA-A-06
				Rockland			P-AT-21A				
				RK-AT-05			P-AT-22A				
							P-AT-25				
				Hanover			P-AT-27				
				HA-AT-01			P-A-52				
							P-A-53				
							P-A-54				
							P-A-55				
							P-A-56				
							P-A-57				
							P-A-58				
							P-A-59A				
							P-A-60				
							P-A-61				

Access Control Point Activation

Region	Communities										
	Bourne	Carver	Duxbury	Route 3	Kingston	Marshfield	Plymouth	Pembroke	Plympton	Sandwich	Wareham
9	BO-AT-01	C-AT-02	D-AT-08	Weymouth	K-AT-05A		P-AT-13A	PE-A-01		SA-A-01	WA-AT-01
	BO-AT-02	C-AT-03	D-AT-09A	WY-T-01	K-AT-06A		P-AT-15B				WA-A-02
	BO-AT-03	C-AT-04					P-AT-16A				WA-A-03
	BO-A-04	C-A-05		Hingham			P-AT-17				WA-A-04
	BO-A-05	C-A-06		HG-AT-01			P-AT-19A				WA-A-05
	BO-A-06	C-A-07					P-AT-20				WA-A-06
		C-A-08		Rockland			P-AT-21A				
		C-A-09		RK-AT-05			P-AT-22A				
		C-A-10					P-AT-25				
		C-A-11		Hanover			P-AT-27				
		C-A-12		HA-AT-01			P-A-52				
		C-A-13B					P-A-53				
							P-A-54				
							P-A-55				
							P-A-56				
							P-A-57				
							P-A-58				
							P-A-59A				
							P-A-60				
							P-A-61				

Access Control Point Activation

Communities

Region	Bourne	Carver	Duxbury	Route 3	Kingston	Marshfield	Plymouth	Pembroke	Plympton	Sandwich	Wareham
10	BO-AT-01	C-A-13A	D-AT-08	Weymouth	K-AT-05A		P-AT-25	PE-A-01	PP-A-01	SA-A-01	WA-AT-01
	BO-AT-02	C-A-14	D-AT-09B	WY-T-01	K-AT-06A		P-AT-26				WA-A-02
	BO-AT-03	C-A-15					P-AT-27				WA-A-03
		C-A-16		Hingham			P-A-39				
				HG-AT-01			P-A-40				
							P-A-41				
				Rockland			P-A-42				
				RK-AT-05			P-A-43				
							P-A-44				
				Hanover			MS-AT-01				
				HA-AT-01			MS-AT-02B				
							MS-AT-03B				
							MS-AT-05B				
							MS-AT-08				
							MS-AT-09				
							MS-AT-10				
							MS-AT-11				
							MS-AT-12				

Access Control Point Activation

Communities

Region	Bourne	Carver	Duxbury	Route 3	Kingston	Marshfield	Plymouth	Pembroke	Plympton	Sandwich	Wareham
11	BO-AT-01	C-AT-02	D-AT-08	Weymouth	K-AT-04A		P-AT-25		PP-A-01	SA-A-01	WA-AT-01
	BO-AT-02	C-AT-03	D-AT-09B	WY-T-01	K-AT-05A		P-AT-26				WA-A-02
	BO-AT-03	C-AT-04			K-AT-06A		P-AT-27				WA-A-03
		C-A-05		Hingham	K-A-16A		P-A-39				
		C-A-06		HG-AT-01	K-A-17		P-A-40				
		C-A-07					P-A-41				
		C-A-08		Rockland			P-A-42				
		C-A-09		RK-AT-05			P-A-43				
		C-A-10					P-A-44				
		C-A-11		Hanover			P-A-70				
		C-A-12		HA-AT-01			MS-AT-01				
		C-A-13A					MS-AT-02B				
							MS-AT-03B				
							MS-AT-05B				
							MS-AT-08				
							MS-AT-09				
							MS-AT-10				
							MS-AT-11				
							MS-AT-12				

Access Control Point Activation

Region	Communities										
	Bourne	Carver	Duxbury	Route 3	Kingston	Marshfield	Plymouth	Pembroke	Plympton	Sandwich	Wareham
12	BO-AT-01	C-AT-02	D-AT-08	Weymouth	K-AT-05A		P-AT-13A	PE-A-01		SA-A-01	WA-AT-01
	BO-AT-02	C-AT-03	D-AT-09A	WY-T-01	K-AT-06A		P-AT-16A				WA-A-02
	BO-AT-03	C-AT-04	D-A-12		K-A-07		P-AT-19A				WA-A-03
		C-A-05		Hingham	K-A-08		P-AT-20				
		C-A-06		HG-AT-01	K-A-09		P-AT-21A				
		C-A-07			K-A-10		P-AT-22A				
		C-A-08		Rockland	K-A-11A		P-AT-23A				
		C-A-09		RK-AT-05	K-A-12A		P-AT-24				
		C-A-10			K-A-13A		P-AT-25				
		C-A-11		Hanover	K-A-15A		P-AT-27				
		C-A-12		HA-AT-01			P-A-28				
		C-A-13A					P-A-29				
							P-A-30				
							P-A-31				
							P-A-32				
							P-A-33				
							P-A-34				
							P-A-35				
							P-A-36B				
							P-A-37				
							P-A-46				
							P-A-47				
							P-A-48				
							MS-AT-01				
							MS-AT-02B				
							MS-AT-03B				
							MS-AT-05B				
							MS-A-08				
							MS-A-09				
							MS-A-10				
							MS-A-11				

Access Control Point Activation

Region	Communities										
	Bourne	Carver	Duxbury	Route 3	Kingston	Marshfield	Plymouth	Pembroke	Plympton	Sandwich	Wareham
13	BO-AT-01	C-AT-02	D-AT-07B	Weymouth	K-AT-05A	M-A-17	P-AT-13A	PE-A-01	PP-A-01	SA-A-01	WA-AT-01
	BO-AT-02	C-AT-03	D-AT-08	WY-T-01	K-AT-06A		P-AT-16A	PE-A-02	PP-A-02		WA-A-02
	BO-AT-03	C-AT-04	D-AT-09A		K-A-07		P-AT-19A	PE-A-03	PP-A-03		WA-A-03
		C-A-05		Hingham	K-A-08		P-AT-20	PE-A-04			
		C-A-06		HG-AT-01	K-A-09		P-AT-21A	PE-A-05			
		C-A-07			K-A-10		P-AT-22A	PE-A-06			
		C-A-08		Rockland			P-AT 23A	PE-A-07			
		C-A-09		RK-AT-05			P-AT-24	PE-A-08			
		C-A-10					P-AT-25				
		C-A-11		Hanover			P-AT-27				
		C-A-12		HA-AT-01			P-A-28				
							P-A-29				
							P-A-30				
							P-A-31				
							P-A-32				
							P-A-33				
							P-A-34				
							P-A-35				
							P-A-36B				
							P-A-37				
							P-A-46				
							P-A-47				
							P-A-48				
							MS-AT-02B				
							MS-AT-03B				
							MS-AT-05B				
							MS-A-08				
							MS-A-09				
							MS-A-10				
							MS-A-11				
							MS-A-12				

Access Control Point Activation

Communities

Region	Bourne	Carver	Duxbury	Route 3	Kingston	Marshfield	Plymouth	Pembroke	Plympton	Sandwich	Wareham
14	BO-AT-01	C-A-13A	D-AT-07B	Weymouth	K-AT-05A	M-A-17	P-AT-13A	PE-A-01	PP-A-01	SA-A-01	WA-AT-01
	BO-AT-02	C-A-14	D-AT-08	WY-T-01	K-AT-06A		P-AT-16A	PE-A-02	PP-A-02		WA-A-02
	BO-AT-03	C-A-15	D-AT-09A		K-A-07		P-AT-19A	PE-A-03	PP-A-03		WA-A-03
		C-A-16		Hingham	K-A-08		P-AT-20	PE-A-04			
				HG-AT-01	K-A-09		P-AT-21A	PE-A-05			
					K-A-10		P-AT-22A	PE-A-06			
				Rockland			P-AT-23A	PE-A-07			
				RK-AT-05			P-AT-24	PE-A-08			
							P-AT-25				
				Hanover			P-AT-27				
				HA-AT-01			P-A-28				
							P-A-29				
							P-A-30				
							P-A-31				
							P-A-32				
							P-A-33				
							P-A-34				
							P-A-35				
							P-A-36B				
							P-A-37				
							P-A-46				
							P-A-47				
							P-A-48				
							MS-AT-02B				
							MS-AT-03B				
							MS-AT-05B				
							MS-A-08				
							MS-A-09				
							MS-A-10				
							MS-A-11				
							MS-A-12				

Access Control Point Activation

Region	Communities										
	Bourne	Carver	Duxbury	Route 3	Kingston	Marshfield	Plymouth	Pembroke	Plympton	Sandwich	Wareham
15		C-A-13A	D-AT-07B	Weymouth	K-AT-05A	M-A-17	P-AT-13A	PE-A-01	PP-A-01	SA-A-01	
			D-AT-08	WY-T-01	K-AT-06A		P-AT-14B	PE-A-02	PP-A-02		
			D-AT-09A		K-A-07		P-AT-16B	PE-A-03	PP-A-03		
				Hingham	K-A-08		P-AT-18	PE-A-04			
				HG-AT-01	K-A-09		P-AT-19A	PE-A-05			
					K-A-10		P-AT-20	PE-A-06			
				Rockland			P-AT-21A	PE-A-07			
				RK-AT-05			P-AT-22A	PE-A-08			
							P-AT-23A				
				Hanover			P-AT-24				
				HA-AT-01			P-AT-25				
							P-AT-27				
							P-A-28				
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							P-A-36B				
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							P-A-51				
							P-A-59B				
							P-A-62				
							P-A-63				
							P-A-64				
							P-A-65				
							P-A-66				
							P-A-67				
							P-A-68				

Access Control Point Activation

Region	Communities										
	Bourne	Carver	Duxbury	Route 3	Kingston	Marshfield	Plymouth	Pembroke	Plympton	Sandwich	Wareham
16		C-A-13A	D-AT-07B	Weymouth	K-AT-05A	M-A-17	P-AT-13A	PE-A-01	PP-A-01	SA-A-01	
			D-AT-08	WY-T-01	K-AT-06A		P-AT-14B	PE-A-02	PP-A-02		
			D-AT-09A		K-A-07		P-AT-16B	PE-A-03	PP-A-03		
				Hingham	K-A-08		P-AT-18	PE-A-04			
				HG-AT-01	K-A-09		P-AT-19A	PE-A-05			
					K-A-10		P-AT-20	PE-A-06			
				Rockland			P-AT-21A	PE-A-07			
				RK-AT-05			P-AT-22A	PE-A-08			
							P-AT-23A				
				Hanover			P-AT-24				
				HA-AT-01			P-AT-25				
							P-AT-27				
							P-A-28				
							P-A-29				
							P-A-30				
							P-A-31				
							P-A-32				
							P-A-33				
							P-A-34				
							P-A-35				
							P-A-36B				
							P-A-37				
							P-A-46				
							P-A-47				
							P-A-48				
							P-A-49				
							P-A-50				
							P-A-51				
							P-A-59B				
							P-A-62				
							P-A-63				
							P-A-64				
							P-A-65				
							P-A-66				
							P-A-67				
							P-A-68				

Access Control Point Activation

Region	Communities										
	Bourne	Carver	Duxbury	Route 3	Kingston	Marshfield	Plymouth	Pembroke	Plympton	Sandwich	Wareham
17		C-A-13A	D-AT-07B	Weymouth	K-AT-05A	M-AT-04	P-AT-13A	PE-A-01	PP-A-01	SA-A-01	
			D-AT-08	WY-T-01	K-AT-06A	M-AT-05	P-AT-14B	PE-A-02	PP-A-02		
			D-AT-09A		K-A-07	M-AT-06	P-AT-16B	PE-A-03	PP-A-03		
				Hingham	K-A-08	M-AT-07	P-AT-18	PE-A-04			
				HG-AT-01	K-A-09	M-A-08	P-AT-19A	PE-A-05			
					K-A-10	M-A-09	P-AT-20	PE-A-06			
				Rockland		M-A-10	P-AT-21A	PE-A-07			
				RK-AT-05		M-A-11	P-AT-22A	PE-A-08			
						M-A-12	P-AT-23A				
				Hanover		M-A-13	P-AT-24				
				HA-AT-01		M-A-14	P-AT-25				
						M-A-15	P-AT-27				
						M-A-16	P-A-28				
							P-A-29				
							P-A-30				
							P-A-31				
							P-A-32				
							P-A-33				
							P-A-34				
							P-A-35				
							P-A-36B				
							P-A-37				
							P-A-46				
							P-A-47				
							P-A-48				
							P-A-49				
							P-A-50				
							P-A-51				
							P-A-59B				
							P-A-62				
							P-A-63				
							P-A-64				
							P-A-65				
							P-A-66				
							P-A-67				
							P-A-68				

Access Control Point Activation

Communities

Region	Bourne	Carver	Duxbury	Route 3	Kingston	Marshfield	Plymouth	Pembroke	Plympton	Sandwich	Wareham
18	BO-AT-01	C-A-12	D-AT-07B	Weymouth	K-AT-05A	M-AT-04	P-AT-13B	PE-A-01	PP-A-01	SA-A-01	
	BO-AT-02	C-A-13A	D-AT-08	WY-T-01	K-AT-06A	M-AT-05	P-AT-16B	PE-A-02	PP-A-02		
	BO-AT-03		D-AT-09A		K-A-07	M-AT-06	P-AT-17	PE-A-03	PP-A-03		
				Hingham	K-A-08	M-AT-07	P-AT-18	PE-A-04			
				HG-AT-01	K-A-09	M-A-08	P-AT-19A	PE-A-05			
					K-A-10	M-A-09	P-AT-20	PE-A-06			
				Rockland	K-A-16B	M-A-10	P-AT-21A	PE-A-07			
				RK-AT-05		M-A-11	P-AT-22A	PE-A-08			
						M-A-12	P-AT-23A				
				Hanover		M-A-13	P-AT-24				
				HA-AT-01		M-A-14	P-AT-25				
						M-A-15	P-AT-27				
						M-A-16	P-A-28				
							P-A-29				
							P-A-30				
							P-A-31				
							P-A-32				
							P-A-33				
							P-A-34				
							P-A-35				
							P-A-36B				
							P-A-37				
							P-A-46				
							P-A-47				
							P-A-48				
							P-A-49				
							P-A-50				
							P-A-51				
							P-A-52				
							P-A-53				
							P-A-54				
							P-A-55				
							P-A-69				

Access Control Point Activation

Region	Communities										
	Bourne	Carver	Duxbury	Route 3	Kingston	Marshfield	Plymouth	Pembroke	Plympton	Sandwich	Wareham
19	BO-AT-01		D-AT-07B	Weymouth	K-AT-04B	M-AT-04	P-AT-13B	PE-A-01		SA-A-01	
	BO-AT-02		D-AT-08	WY-T-01	K-AT-05B	M-AT-05	P-AT-16B	PE-A-02			
	BO-AT-03		D-AT-09B		K-AT-06B	M-AT-06	P-AT-19B	PE-A-03			
				Hingham	K-A-11B	M-AT-07	P-AT-20	PE-A-04			
				HG-AT-01	K-A-12B	M-A-08	P-AT-21B	PE-A-05			
					K-A-13B	M-A-09	P-AT-22B	PE-A-06			
				Rockland	K-A-14	M-A-10	P-AT-24	PE-A-07			
				RK-AT-05	K-A-15B	M-A-11	P-AT-25	PE-A-08			
						M-A-12	P-AT-27				
				Hanover		M-A-13	P-A-28				
				HA-AT-01		M-A-14	P-A-29				
						M-A-15	P-A-30				
						M-A-16	P-A-31				
							P-A-32				
							P-A-33				
							P-A-34				
							P-A-35				
							P-A-37				
							P-A-38				

Access Control Point Activation

Region	Communities										
	Bourne	Carver	Duxbury	Route 3	Kingston	Marshfield	Plymouth	Pembroke	Plympton	Sandwich	Wareham
20	BO-AT-01		D-AT-08	Weymouth	K-AT-05A	M-AT-04	P-AT-13A	PE-A-01		SA-A-01	
	BO-AT-02		D-AT-09A	WY-T-01	K-AT-06A	M-AT-05	P-AT-16A				
	BO-AT-03		D-AT-10			M-AT-06	P-AT-19A				
				Hingham		M-AT-07	P-AT-20				
				HG-AT-01		M-A-08	P-AT-21A				
						M-A-09	P-AT-22A				
				Rockland		M-A-10	P-AT-24				
				RK-AT-05		M-A-11	P-AT-25				
						M-A-12	P-AT-27				
				Hanover		M-A-13	P-A-28				
				HA-AT-01		M-A-14	P-A-29				
						M-A-15	P-A-30				
						M-A-16	P-A-31				
							P-A-32				
							P-A-33				
							P-A-34				
							P-A-35				
							P-A-37				
							P-A-38				

Access Control Point Activation

Communities

Region	Bourne	Carver	Duxbury	Route 3	Kingston	Marshfield	Plymouth	Pembroke	Plympton	Sandwich	Wareham
21	BO-AT-01		D-AT-08	Weymouth	K-AT-05A		P-AT-13A	PE-A-01		SA-A-01	
	BO-AT-02		D-AT-09A	WY-T-01	K-AT-06A		P-AT-16A				
	BO-AT-03		D-AT-10				P-AT-17				
			D-AT-11	Hingham			P-AT-18				
				HG-AT-01			P-AT-19A				
							P-AT-20				
				Rockland			P-AT-21A				
				RK-AT-05			P-AT-22A				
							P-AT-23A				
				Hanover			P-AT-25				
				HA-AT-01			P-AT-26				
							P-AT-27				
							P-A-39				
							P-A-40				
							P-A-41				
							P-A-42				
							P-A-43				
							P-A-44				
							P-A-45				
							P-A-49				
							P-A-50				
							P-A-51				
							P-A-52				
							P-A-53				
							P-A-54				
							P-A-55				

Access Control Point Activation

Region	Communities										
	Bourne	Carver	Duxbury	Route 3	Kingston	Marshfield	Plymouth	Pembroke	Plympton	Sandwich	Wareham
22	BO-AT-01	C-AT-02	D-AT-07B	Weymouth	K-AT-05A	M-AT-04	P-AT-13A	PE-A-01	PP-A-01	SA-A-01	WA-AT-01
	BO-AT-02	C-AT-03	D-AT-08	WY-T-01	K-AT-06A	M-AT-05	P-AT-16A	PE-A-02	PP-A-02		WA-A-02
	BO-AT-03	C-AT-04	D-AT-09A		K-A-07	M-AT-06	P-AT-19A	PE-A-03	PP-A-03		WA-A-03
	BO-A-04	C-A-05		Hingham	K-A-08	M-AT-07	P-AT-20	PE-A-04			WA-A-04
	BO-A-05	C-A-06		HG-AT-01	K-A-09	M-A-08	P-AT-21A	PE-A-05			WA-A-05
	BO-A-06	C-A-07			K-A-10	M-A-09	P-AT-22A	PE-A-06			WA-A-06
		C-A-08		Rockland		M-A-10	P-AT-25	PE-A-07			
		C-A-09		RK-AT-05		M-A-11	P-AT-27	PE-A-08			
		C-A-10				M-A-12	P-A-56				
		C-A-11		Hanover		M-A-13	P-A-57				
		C-A-12		HA-AT-01		M-A-14	P-A-58				
		C-A-13A				M-A-15					
						M-A-16					

APPENDIX M

Estimated Traffic Demands at all Origin Centroids, Loading Rates and Origin-Destination Patterns

Traffic Demand for Scenarios 1,2 Total Generated Trips						
Community	Centroid	Permanent	Centroid	Employees	Centroid	Transient
Plymouth	2056	165	2250	250	2503	685
	2057	493	2253	250	2504	835
	2059	642	2254	125	2507	227
	2058	346	2255	125	2508	149
	2047	584	2257	71	2509	227
	2048	584	2259	490	2550	1205
	2043	584	2260	245	2551	177
	2044	684	2266	612	2611	99
	2045	684	2272	614	2612	75
	2046	684	2273	125	2613	218
	2051	493	2275	111	2614	196
	2052	493	2277	337	2615	1186
	2053	493	2279	340	2616	36
	2054	493	2283	565	2617	274
	2050	304	2286	225	2618	17
	2055	682	2289	395	2619	588
	2038	437	2291	162	2620	110
	2039	437	2293	80	2621	68
	2040	437	2294	80	2622	34
	2041	437	2295	242	2623	222
	2042	437			2640	12
	2043	437			2641	297
	2063	476			2642	17
	2064	476			2643	24
	2065	476			2706	90
	2060	159			2707	320
	2061	159			2715	125
	2062	159			2716	248
	2036	418			2717	248
	2037	418			2805	100
	2034	139				
	2035	139				
	2018	178				
	2019	472				
	2020	472				
	2021	472				
	2022	472				
	2023	472				
	2024	317				
	2025	317				
	2027	141				
	2026	72				
	2028	213				
	2029	623				
	2031	317				
	2030	159				
	2033	398				
	2032	190				
	2103	99				
	2104	99				
	Totals	***19332***		***5444***		***6109***

Traffic Demand for Scenarios 1,2 Total Generated Trips						
Community	Centroid	Permanent	Centroid	Employees	Centroid	Transient
Kingston	2066	692	2220	193	2403	387
	2067	692	2221	191	2404	319
	2068	692	2222	191	2502	27
	2069	692	2223	191	2607	42
	2070	692	2224	191	2608	5
	2072	246	2225	191	2610	3
	2073	246	2226	191	2710	90
	2074	246	2227	191	2804	29
	2071	124	2228	191		
			2229	100		
			2230	100		
			2231	100		
			2232	102		
			2233	101		
	Totals	***4322***		***2224***		***902***

Traffic Demand for Scenarios 1,2 Total Generated Trips						
Community	Centroid	Permanent	Centroid	Employees	Centroid	Transient
Carver	2076	208	2240	82	2401	0
	2077	210	2241	82	2402	0
	2078	210	2242	80	2552	94
	2106	210	2243	84	2553	94
	2079	210	2244	82	2626	333
	2080	210	2245	82	2701	30
	2082	151			2702	151
	2083	151				
	2084	151				
	2085	151				
	2086	151				
	2088	151				
	2089	151				
	2105	151				
	Totals	***2466***		***492***		***702***

Traffic Demand for Scenarios 1,2 Total Generated Trips						
Community	Centroid	Permanent	Centroid	Employees	Centroid	Transient
Duxbury	2007	284	2201	21	2500	530
	2008	284	2202	21	2501	524
	2001	341	2203	21	2601	90
	2002	521	2204	21	2602	14
	2003	511	2205	21	2603	7
	2004	341	2206	18	2605	8
	2013	225	2207	12	2708	280
	2014	225	2208	7	2801	39
	2012	61	2209	7	2802	39
	2016	25	2210	7	2803	38
	2017	101	2211	10		
	2107	34	2212	7		
	2108	34	2213	8		
	2015	87				
	2009	337				
	2010	337				
	2011	337				
	2110	341				
	2111	341				
	2112	341				
	2113	341				
	Totals	***5680***		***181***		***1569***

Traffic Demand for Scenarios
1, 2
Total Generated Trips

Community	Centroid	Permanent	Centroid	Employees	Centroid	Transient	
Marshfield	2101	621	2299	110	2505	620	
	2102	94			2506	285	
					2712	753	
					2800	41	
	Totals	***715***		***110***		***1699***	
Scenario Totals		***32515***		***8451***		***12981***	***53947***

Traffic Demand for Scenarios 3,4 Total Generated Trips						
Community	Centroid	Permanent	Centroid	Employees	Centroid	Transient
Plymouth	2056	165	2250	357	2503	514
	2057	493	2253	357	2504	626
	2059	642	2254	178	2507	171
	2058	346	2255	178	2508	111
	2047	584	2257	178	2509	171
	2048	584	2259	700	2550	904
	2049	584	2260	350	2551	133
	2044	684	2266	874	2611	75
	2045	684	2272	877	2612	56
	2046	684	2273	178	2613	164
	2051	493	2275	159	2614	148
	2052	493	2277	482	2615	890
	2053	493	2279	486	2616	28
	2054	493	2283	807	2617	206
	2050	304	2286	321	2618	12
	2055	682	2289	564	2619	441
	2038	437	2291	404	2620	83
	2039	437	2293	201	2621	52
	2040	437	2294	201	2622	25
	2041	437	2295	604	2623	166
	2042	437			2640	9
	2043	437			2641	223
	2063	476			2642	12
	2064	476			2643	19
	2065	476			2706	68
	2060	159			2707	240
	2061	159			2715	94
	2062	159			2716	186
	2036	418			2717	186
	2037	418			2805	75
	2034	139				
	2035	139				
	2018	178				
	2019	472				
	2020	472				
	2021	472				
	2022	472				
	2023	472				
	2024	317				
	2025	317				
	2027	141				
	2026	72				
	2028	213				
	2029	423				
	2031	317				
	2030	159				
	2033	398				
	2032	190				
	2103	99				
	2104	99				
	Totals	***19332***		***8456***		***6088***

Traffic Demand for Scenarios 3,4 Total Generated Trips						
Community	Centroid	Permanent	Centroid	Employees	Centroid	Transient
Kingston	2066	692	2220	276	2603	291
	2067	692	2221	273	2404	240
	2068	692	2222	273	2502	20
	2069	692	2223	273	2607	32
	2070	692	2224	273	2608	4
	2072	246	2225	273	2610	2
	2073	246	2226	273	2710	68
	2074	246	2227	273	2804	22
	2071	124	2228	273		
			2229	250		
			2230	250		
			2231	250		
			2232	255		
			2233	253		
	Totals	**4322**		**3718**		**679**

Traffic Demand for Scenarios
3,4
Total Generated Trips

Community	Centroid	Permanent	Centroid	Employees	Centroid	Transient
Carver	2076	208	2240	204	2401	0
	2077	210	2241	206	2402	0
	2078	210	2242	201	2552	71
	2106	210	2243	210	2553	71
	2079	210	2244	206	2626	250
	2080	210	2245	206	2701	23
	2082	151			2702	113
	2083	151				
	2084	151				
	2085	151				
	2086	151				
	2088	151				
	2089	151				
	2105	151				
	Totals	***2666***		***1233***		***528***

Traffic Demand for Scenarios 3,4 Total Generated Trips						
Community	Centroid	Permanent	Centroid	Employees	Centroid	Transient
Duxbury	2007	284	2201	30	2500	398
	2008	284	2202	30	2501	393
	2001	341	2203	30	2601	67
	2002	521	2204	30	2602	11
	2003	511	2205	30	2603	5
	2004	341	2206	26	2605	6
	2013	225	2207	17	2708	210
	2014	225	2208	17	2801	30
	2012	61	2209	17	2802	30
	2016	256	2210	17	2803	29
	2017	101	2211	26		
	2107	34	2212	17		
	2108	34	2213	21		
	2015	87				
	2009	337				
	2010	337				
	2011	337				
	2110	341				
	2111	341				
	2112	341				
	2113	341				
	Totals	*5680*		*308*		*1179*

Traffic Demand for Scenarios
3,4
Total Generated Trips

Community	Centroid	Permanent	Centroid	Employees	Centroid	Transient	
Marshfield	2101	621	2299	157	2505	465	
	2102	94			2506	214	
					2712	565	
					2800	31	
	Totals	*715*		*157*		*1275*	
Scenario Totals		*32515*		*13872*		*9749*	*56136*

Traffic Demand for Scenarios 5, 6, and 7 Total Generated Trips						
Community	Centroid	Permanent	Centroid	Employees	Centroid	Transient
Plymouth	2056	165	2250	357	2503	0
	2057	493	2253	357	2504	0
	2059	642	2254	178	2507	0
	2058	346	2255	178	2508	0
	2047	584	2257	178	2509	0
	2048	584	2259	700	2550	301
	2049	584	2260	350	2551	44
	2044	684	2266	874	2611	25
	2045	684	2272	877	2612	19
	2046	684	2273	178	2613	55
	2051	493	2275	159	2614	50
	2052	493	2277	482	2615	297
	2053	493	2279	486	2616	9
	2054	493	2283	807	2617	68
	2050	304	2286	321	2618	4
	2055	682	2289	564	2619	147
	2038	437	2291	404	2620	28
	2039	437	2293	201	2621	18
	2040	437	2294	201	2622	9
	2041	437	2295	604	2623	55
	2042	437			2640	3
	2043	437			2641	74
	2063	476			2642	4
	2064	476			2643	7
	2065	476			2706	23
	2060	159			2707	80
	2061	159			2715	31
	2062	159			2716	62
	2036	418			2717	62
	2037	418			2805	25
	2034	139				
	2035	139				
	2018	178				
	2019	472				
	2020	472				
	2021	472				
	2022	472				
	2023	472				
	2024	317				
	2025	317				
	2027	141				
	2026	72				
	2028	213				
	2029	423				
	2031	317				
	2030	159				
	2033	398				
	2032	190				
	2103	99				
	2104	99				
	Totals	*19332*		*8456*		*1500*

Traffic Demand for Scenarios 5, 6, and 7 Total Generated Trips						
Community	Centroid	Permanent	Centroid	Employees	Centroid	Transient
Kingston	2066	692	2220	276	2403	97
	2067	692	2221	273	2404	80
	2068	692	2222	273	2502	0
	2069	692	2223	273	2607	11
	2070	692	2224	273	2608	1
	2072	246	2225	273	2610	1
	2073	246	2226	273	2710	23
	2074	246	2227	273	2804	7
	2071	124	2228	273		
			2229	250		
			2230	250		
			2231	250		
			2232	255		
			2233	253		
	Totals	***4322***		***3718***		***230***

Traffic Demand for Scenarios 5, 6, and 7 Total Generated Trips						
Community	Centroid	Permanent	Centroid	Employees	Centroid	Transient
Carver	2076	208	2240	204	2401	0
	2077	210	2241	206	2402	0
	2078	210	2242	201	2552	0
	2106	210	2243	210	2553	0
	2079	210	2244	206	2626	83
	2080	210	2245	206	2701	8
	2082	151			2702	38
	2083	151				
	2084	151				
	2085	151				
	2086	151				
	2088	151				
	2089	151				
	2105	151				
	Totals	***2466***		***1233***		***129***

Traffic Demand for Scenarios 5, 6, and 7 Total Generated Trips						
Community	Centroid	Permanent	Centroid	Employees	Centroid	Transient
Duxbury	2007	284	2201	30	2500	0
	2008	284	2202	30	2501	0
	2001	341	2203	30	2601	23
	2002	521	2204	30	2602	4
	2003	511	2205	30	2603	2
	2004	341	2206	26	2605	2
	2013	225	2207	17	2708	70
	2014	225	2208	17	2801	10
	2012	61	2209	17	2802	10
	2016	256	2210	17	2803	10
	2017	101	2211	26		
	2107	34	2212	17		
	2108	34	2213	21		
	2015	87				
	2009	337				
	2010	337				
	2011	337				
	2110	341				
	2111	341				
	2112	341				
	2113	341				
	Totals	***5680***		***308***		***131***

Traffic Demand for Scenarios 5, 6, and 7 Total Generated Trips							
Community	Centroid	Permanent	Centroid	Employees	Centroid	Transient	
Marshfield	2101	621	2299	157	2505	0	
	2102	94			2506	0	
					2712	188	
					2800	10	
	Totals	***715***		***157***		***198***	
Scenario Totals		***32515***		***13872***		***2178***	***48565***

Traffic Demand for Scenarios 8, 9, and 10 Total Generated Trips						
Community	Centroid	Permanent	Centroid	Employees	Centroid	Transient
Plymouth	2056	165	2250	89	2503	0
	2057	493	2253	89	2504	0
	2059	642	2254	45	2507	0
	2058	346	2255	45	2508	0
	2047	584	2257	45	2509	0
	2048	584	2259	175	2550	301
	2049	584	2260	88	2551	44
	2044	684	2266	219	2611	25
	2045	684	2272	219	2612	19
	2046	684	2273	45	2613	55
	2051	493	2275	40	2614	50
	2052	493	2277	121	2615	297
	2053	493	2279	122	2616	9
	2054	493	2283	202	2617	68
	2050	304	2286	80	2618	4
	2055	682	2289	141	2619	147
	2038	437	2291	101	2620	28
	2039	437	2293	50	2621	18
	2040	437	2294	50	2622	9
	2041	437	2295	151	2623	55
	2042	437			2640	3
	2043	437			2641	74
	2063	476			2642	4
	2064	476			2643	7
	2065	476			2706	23
	2060	159			2707	80
	2061	159			2715	31
	2062	159			2716	62
	2036	418			2717	62
	2037	418			2800	25
	2034	139				
	2035	139				
	2018	178				
	2019	472				
	2020	472				
	2021	472				
	2022	472				
	2023	472				
	2024	317				
	2025	317				
	2027	141				
	2026	72				
	2028	213				
	2029	423				
	2031	317				
	2030	159				
	2033	398				
	2032	190				
	2103	99				
	2104	99				
	Totals	***19332***		***2117***		***1500***

Traffic Demand for Scenarios 6, 9, and 10 Total Generated Trips						
Community	Centroid	Permanent	Centroid	Employees	Centroid	Transient
Kingston	2066	692	2220	69	2403	97
	2067	692	2221	68	2404	80
	2068	692	2222	68	2502	0
	2069	692	2223	68	2607	11
	2070	692	2224	68	2608	1
	2072	246	2225	68	2610	1
	2073	246	2226	68	2710	23
	2074	246	2227	68	2804	7
	2071	124	2228	68		
			2229	63		
			2230	63		
			2231	63		
			2232	64		
			2233	63		
	Totals	4322		929		220

Traffic Demand for Scenarios 8, 9, and 10 Total Generated Trips						
Community	Centroid	Permanent	Centroid	Employees	Centroid	Transient
Carver	2076	208	2240	51	2401	0
	2077	210	2241	52	2402	1480
	2078	210	2242	50	2552	0
	2106	210	2243	53	2553	0
	2079	210	2244	52	2626	83
	2080	210	2245	52	2701	8
	2082	151			2702	38
	2083	151				
	2084	151				
	2085	151				
	2086	151				
	2088	151				
	2089	151				
	2105	151				
	Totals	***2466***		***310***		***1609***

Traffic Demand for Scenarios 8, 9, and 10 Total Generated Trips						
Community	Centroid	Permanent	Centroid	Employees	Centroid	Transient
Duxbury	2007	284	2201	8	2500	0
	2008	284	2202	8	2501	0
	2001	341	2203	8	2601	23
	2002	521	2204	8	2602	4
	2003	511	2205	8	2603	2
	2004	341	2206	7	2605	2
	2013	225	2207	4	2708	70
	2014	225	2208	4	2801	10
	2012	61	2209	4	2802	10
	2016	256	2210	4	2803	10
	2017	101	2211	7		
	2107	34	2212	4		
	2108	34	2213	5		
	2015	87				
	2009	337				
	2010	337				
	2011	337				
	2110	341				
	2111	341				
	2112	341				
	2113	341				
	Totals	***5680***		***79***		***131***

Traffic Demand for Scenarios 8, 9, and 10 Total Generated Trips							
Community	Centroid	Permanent	Centroid	Employees	Centroid	Transient	
Marshfield	2101	621	2299	39	2505	0	
	2102	94	0	0	2506	0	
					2712	188	
					2800	10	
	Totals	***715***		***39***		***198***	
Scenario Totals		***32515***		***3474***		***3658***	***39647***

APPENDIX N

Network Link Attributes

NETWORK LINK CAPACITIES AND TRAFFIC FLOW CHARACTERISTICS

LINK	LN	CAPACITY (VEH/HR)	TURN PERCENTS L	T	R	D	DIR	DESCRIPTION	COMMUNITY
(1, 2)	1	1161	100	0	0	0	W	EDISON ACCESS RD	PLYMOUTH
(1, 202)	1	200	100	0	0	0	S	EDISON ACCESS RD	PLYMOUTH
(2, 202)	1	1300	0	100	0	0	SE	ROCKY HILL RD	PLYMOUTH
(2, 4)	1	1161	0	0	100	0	W	ROCKY HILL RD	PLYMOUTH
(3, 8)	1	1161	0	0	100	0	S	ROCKY HILL RD	PLYMOUTH
(3, 435)	1	1161	0	100	0	0	NE	WARRENDALE RD	PLYMOUTH
							SE	JOHN ALDEN RD	PLYMOUTH
(4, 209)	1	1440	100	0	0	0	N	ROUTE 3A	PLYMOUTH
(5, 210)	1	1161	0	0	100	0	S	SANDWICH RD	PLYMOUTH
(5, 23)	1	1161	0	0	0	100	NW	SANDWICH RD	PLYMOUTH
(6, 85)	1	1161	0	0	100	0	S	ROXIE CAHOON RD	BOURNE
(7, 211)	2	3428	0	100	0	0	S	ROUTE 3	PLYMOUTH
(7, 34)	2	3428	0	100	0	0	N	ROUTE 3	PLYMOUTH
(8, 12)	1	1220	0	100	0	0	SW	WHITEHRSE BCH RD	PLYMOUTH
(9, 8)	1	1161	0	100	0	0	SW	WHITEHRSE BCH RD	PLYMOUTH
(9, 431)	1	1161	0	100	0	0	SE	TAYLOR AVE	PLYMOUTH
(10, 17)	1	1161	100	0	0	0	N	CLIFFORD RD	PLYMOUTH
(10, 19)	1	1161	0	100	0	0	SW	CLIFFORD RD	PLYMOUTH
(11, 31)	1	1161	100	0	0	0	E	SUMMER ST	PLYMOUTH
(11, 32)	1	1161	0	100	0	0	S	NEWFIELD ST	PLYMOUTH
							SE	BIRCH AVE	PLYMOUTH
							S	STAFFORD ST	PLYMOUTH
							SE	AVERY RD	PLYMOUTH
(11, 89)	1	1161	0	6	94	0	W	SUMMER ST	PLYMOUTH
(12, 20)	1	1440	0	100	0	0	S	ROUTE 3A	PLYMOUTH
(12, 28)	1	1161	0	100	0	0	SW	BEAVERDAM RD	PLYMOUTH
(13, 31)	1	1440	50	50	0	0	N	ROUTE 3A	PLYMOUTH
(14, 81)	1	1440	0	100	0	0	S	ROUTE 3A	PLYMOUTH
(15, 14)	1	1161	100	0	0	0	SW	MANOMET PT RD	PLYMOUTH
(15, 22)	1	220	100	0	0	0	S	MANOMET AVE	PLYMOUTH
							SW	OLD BEACH RD	PLYMOUTH
(15, 431)	1	1161	0	100	0	0	NW	TAYLOR AVE	PLYMOUTH
(16, 84)	1	1020	100	0	0	0	N	ROUTE 3A	PLYMOUTH
(17, 16)	1	1161	100	0	0	0	N	CLIFFORD RD	PLYMOUTH
(17, 5)	1	480	100	0	0	0	NW	SANDWICH RD	PLYMOUTH
(18, 210)	1	1161	100	0	0	0	N	SANDWICH RD	PLYMOUTH
(19, 27)	1	1161	0	100	0	0	SW	JORDAN RD	PLYMOUTH
(19, 18)	1	1161	0	100	0	0	NW	OLD SANDWICH RD	PLYMOUTH
(20, 22)	1	220	0	0	100	0	SW	BARLET RD	PLYMOUTH
							E	FRESH POND AVE	PLYMOUTH
(20, 14)	1	1440	0	100	0	0	S	ROUTE 3A	PLYMOUTH
(21, 46)	1	1440	0	100	0	0	S	ROUTE 3A	PLYMOUTH
(21, 44)	1	1161	0	100	0	0	W	SHIP POND RD	PLYMOUTH
(23, 90)	1	1440	0	100	0	0	N	ROUTE 3A	PLYMOUTH

L = LEFT TURN T = THROUGH MOVEMENT R = RIGHT TURN D = DIAGONAL MOVEMENT

NETWORK LINK CAPACITIES AND TRAFFIC FLOW CHARACTERISTICS

LINK	LN	CAPACITY (VEH/HR)	TURN PERCENTS L	T	R	D	DIR	DESCRIPTION	COMMUNITY
(23, 33)	1	1300	67	33	0	0	SW	OBERY ST	PLYMOUTH
(24, 47)	1	200	0	80	12	0	SW	PRINCE	PLYMOUTH
(25, 84)	1	480	0	100	0	0	S	BEACH ACCESS RD	PLYMOUTH
(26, 216)	2	3428	0	100	0	0	N	ROUTE 3	PLYMOUTH
(26, 34)	2	3428	0	100	0	0	S	ROUTE 3	PLYMOUTH
(26, 606)	1	1333	0	0	100	0	S	RAMP	PLYMOUTH
(27, 38)	1	1161	0	100	0	0	S	MAST RD	PLYMOUTH
(27, 36)	1	1161	100	0	0	0	SW	JORDAN RD	PLYMOUTH
(28, 608)	1	1161	0	100	0	0	SW	CLARK RD	PLYMOUTH
(29, 77)	1	1161	0	50	50	0	SW	KNAPP TER	PLYMOUTH
(30, 432)	1	1440	0	100	0	0	S	ROUTE 3A	PLYMOUTH
(31, 48)	1	1440	40	60	0	0	N	ROUTE 3A	PLYMOUTH
(31, 11)	1	1260	0	100	0	0	W	SUMMER ST	PLYMOUTH
(32, 13)	1	220	100	0	0	0	N	SOUTH ST	PLYMOUTH
(32, 33)	1	200	67	33	0	0	S	SOUTH ST	PLYMOUTH
(32, 11)	1	240	100	0	0	0	NW	AVERY RD	PLYMOUTH
							N	STAFFORD ST	PLYMOUTH
							NW	BIRCH AVE	PLYMOUTH
							N	NEWFIELD ST	PLYMOUTH
(33, 34)	1	1333	0	100	0	0	N	RAMP	PLYMOUTH
(33, 606)	1	1161	0	100	0	0	S	LONG POND RD	PLYMOUTH
(34, 26)	2	3428	0	100	0	0	N	ROUTE 3	PLYMOUTH
(34, 7)	2	3428	0	100	0	0	S	ROUTE 3	PLYMOUTH
(34, 33)	1	178	100	0	0	0	N	RAMP	PLYMOUTH
(35, 606)	1	1161	0	100	0	0	N	LONG POND RD	PLYMOUTH
(35, 36)	1	1161	0	100	0	0	S	LONG POND RD	PLYMOUTH
(35, 51)	1	1161	100	0	0	0	SW	GUNNER'S EXC RD	PLYMOUTH
							SW	SNAKE HILL RD	PLYMOUTH
(36, 37)	1	1161	0	0	100	0	S	LONG POND RD	PLYMOUTH
(37, 39)	1	1161	0	100	0	0	S	LONG POND RD	PLYMOUTH
(37, 51)	1	1161	100	0	0	0	SW	ALDEN RD	PLYMOUTH
(38, 39)	1	1161	0	100	0	0	S	ROCK RD	PLYMOUTH
(39, 40)	1	1161	0	100	0	0	S	LONG POND RD	PLYMOUTH
(39, 52)	1	1161	0	100	0	0	S	MAST RD	PLYMOUTH
(40, 205)	1	1161	0	100	0	0	S	LONG POND RD	PLYMOUTH
(40, 41)	1	1161	100	0	0	0	S	INDEPENDENCE RD	PLYMOUTH
(41, 42)	1	1161	100	0	0	0	E	OAR & LINE RD	PLYMOUTH
							E	CLARK RD	PLYMOUTH
							SE	LOWER LONG POND	PLYMOUTH
(41, 217)	1	1300	100	0	0	0	S	INDEPENDENCE RD	PLYMOUTH
(42, 205)	1	1161	0	0	100	0	N	LONG POND RD	PLYMOUTH
(42, 41)	1	1161	100	0	0	0	NW	LOWER LONG POND	PLYMOUTH
							W	CLARK RD	PLYMOUTH
							W	OAR & LINE RD	PLYMOUTH
(42, 53)	1	1020	0	100	0	0	S	LONG POND RD	PLYMOUTH
(43, 220)	2	3428	0	100	0	0	S	ROUTE 3	PLYMOUTH
(43, 212)	2	3428	0	100	0	0	N	ROUTE 3	PLYMOUTH

L = LEFT TURN T = THROUGH MOVEMENT R = RIGHT TURN D = DIAGONAL MOVEMENT

NETWORK LINK CAPACITIES AND TRAFFIC FLOW CHARACTERISTICS

LINK	LN	CAPACITY (VEH/HR)	TURN PERCENTS L	T	R	D	DIR	DESCRIPTION	COMMUNITY
(44, 53)	1	480	0	100	0	0	W	SHIP POND RD	PLYMOUTH
(45, 48)	2	2322	0	49	51	0	W	PARK AVE	PLYMOUTH
							W	N. PARR AVE	PLYMOUTH
(46, 54)	1	1440	0	100	0	0	S	ROUTE 3A	PLYMOUTH
(47, 56)	1	520	100	0	0	0	W	CHERRY ST	PLYMOUTH
(47, 166)	1	1440	0	100	0	0	N	ROUTE 3A	PLYMOUTH
(48, 77)	1	1440	79	21	0	0	N	ROUTE 3A	PLYMOUTH
(48, 79)	1	1440	0	100	0	0	W	ROUTE 44	PLYMOUTH
(49, 219)	1	1161	0	0	100	0	W	LITTLE POND RD	PLYMOUTH
							W	FED FURNACE RD	PLYMOUTH
(50, 72)	1	740	100	0	0	0	W	KINGS POND	PLYMOUTH
								PLAIN RD	PLYMOUTH
(50, 213)	1	1161	100	0	0	0	S	SOUTH POND RD	PLYMOUTH
							SW	ROCKY POND RD	PLYMOUTH
(51, 91)	1	1161	0	100	0	0	SW	LOWER COL PD RD	PLYMOUTH
(51, 58)	1	1161	0	100	0	0	SW	UPPER COL PD RD	PLYMOUTH
(52, 218)	1	1161	0	100	0	0	S	MAST RD	PLYMOUTH
(53, 68)	1	1161	0	100	0	0	S	LONG POND RD	PLYMOUTH
(53, 217)	1	200	0	100	0	0	W	HERRING WAY	PLYMOUTH
							SW	HALFWAY POND RD	PLYMOUTH
(54, 60)	1	1440	0	100	0	0	S	ROUTE 3A	PLYMOUTH
(55, 56)	1	871	0	100	0	0	N	RAMP	PLYMOUTH
(55, 164)	2	3428	0	100	0	0	N	ROUTE 3	PLYMOUTH
									KINGSTON
(55, 216)	2	3428	0	100	0	0	S	ROUTE 3	PLYMOUTH
(56, 47)	1	200	100	0	0	0	E	CHERRY ST	PLYMOUTH
(56, 55)	1	1333	0	100	0	0	N	RAMP	PLYMOUTH
(57, 433)	2	2880	0	100	0	0	W	ROUTE 44	PLYMOUTH
(57, 229)	2	2240	0	0	100	0	E	ROUTE 44	PLYMOUTH
(58, 207)	1	1161	0	0	100	0	SW	UPPER COL PD RD	PLYMOUTH
(59, 66)	1	1161	0	100	0	0	S	BOURNE RD	PLYMOUTH
(60, 69)	1	1440	0	50	0	50	S	ROUTE 3A	PLYMOUTH
(61, 79)	1	1161	0	0	100	0	S	STANDISH ST	PLYMOUTH
(62, 70)	2	2880	0	87	13	0	W	ROUTE 44	PLYMOUTH
(62, 63)	1	1300	0	100	0	0	S	SEVEN HILLS RD	PLYMOUTH
(63, 71)	1	1161	0	100	0	0	SW	S. MEADOW RD	PLYMOUTH
(63, 72)	1	760	0	100	0	0	S	FED FURNACE RD	PLYMOUTH
(64, 50)	1	1160	0	100	0	0	SW	WATER COURSE RD	PLYMOUTH
(65, 91)	1	1161	0	0	100	0	S	BARE HILL RD	PLYMOUTH
(66, 73)	1	1161	0	100	0	0	S	BOURNE RD	PLYMOUTH
(66, 239)	1	1161	0	100	0	0	SW	LAKEVIEW BLVD	PLYMOUTH
							NW	WHITE ISLAND PD	PLYMOUTH
(67, 6)	1	1161	0	100	0	0	S	VALLEY RD	PLYMOUTH
							S	ROXIE CAHOON RD	PLYMOUTH
							S	CEDARVILLE RD	PLYMOUTH
(68, 74)	1	1161	0	100	0	0	S	LONG POND RD	PLYMOUTH
(69, 223)	1	1161	100	0	0	0	SW	HERRING POND RD	PLYMOUTH
(69, 87)	1	1440	0	100	0	0	S	ROUTE 3A	PLYMOUTH

L = LEFT TURN T = THROUGH MOVEMENT R = RIGHT TURN D = DIAGONAL MOVEMENT

NETWORK LINK CAPACITIES AND TRAFFIC FLOW CHARACTERISTICS

LINK	LN	CAPACITY (VEH/HR)	TURN PERCENTS L	T	R	D	DIR	DESCRIPTION	COMMUNITY
(70, 78)	1	1260	0	100	0	0	W	ROUTE 44	PLYMOUTH
(70, 76)	1	1333	0	100	0	0	W	ROUTE 80	PLYMOUTH
(71, 78)	1	240	100	0	0	0	N	MONTGOMERY DR	PLYMOUTH
(71, 224)	1	1161	0	100	0	0	SW	S. MEADOW RD	PLYMOUTH
(72, 125)	1	1161	0	100	0	0	S	FED FURNACE RD	PLYMOUTH
							S	TREMONT RD	CARVER
(73, 82)	1	1161	0	100	0	0	S	BOURNE RD	PLYMOUTH
(74, 87)	1	1161	0	100	0	0	S	LONG POND RD	PLYMOUTH
							S	WADSWORTH RD	PLYMOUTH
(74, 223)	1	1161	0	0	100	0	N	HERRING POND RD	PLYMOUTH
(75, 401)	2	3423	0	100	0	0	S	ROUTE 3	BOURNE
(75, 220)	2	3428	0	100	0	0	N	ROUTE 3	PLYMOUTH
(76, 162)	1	1333	0	100	0	0	NW	ROUTE 80	KINGSTON
(76, 142)	1	1161	0	100	0	0	W	PARTING WAYS	KINGSTON
(77, 56)	1	980	100	0	0	0	W	OLMSTEAD TERR	PLYMOUTH
							NW	GOULD RD	PLYMOUTH
							W	LIBERTY HILL ST	PLYMOUTH
							NW	OCEAN AVE	PLYMOUTH
							W	NICKS ROCK RD	PLYMOUTH
(77, 47)	1	1300	23	77	0	0	N	ROUTE 3A	PLYMOUTH
(78, 88)	1	1440	0	100	0	0	W	ROUTE 44	PLYMOUTH
(78, 71)	1	1161	0	0	100	0	S	MONTGOMERY DR	PLYMOUTH
(79, 229)	2	2240	34	66	0	0	W	ROUTE 44	PLYMOUTH
(80, 166)	1	1161	0	0	100	0	2	BOUNDARY ST	KINGSTON
(81, 22)	1	1280	0	100	0	0	S	ROUTE 3A	PLYMOUTH
(82, 402)	1	1161	0	0	100	0	S	BAY RD	BOURNE
(83, 237)	1	1161	0	0	100	0	SW	RED BROOK RD	WAREHAM
(84, 434)	1	1440	0	100	0	0	N	ROUTE 3A	PLYMOUTH
(84, 5)	1	1020	0	100	0	0	S	CLIFF	PLYMOUTH
(85, 403)	2	2880	0	100	0	0	SW	CRANBERRY HWY	BOURNE
(86, 56)	1	520	0	0	100	0	NE	NICKS ROCK RD	PLYMOUTH
(87, 400)	1	1440	0	0	0	100	S	ROUTE 3A	BOURNE
(88, 225)	1	1440	0	100	0	0	W	ROUTE 44	PLYMOUTH
(89, 49)	1	1161	0	100	0	0	W	SUMMER ST	PLYMOUTH
(89, 11)	1	1260	0	100	0	0	E	SUMMER ST	PLYMOUTH
(89, 215)	1	1440	100	0	0	0	N	WESTERLY RTE	PLYMOUTH
(90, 13)	1	1280	0	100	0	0	N	ROUTE 3A	PLYMOUTH
(90, 23)	1	1440	0	0	100	0	S	ROUTE 3A	PLYMOUTH
(91, 204)	1	420	0	0	100	0	SW	LOWER COL PD RD	CARVER
(92, 67)	1	1161	0	100	0	0	SE	ISLAND LAKE RD	PLYMOUTH
(93, 238)	1	320	0	100	0	0	S	PLYMOUTH AVE	WAREHAM
(97, 105)	2	3428	0	100	0	0	S	ROUTE 195	WAREHAM
(97, 100	2	3428	0	100	0	0	NW	ROUTE 25	WAREHAM
(100, 507)	1	1714	0	100	0	0	NW	ROUTE 25	WAREHAM
(102, 105)	1	1333	0	0	0	100	S	RAMP	WAREHAM

L = LEFT TURN T = THROUGH MOVEMENT R = RIGHT TURN D = DIAGONAL MOVEMENT

NETWORK LINK CAPACITIES AND TRAFFIC FLOW CHARACTERISTICS

LINK	LN	CAPACITY (VEH/HR)	TURN PERCENTS L	T	R	D	DIR	DESCRIPTION	COMMUNITY
(102, 504)	1	1440	0	100	0	0	NW	ROUTE 28	WAREHAM
(105, 234)	2	2322	0	100	0	0	S	ROUTE 195	WAREHAM
(107, 230)	2	2666	0	100	0	0	NW	ROUTE 25	WAREHAM
(107, 231)	1	1440	0	100	0	0	NW	ROUTE 28	WAREHAM
(108, 107)	3	4320	0	100	0	0	NW	ROUTE 28	WAREHAM
(109, 133)	1	1333	0	100	0	0	W	ROUTE 44	CARVER
(109, 139)	1	1440	0	100	0	0	N	ROUTE 58	CARVER PLYMPTON
(110, 109)	1	1440	90	10	0	0	N	ROUTE 58	CARVER
(110, 124)	1	1440	0	100	0	0	W	PLYMOUTH RD	CARVER
(111, 110)	1	1240	0	10	90	0	W	PLYMOUTH RD	CARVER
(112, 111)	1	1260	0	100	0	0	W	PLYMOUTH RD	CARVER
(112, 116)	1	1300	49	0	51	0	SW	WENHAM RD	CARVER
(113, 111)	1	1260	0	0	100	0	S	GATE ST	CARVER
(114, 131)	1	1440	0	100	0	0	N	ROUTE 58	CARVER
(115, 118)	1	1440	0	100	0	0	S	ROUTE 58	CARVER
(116, 117)	1	1161	0	100	0	0	S	CENTRE ST	CARVER
(116, 111)	1	240	100	0	0	0	NW	CENTRE ST	CARVER
(116, 114)	1	1161	0	0	0	100	W	PURCHASE ST	CARVER
(117, 116)	1	200	0	0	0	100	N	CENTRE ST	CARVER
(117, 119)	1	1161	0	100	0	0	S	CENTRE ST	CARVER
(117, 120)	1	200	0	0	100	0	SE	POND ST	CARVER
(118, 126)	1	1440	0	100	0	0	S	ROUTE 58	CARVER
(119, 114)	1	1440	0	100	0	0	N	ROUTE 58	CARVER
(119, 121)	1	1440	0	100	0	0	S	ROUTE 58	CARVER
(120, 121)	1	1161	0	0	6	94	SW	S. MEADOW RD	CARVER
(120, 117)	1	1161	100	0	0	0	NW	POND RD	CARVER
(121, 119)	1	1440	0	100	0	0	N	ROUTE 58	CARVER
(121, 122)	1	1440	0	100	0	0	S	ROUTE 58	CARVER
(122, 132)	1	1440	0	100	0	0	S	ROUTE 58	CARVER
(123, 128)	1	1161	0	100	0	0	SW	TREMONT RD	CARVER
(125, 250)	1	1161	0	100	0	0	SW	ROCHESTER RD	CARVER
(126, 125)	1	1161	0	100	0	0	SW	INDIAN RD	CARVER
(126, 127)	1	880	0	100	0	0	S	ROUTE 58	CARVER
(127, 244)	1	1440	0	100	0	0	S	ROUTE 58	CARVER
(128, 127)	1	620	0	100	0	0	SW	TREMONT RD	CARVER
(129, 122)	1	1161	100	0	0	0	W	MAYFLOWER RD	CARVER
(130, 245)	1	1161	100	0	0	0	NW	CRANBERRY RD	CARVER
(130, 94)	1	1161	0	100	0	0	S	TIHONET RD	CARVER
(131, 110)	1	260	10	90	0	0	N	ROUTE 58	PLYMOUTH CARVER

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NETWORK LINK CAPACITIES AND TRAFFIC FLOW CHARACTERISTICS

LINK	LN	CAPACITY (VEH/HR)	TURN PERCENTS L	T	R	D	DIR	DESCRIPTION	COMMUNITY
(132, 115)	1	1440	0	100	0	0	S	ROUTE 58	CARVER
(137, 506)	1	1440	0	100	0	0	N	ROUTE 58	PLYMPTON
(139, 137)	1	1440	0	100	0	0	N	ROUTE 58	PLYMPTON
(140, 139)	1	1161	0	0	100	0	NW	PLEASANT ST	CARVER
									PLYMPTON
(142, 140)	1	1161	0	0	100	0	W	HIGH ST	CARVER
(145, 137)	1	1161	0	0	100	0	W	BROOK ST	PLYMPTON
							W	COLCHESTER RD	PLYMPTON
							W	MAYFLOWER	PLYMPTON
(146, 287)	1	1161	0	100	0	0	S	DELANO AVE	KINGSTON
(147, 295)	1	1333	0	100	0	0	NW	PEMBROKE ST	KINGSTON
(148, 147)	1	1161	0	0	100	0	W	WINTER ST	KINGSTON
(149, 163)	1	280	100	0	0	0	SW	EAST AVE	KINGSTON
(151, 150)	1	1333	0	100	0	0	W	WAPPING RD	KINGSTON
(152, 147)	1	1333	0	100	0	0	NW	PEMBROKE ST	KINGSTON
(153, 152)	1	1333	0	100	0	0	NW	PEMBROKE ST	KINGSTON
(153, 151)	1	1333	0	100	0	0	W	WAPPING RD	KINGSTON
(154, 153)	1	1333	100	0	0	0	NW	PEMBROKE ST	KINGSTON
(154, 160)	1	1161	0	100	0	0	SW	ELM ST	KINGSTON
(155, 198)	1	1440	0	100	0	0	N	ROUTE 3A	KINGSTON
(156, 661)	2	3428	0	100	0	0	N	ROUTE 3	DUXBURY
(156, 195)	1	1333	100	0	0	0	N	RAMP	DUXBURY
(156, 281)	2	3428	0	100	0	0	S	ROUTE 3	KINGSTON
(157, 165)	1	1161	0	100	0	0	SW	SMITHS LANE	KINGSTON
(157, 161)	1	580	100	0	0	0	NE	SMITHS LANE	KINGSTON
							N	CRESCENT	KINGSTON
(158, 307)	1	240	100	0	0	0	N	LORING ST	DUXBURY
							N	PARKS ST	DUXBURY
(158, 196)	1	1161	100	0	0	0	NE	BAY AVE	DUXBURY
(160, 159)	1	1040	0	100	0	0	SW	ROUTE 80	KINGSTON
(160, 162)	1	1161	0	0	100	0	SW	INDIAN POND RD	KINGSTON
(161, 157)	1	1161	0	100	0	0	S	CRESCENT	KINGSTON
							SW	SMITHS LANE	KINGSTON
(161, 282)	1	1240	0	63	37	0	N	ROUTE 3A	KINGSTON
(162, 76)	1	1333	0	0	100	0	S	ROUTE 80	KINGSTON
(162, 159)	1	460	100	0	0	0	N	ROUTE 80	KINGSTON
(163, 161)	1	580	0	0	100	0	S	HOWLANDS LA	KINGSTON
(164, 623)	2	3428	0	100	0	0	N	ROUTE 3	KINGSTON
(164, 624)	1	1333	0	0	100	0	S	RAMP	KINGSTON
(164, 55)	2	3428	0	100	0	0	S	ROUTE 3	KINGSTON
(165, 623)	1	1333	0	100	0	0	N	RAMP	KINGSTON
(165, 157)	1	1161	0	100	0	0	NE	SMITHS LANE	KINGSTON
(166, 161)	1	920	0	100	0	0	N	ROUTE 3A	KINGSTON
(167, 502)	1	0	100	0	0	0	N	ROUTE 53	PEMBROKE

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NETWORK LINK CAPACITIES AND TRAFFIC FLOW CHARACTERISTICS

LINK	LN	CAPACITY (VEH/HR)	TURN PERCENTS L	T	R	D	DIR	DESCRIPTION	COMMUNITY
(168, 167)	1	1333	0	100	0	0	N	ROUTE 53	PEMBROKE
(169, 167)	1	1161	0	0	100	0	W	ROUTE 14	PEMBROKE
(170, 420)	1	1161	0	100	0	0	NW	UNION ST	DUXBURY
(171, 421)	2	3428	0	100	0	0	N	ROUTE 3	DUXBURY
(171, 176)	2	3428	0	100	0	0	S	ROUTE 3	DUXBURY
(172, 460)	1	1161	100	0	0	0	N	ACORN ST	MARSHFIELD
(173, 174)	1	1333	0	100	0	0	N	ROUTE 53	DUXBURY
(174, 168)	1	1333	0	100	0	0	N	ROUTE 53	DUXBURY
(175, 301)	1	200	100	0	0	0	N	UNION ST	DUXBURY
(176, 171)	2	3428	0	100	0	0	N	ROUTE 3	DUXBURY
(176, 663)	2	3428	0	100	0	0	S	ROUTE 3	DUXBURY
(176, 298)	1	1333	0	0	100	0	S	RAMP	DUXBURY
(177, 460)	1	1440	0	100	0	0	N	ROUTE 3A	MARSHFIELD
(178, 297)	1	1161	0	0	100	0	W	ROUTE 14	DUXBURY
(179, 178)	1	1333	0	100	0	0	W	ROUTE 139	DUXBURY
(179, 177)	1	1440	0	100	0	0	N	ROUTE 3A	DUXBURY
(179, 412)	1	1333	100	0	0	0	NE	ROUTE 139	MARSHFIELD
(180, 181)	1	1161	100	0	0	0	E	BIRCH ST	DUXBURY
(181, 173)	1	1160	0	100	0	0	N	ROUTE 53	DUXBURY
(182, 173)	1	340	0	0	100	0	W	CROSS ST	DUXBURY
(182, 175)	1	1161	0	100	0	0	N	UNION ST	DUXBURY
(183, 184)	1	1161	0	100	0	0	NE	CHANDLER ST	DUXBURY
(183, 182)	1	1161	100	0	0	0	NW	UNION ST	DUXBURY
(183, 304)	1	1161	0	0	100	0	S	CHANDLER ST	DUXBURY
(184, 298)	1	1161	100	0	0	0	N	CHANDLER ST	DUXBURY
(184, 183)	1	1161	0	100	0	0	SW	CHANDLER ST	DUXBURY
(185, 297)	1	1161	0	100	0	0	N	LINCOLN ST	DUXBURY
(185, 184)	1	1161	100	0	0	0	W	MAYFLOWER	DUXBURY
(186, 185)	1	1161	0	100	0	0	W	MODOC ST	DUXBURY
(187, 300)	1	1500	0	0	100	0	W	CEDAR ST	DUXBURY
							W	ST GEORGE	DUXBURY
(188, 303)	1	680	0	100	0	0	N	ROUTE 53	DUXBURY
(188, 148)	1	1161	0	100	0	0	W	WINTER ST	DUXBURY
(189, 185)	1	1161	0	100	0	0	NW	MAYFLOWER ST	DUXBURY
(190, 187)	1	960	0	100	0	0	N	WASHINGTON ST	DUXBURY
(191, 192)	1	1161	0	100	0	0	N	LAUREL ST	DUXBURY
(192, 463)	1	460	100	0	0	0	N	OCEAN ST	MARSHFIELD
(193, 304)	1	1161	0	100	0	0	NW	ELM ST	DUXBURY
(194, 190)	1	1161	0	100	0	0	NE	WASHINGTON ST	DUXBURY
(194, 197)	1	1240	0	0	100	0	NW	DEPOT ST	DUXBURY

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NETWORK LINK CAPACITIES AND TRAFFIC FLOW CHARACTERISTICS

LINK	LN	CAPACITY (VEH/HR)	TURN PERCENTS L	T	R	D	DIR	DESCRIPTION	COMMUNITY
(194, 306)	1	1300	0	96	4	0	NW	CHESTNUT ST	DUXBURY
(195, 156)	1	1333	0	100	0	0	N	RAMP	DUXBURY
(195, 662)	2	2880	0	100	0	0	W	TREMONT ST	DUXBURY
(196, 194)	1	640	54	0	0	46	NE	BAY AVE	DUXBURY
(196, 305)	1	1060	100	0	0	0	NW	SOULE AVE	DUXBURY
(197, 300)	1	1500	100	0	0	0	N	ROUTE 3A	DUXBURY
(198, 662)	2	2880	0	100	0	0	E	TREMONT ST	DUXBURY
(198, 188)	1	1333	0	100	0	0	N	ROUTE 53	DUXBURY
(199, 194)	1	860	54	46	0	0	N	STANDISH ST	DUXBURY
(200, 12)	1	280	0	0	100	0	S	ROUTE 3A	PLYMOUTH
(200, 4)	1	1440	0	100	0	0	N	ROUTE 3A	PLYMOUTH
(201, 7)	1	1714	0	100	0	0	W	RTE 3 APPROACH	PLYMOUTH
(202, 3)	1	1161	0	100	0	0	SE	ROCKY HILL RD	PLYMOUTH
(202, 200)	1	1161	100	0	0	0	S	EDISON ACCESS RD	PLYMOUTH
(203, 205)	1	1161	100	0	0	0	SW	CLARK RD	PLYMOUTH
(203, 211)	1	1333	0	100	0	0	S	RAMP	PLYMOUTH
(204, 130)	1	1161	100	0	0	0	NW	EAST HEAD RD	CARVER
(205, 203)	1	1161	100	0	0	0	NE	CLARK RD	PLYMOUTH
(205, 42)	1	1161	0	0	100	0	S	LONG POND RD	PLYMOUTH
(206, 30)	1	1161	100	0	0	0	W	SHORE DR	PLYMOUTH
(206, 227)	1	1161	0	100	0	0	S	ELLISVILLE DR	PLYMOUTH
(207, 204)	1	1080	0	100	0	0	NW	FEARING POND RD	PLYMOUTH
(208, 207)	1	1161	0	100	0	0	NW	FEARING POND RD	PLYMOUTH
(209, 16)	1	1440	0	100	0	0	N	ROUTE 3A	PLYMOUTH
(209, 201)	1	1714	0	100	0	0	W	RTE 3 APPROACH	PLYMOUTH
(210, 201)	1	1333	0	100	0	0	N	RAMP	PLYMOUTH
(211, 203)	1	1333	0	100	0	0	S	RAMP	PLYMOUTH
(211, 212)	2	3428	0	100	0	0	S	ROUTE 3	PLYMOUTH
(211, 7)	2	3428	0	100	0	0	N	ROUTE 3	PLYMOUTH
(212, 43)	2	3428	0	100	0	0	S	ROUTE 3	PLYMOUTH
(212, 608)	1	1333	100	0	0	0	N	RAMP	PLYMOUTH
(212, 211)	2	3428	0	100	0	0	N	ROUTE 3	PLYMOUTH
(213, 221)	1	1161	0	100	0	0	SW	ROCKY POND RD	PLYMOUTH
(213, 65)	1	1161	0	100	0	0	E	WIDGEON POND RD	PLYMOUTH
							S	KAMESIT RD	PLYMOUTH
(214, 73)	1	1161	0	100	0	0	S	RAYMOND RD	PLYMOUTH
							S	LITTLE SNDY PD RD	PLYMOUTH
(215, 229)	1	380	100	0	0	0	N	WESTERLY RTE	PLYMOUTH
(215, 216)	1	1333	0	100	0	0	N	RAMP	PLYMOUTH
(216, 55)	2	3428	0	100	0	0	N	ROUTE 3	PLYMOUTH
(216, 57)	1	1333	100	0	0	0	S	RAMP	PLYMOUTH

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NETWORK LINK CAPACITIES AND TRAFFIC FLOW CHARACTERISTICS

LINK	LN	CAPACITY (VEH/HR)	TURN PERCENTS L	T	R	D	DIR	DESCRIPTION	COMMUNITY
(216, 26)	2	3428	0	100	0	0	S	ROUTE 3	PLYMOUTH
(216, 215)	1	1333	100	0	0	0	N	RAMP	PLYMOUTH
(217, 59)	1	1161	0	0	100	0	S	BOURNE RD	PLYMOUTH
(217, 218)	1	1161	100	0	0	0	W	HALFWAY POND RD	PLYMOUTH
(218, 93)	1	1161	0	100	0	0	S	WAREHAM RD	PLYMOUTH
							S	SANDY BEACH RD	PLYMOUTH
(219, 62)	1	580	100	0	0	0	W	CARVER	PLYMOUTH
(219, 63)	1	200	0	100	0	0	SW	FED FURNACE RD	PLYMOUTH
(220, 223)	1	1333	100	0	0	0	S	RAMP	PLYMOUTH
(220, 75)	2	3428	0	100	0	0	S	ROUTE 3	PLYMOUTH
(220, 43)	2	3428	0	100	0	0	N	ROUTE 3	PLYMOUTH
(221, 65)	1	1161	0	100	0	0	SE	ROCK RD	PLYMOUTH
							S	BARE HILL RD	PLYMOUTH
(222, 72)	1	740	0	0	100	0	NE	ROCKY NECK RD	PLYMOUTH
(223, 220)	1	1333	0	100	0	0	S	RAMP	PLYMOUTH
(223, 74)	1	1161	100	0	0	0	S	HERRING PD RD	PLYMOUTH
(224, 225)	1	1161	100	0	0	0	N	PINEWOOD RD	PLYMOUTH
(224, 120)	1	1300	0	100	0	0	SW	SOUTH MEADOW RD	PLYMOUTH
									CARVER
(225, 224)	1	1161	0	0	100	0	S	PINEWOOD RD	PLYMOUTH
(225, 112)	1	1440	12	88	0	0	W	ROUTE 44	PLYMOUTH
(226, 54)	1	1161	0	0	100	0	SE	OLD SANDWICH RD	PLYMOUTH
(227, 432)	1	1161	100	0	0	0	S	COD RD	PLYMOUTH
							S	HYANNIS RD	PLYMOUTH
(228, 13)	1	220	0	0	100	0	W	LINCOLN	PLYMOUTH
(229, 57)	2	2880	0	100	0	0	W	ROUTE 44	PLYMOUTH
(229, 215)	1	1440	0	100	0	0	S	WESTERLY RTE	PLYMOUTH
(230, 97)	2	3428	0	75	0	25	NW	ROUTE 25	WAREHAM
(231, 102)	1	1440	0	100	0	0	NW	ROUTE 28	WAREHAM
(237, 108)	2	2880	0	100	0	0	NW	CRANBERRY HWY	WAREHAM
(239, 238)	1	1180	100	0	0	0	SW	BARKER RD	WAREHAM
(240, 83)	1	1161	0	0	100	0	S	RED BROOK RD	WAREHAM
(243, 103)	1	1440	0	100	0	0	S	ROUTE 58	WAREHAM
(243, 100)	1	1333	0	100	0	0	NW	RAMP	WAREHAM
(244, 243)	1	1440	0	100	0	0	S	ROUTE 58	WAREHAM
(245, 128)	1	1161	100	0	0	0	NW	CRANBERRY RD	CARVER
(245, 246)	1	1161	0	100	0	0	S	FEDERAL RD	CARVER
(246, 247)	1	1161	0	100	0	0	S	FEDERAL RD	CARVER
(281, 156)	2	3428	0	100	0	0	N	ROUTE 3	KINGSTON
(281, 282)	1	260	0	0	100	0	N	RAMP	KINGSTON
(281, 622)	2	3428	0	100	0	0	S	ROUTE 3	KINGSTON
(282, 281)	1	1333	0	100	0	0	N	RAMP	KINGSTON

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NETWORK LINK CAPACITIES AND TRAFFIC FLOW CHARACTERISTICS

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(282, 621)	1	1440	0	100	0	0	N	ROUTE 3A	KINGSTON
(288, 287)	1	1161	100	0	0	0	W	LEIGH RD	KINGSTON
(284, 282)	1	1500	37	63	0	0	N	PLEASANT	KINGSTON
(285, 160)	1	1333	0	100	0	0	W	ROUTE 80	KINGSTON
(285, 286)	1	1440	63	37	0	0	N	ROUTE 3A	KINGSTON
(286, 154)	1	1333	0	100	0	0	NW	ROUTE 27	KINGSTON
(286, 155)	1	1440	0	100	0	0	N	ROUTE 3A	KINGSTON
(287, 163)	1	1220	0	100	0	0	S	HOWLAND LANE	KINGSTON
(296, 199)	1	1161	0	100	0	0	SE	CRESCENT ST	DUXBURY
(297, 176)	1	1333	0	100	0	0	N	RAMP	DUXBURY
(297, 298)	1	1161	0	100	0	0	W	ROUTE 14	DUXBURY
(298, 299)	1	1161	0	100	0	0	W	ROUTE 14	DUXBURY
(298, 297)	1	1161	100	0	0	0	E	ROUTE 14	DUXBURY
(299, 302)	1	1161	0	100	0	0	NE	FRANKLIN ST	DUXBURY
(299, 301)	1	1300	0	100	0	0	W	ROUTE 14	DUXBURY
(300, 179)	1	1100	0	100	0	0	N	ROUTE 3A	DUXBURY
(300, 178)	1	1161	100	0	0	0	NW	ROUTE 14	DUXBURY
(301, 170)	1	1161	0	100	0	0	NW	UNION ST	DUXBURY
(301, 169)	1	1161	0	100	0	0	W	ROUTE 14	DUXBURY
(302, 172)	1	1161	0	100	0	0	NE	FRANKLIN ST	DUXBURY
							NE	ACORN ST	DUXBURY
(303, 181)	1	1333	0	100	0	0	N	ROUTE 53	DUXBURY
(304, 303)	1	820	0	100	0	0	NW	SUMMER ST	DUXBURY
(304, 183)	1	1161	100	0	0	0	N	CHANDLER ST	DUXBURY
(305, 306)	1	200	0	100	0	0	N	ROUTE 3A	DUXBURY
(305, 307)	1	1260	0	100	0	0	S	ROUTE 3A	DUXBURY
(306, 305)	1	440	0	100	0	0	S	ROUTE 3A	DUXBURY
(306, 193)	1	1161	0	100	0	0	W	TOBEY GARDEN ST	DUXBURY
(306, 197)	1	260	0	100	0	0	N	ROUTE 3A	DUXBURY
(307, 195)	1	1440	0	100	0	0	S	ROUTE 3A	DUXBURY
(307, 193)	1	1161	100	0	0	0	N	OAK ST	DUXBURY
							N	SCHOOL ST	DUXBURY
(307, 305)	1	440	0	100	0	0	N	ROUTE 3A	DUXBURY
(308, 187)	1	540	0	100	0	0	NW	POWDER PT AVE	DUXBURY
(309, 148)	1	1161	0	0	100	0	SE	PINE	DUXBURY
(309, 180)	1	1161	0	0	100	0	N	LAKE SHORE DR	DUXBURY
(400, 401)	1	1440	0	100	0	0	SW	ROUTE 3A	BOURNE
(401, 85)	2	2880	0	100	0	0	NW	CRANBERRY HWY	BOURNE
(401, 75)	2	3428	0	100	0	0	N	ROUTE 3	BOURNE
(402, 404)	2	2880	0	100	0	0	NW	CRANBERRY HWY	BOURNE
(403, 402)	2	2880	0	100	0	0	W	CRANBERRY HWY	BOURNE

L = LEFT TURN T = THROUGH MOVEMENT R = RIGHT TURN D = DIAGONAL MOVEMENT

NETWORK LINK CAPACITIES AND TRAFFIC FLOW CHARACTERISTICS

LINK	LN	CAPACITY (VEH/HR)	TURN PERCENTS L	T	R	D	DIR	DESCRIPTION	COMMUNITY
(404, 237)	2	2880	0	100	0	0	W	CRANBERRY HWY	WAREHAM
(410, 500)	1	1333	0	100	0	0	NW	ROUTE 139	MARSHFIELD
(410, 413)	1	280	0	100	0	0	S	ROUTE 139	MARSHFIELD
(411, 417)	1	1161	0	100	0	0	N	ISLAND	MARSHFIELD
(412, 413)	1	280	0	100	0	0	NE	ROUTE 139	MARSHFIELD
(412, 179)	1	400	0	0	100	0	SW	ROUTE 139	MARSHFIELD
(412, 501)	1	1161	0	100	0	0	NW	WEBSTER ST	MARSHFIELD
(413, 410)	1	1333	100	0	0	0	N	ROUTE 139	MARSHFIELD
(413, 412)	1	1333	0	70	30	0	SW	ROUTE 139	MARSHFIELD
(414, 422)	1	1161	0	100	0	0	N	BEACH ACCESS RD	DUXBURY
(414, 425)	1	1161	0	100	0	0	W	POWDER POINT BR	DUXBURY
(415, 413)	1	1220	46	0	54	0	N	GURNET RD	DUXBURY
							N	BAY AVE	MARSHFIELD
							NW	BEACH	MARSHFIELD
(416, 411)	1	1161	100	0	0	0	E	CENTRAL	MARSHFIELD
(417, 410)	1	1161	0	100	0	0	NW	ISLAND	MARSHFIELD
(418, 419)	1	1333	0	100	0	0	W	ROUTE 139	MARSHFIELD
(419, 461)	2	2880	0	50	50	0	NW	ROUTE 139	MARSHFIELD
(420, 502)	1	0	0	100	0	0	NW	SPRING ST	PEMBROKE
								PLEASANT	PEMBROKE
(421, 681)	2	3428	0	100	0	0	N	ROUTE 3	MARSHFIELD
									PEMBROKE
(421, 171)	2	3428	0	100	0	0	S	ROUTE 3	DUXBURY
(422, 415)	1	1161	0	100	0	0	N	BEACH ACCESS RD	DUXBURY
(423, 414)	1	1161	70	30	0	0	NW	BEACH ACCESS RD	DUXBURY
(424, 428)	1	1161	0	100	0	0	NE	BEACH ACCESS RD	PLYMOUTH
(425, 308)	1	1161	0	100	0	0	SW	POWDER POINT AVE	DUXBURY
(426, 190)	1	1161	0	0	100	0	NW	MATTAKEESET CT	DUXBURY
(427, 296)	1	1161	0	0	100	0	NE	HOWLANDS LDG	DUXBURY
(428, 423)	1	1161	100	0	0	0	NE	BEACH ACCESS RD	DUXBURY
(431, 9)	1	1161	100	0	0	0	NW	TAYLOR AVE	PLYMOUTH
(431, 15)	1	1161	0	0	100	0	SE	TAYLOR AVE	PLYMOUTH
(432, 21)	1	1440	0	100	0	0	S	ROUTE 3A	PLYMOUTH
(433, 62)	2	2880	0	100	0	0	W	ROUTE 44	PLYMOUTH
(433, 57)	2	2880	0	100	0	0	E	ROUTE 44	PLYMOUTH
(434, 23)	1	1440	100	0	0	0	N	ROUTE 3A	PLYMOUTH
(435, 9)	1	1161	0	0	100	0	SE	PRISCILLA BO RD	PLYMOUTH
(436, 45)	1	1161	0	0	100	0	SE	WATER ST	PLYMOUTH
(451, 158)	1	1161	0	100	0	0	N	LORING ST	DUXBURY
(452, 451)	1	1161	0	100	0	0	NE	LANDING RD	KINGSTON
(452, 286)	1	1161	0	0	0	100	SW	LANDING RD	KINGSTON
(453, 452)	1	1161	54	0	46	0	NW	RIVER ST	KINGSTON
(460, 419)	1	1440	100	0	0	0	N	ROUTE 3A	MARSHFIELD

L = LEFT TURN T = THROUGH MOVEMENT R = RIGHT TURN D = DIAGONAL MOVEMENT

NETWORK LINK CAPACITIES AND TRAFFIC FLOW CHARACTERISTICS

LINK	LN	CAPACITY (VEH/HR)	TURN PERCENTS L	T	R	D	DIR	DESCRIPTION	COMMUNITY
(461, 463)	1	1040	0	100	0	0	NW	ROUTE 139	MARSHFIELD
(461, 462)	1	1440	0	100	0	0	N	ROUTE 3A	MARSHFIELD
(463, 464)	2	2880	0	50	50	0	NW	ROUTE 139	MARSHFIELD
(464, 682)	2	2880	0	100	0	0	W	ROUTE 139	PEMBROKE
(464, 465)	1	1333	0	100	0	0	N	RAMP	PEMBROKE
(465, 468)	2	3428	0	100	0	0	N	ROUTE 3	PEMBROKE
(465, 681)	2	3428	0	100	0	0	S	ROUTE 3	PEMBROKE
									MARSHFIELD
(466, 467)	1	1161	0	100	0	0	N	ROUTE 53	PEMBROKE
(468, 465)	2	3428	0	100	0	0	S	ROUTE 3	PEMBROKE
(500, 418)	1	1260	0	100	0	0	NW	ROUTE 139	MARSHFIELD
							W	ROUTE 139	MARSHFIELD
(501, 418)	1	240	100	0	0	0	NW	WEBSTER ST	MARSHFIELD
(502, 466)	1	460	0	100	0	0	N	ROUTE 53	PEMBROKE
(502, 469)	1	1161	0	100	0	0	SW	BARKER ST	PEMBROKE
(606, 26)	1	1333	0	100	0	0	N	RAMP	PLYMOUTH
(606, 33)	1	1300	0	0	100	0	N	LONG POND RD	PLYMOUTH
(606, 35)	1	1161	0	50	50	0	S	LONG POND RD	PLYMOUTH
(608, 203)	1	1161	0	0	0	100	SW	CLARK RD	PLYMOUTH
(621, 285)	1	1440	100	0	0	0	N	ROUTE 3A	KINGSTON
(622, 621)	1	1333	100	0	0	0	S	RAMP	KINGSTON
(622, 623)	2	3428	0	100	0	0	S	ROUTE 3	KINGSTON
(622, 281)	2	3428	0	97	3	0	N	ROUTE 3	KINGSTON
(623, 165)	1	1333	100	0	0	0	N	RAMP	KINGSTON
(623, 622)	2	3428	0	100	0	0	N	ROUTE 3	KINGSTON
(623, 164)	2	3428	0	100	0	0	S	ROUTE 3	KINGSTON
(624, 165)	1	1161	20	80	0	0	NE	GALLEN RD	KINGSTON
(661, 156)	2	3428	0	100	0	0	S	ROUTE 3	DUXBURY
(661, 663)	2	3428	0	100	0	0	N	ROUTE 3	DUXBURY
(661, 662)	1	1333	0	0	100	0	S	RAMP	DUXBURY
(662, 195)	1	1440	0	0	100	0	E	TREMONT ST	DUXBURY
(662, 198)	1	1440	0	0	100	0	W	TREMONT ST	KINGSTON
(663, 661)	2	3428	0	100	0	0	S	ROUTE 3	DUXBURY
(663, 297)	1	1333	100	0	0	0	N	RAMP	DUXBURY
(663, 176)	2	3428	0	100	0	0	N	ROUTE 3	DUXBURY
(681, 465)	2	3428	0	100	0	0	N	ROUTE 3	PEMBROKE
(681, 682)	1	1333	100	0	0	0	S	RAMP	PEMBROKE
(681, 421)	2	3428	0	100	0	0	S	ROUTE 3	PEMBROKE
									MARSHFIELD
(681, 464)	1	1333	100	0	0	0	N	RAMP	MARSHFIELD
(682, 466)	2	2080	0	0	100	0	W	ROUTE 139	PEMBROKE
(8013, 468)	2	3428	0	100	0	0	S	ROUTE 3	PEMBROKE
(8500, 401)	2	3428	0	100	0	0	N	ROUTE 3	BOURNE

APPENDIX O

Subarea Bus Routes

PICK UP POINT LOCATIONS

There are 4 Pick Up Points:

Sub Area		
9	1 -	West end of Powder Point Bridge in Duxbury
7	2 -	Route 3A (Court St.) at Cordage Park in Plymouth
7	3 -	Route 3A (Court St.) and Robbins Rd. in Plymouth
7	4 -	Water Street at the Sheraton Hotel in Plymouth

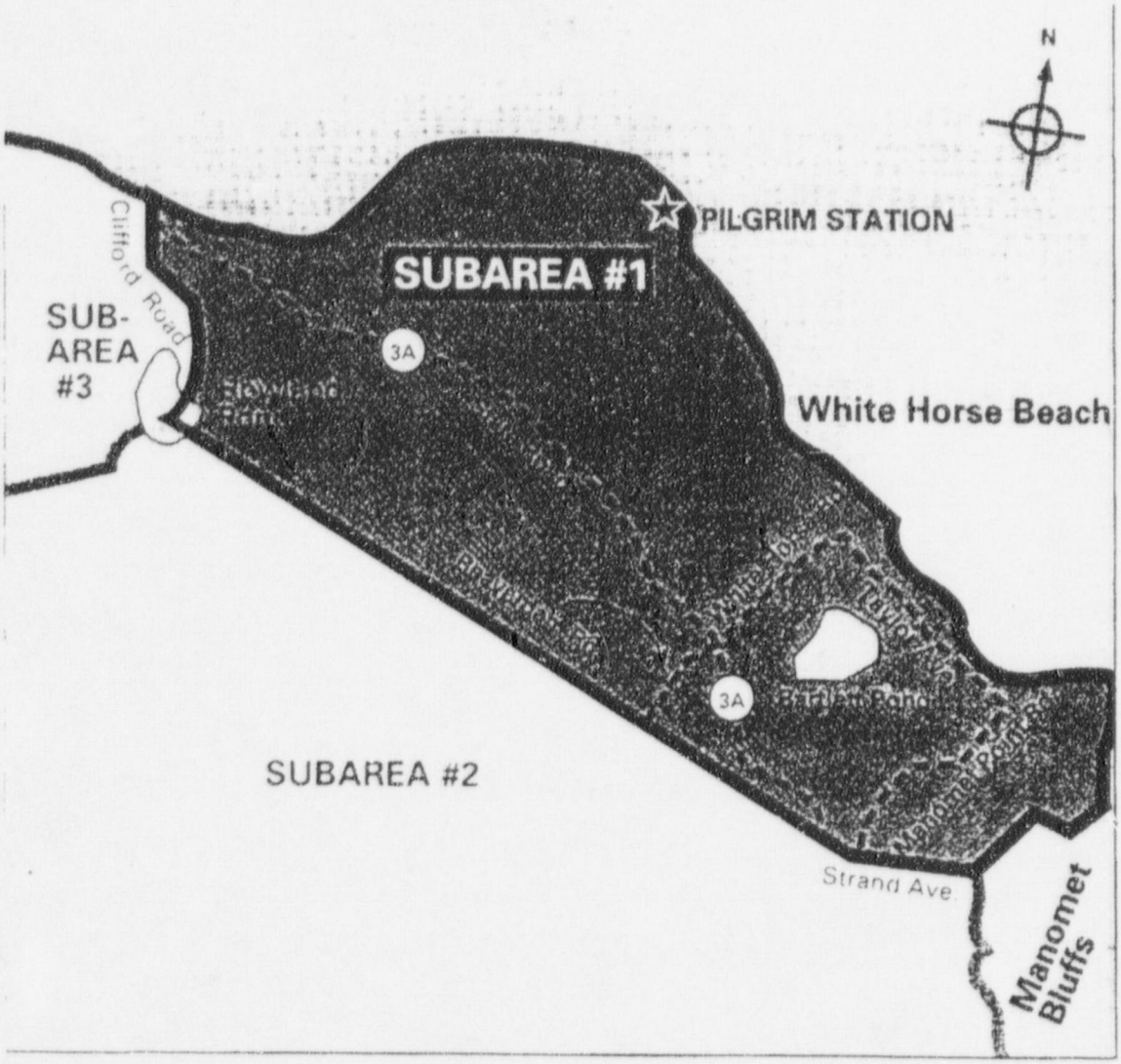

Figure O-1 Bus Routes for Subarea 1

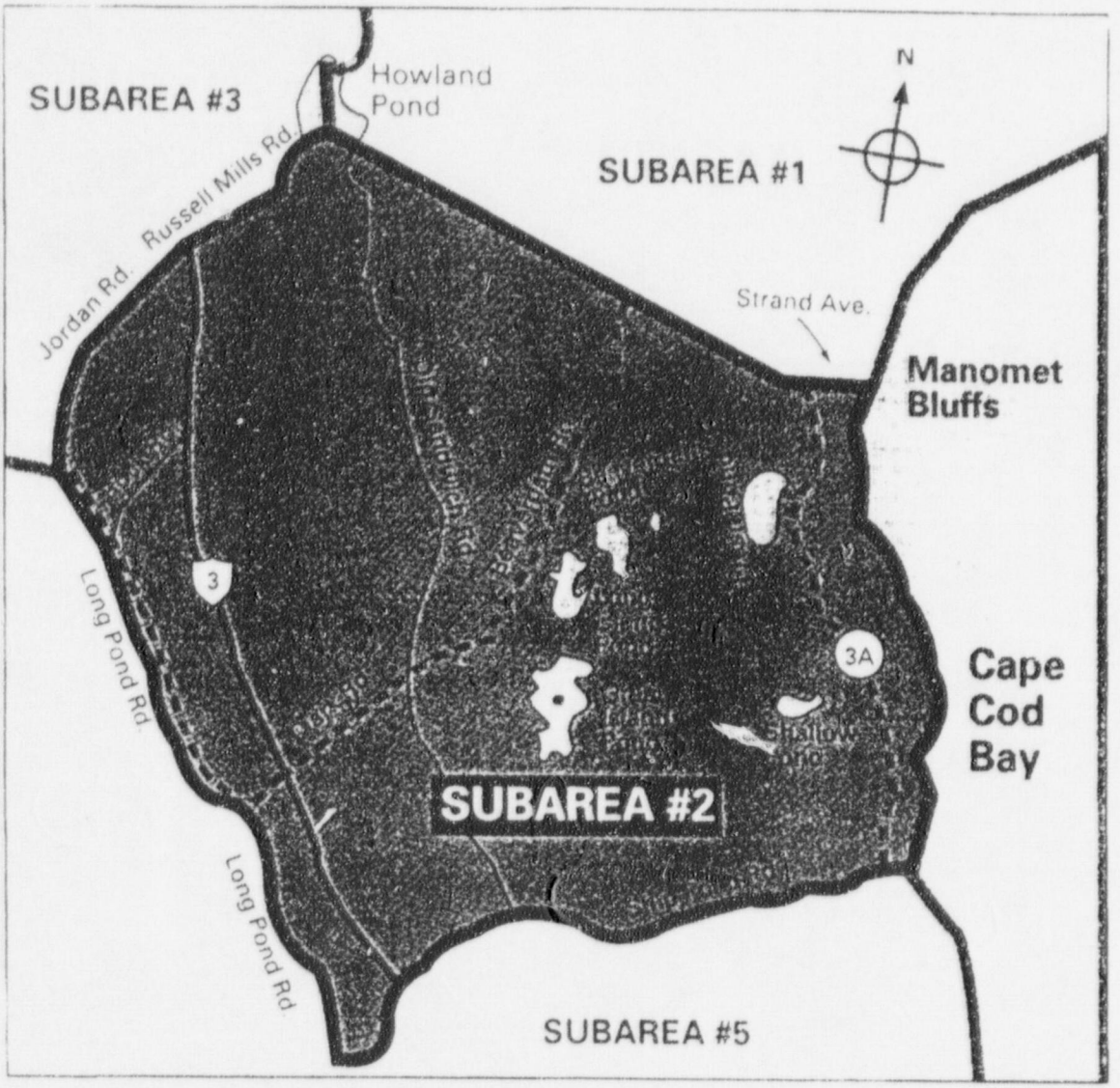

Figure O-2. Bus Routes for Subarea 2

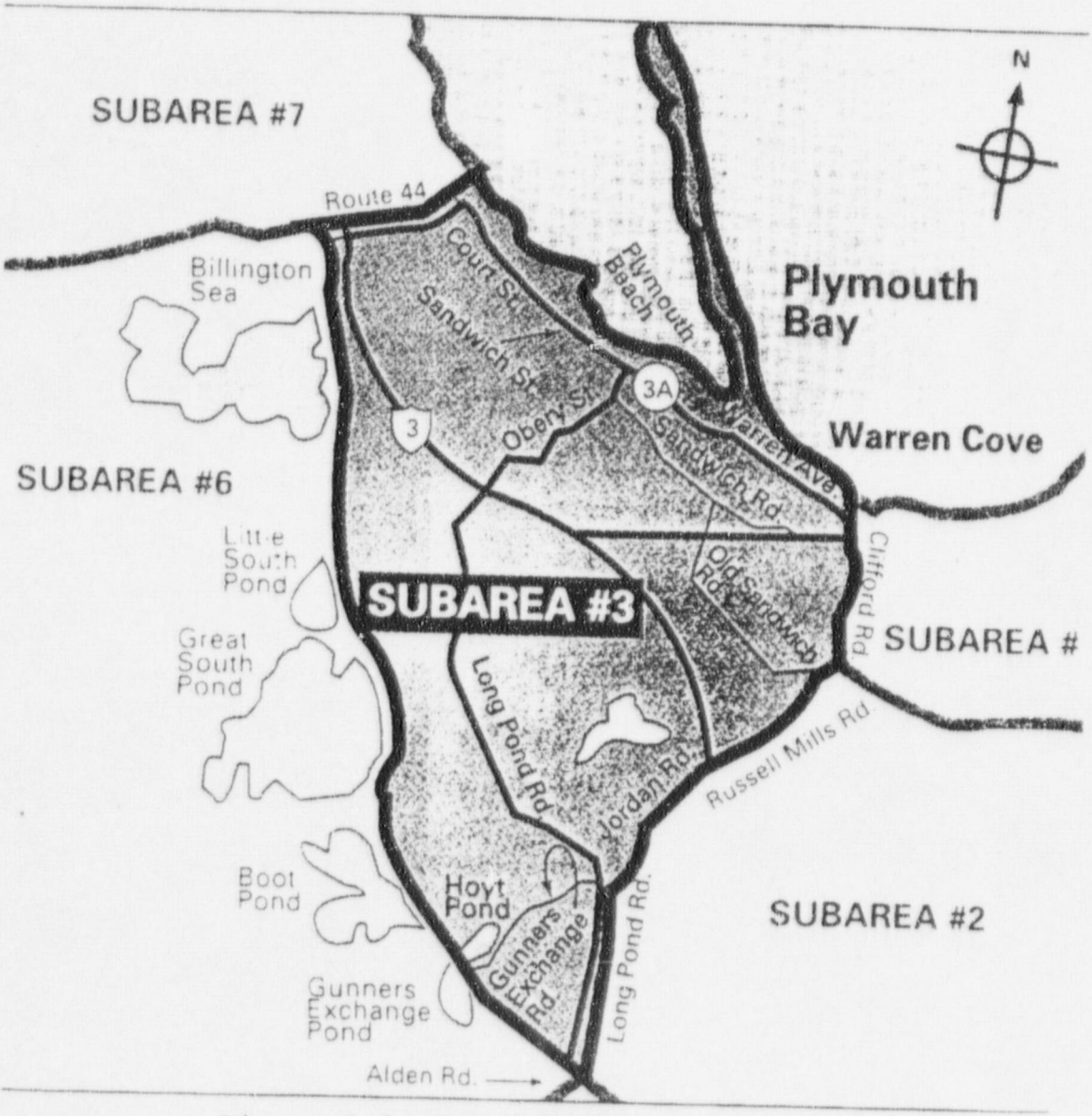

Figure O-3. Bus Routes for Subarea 3

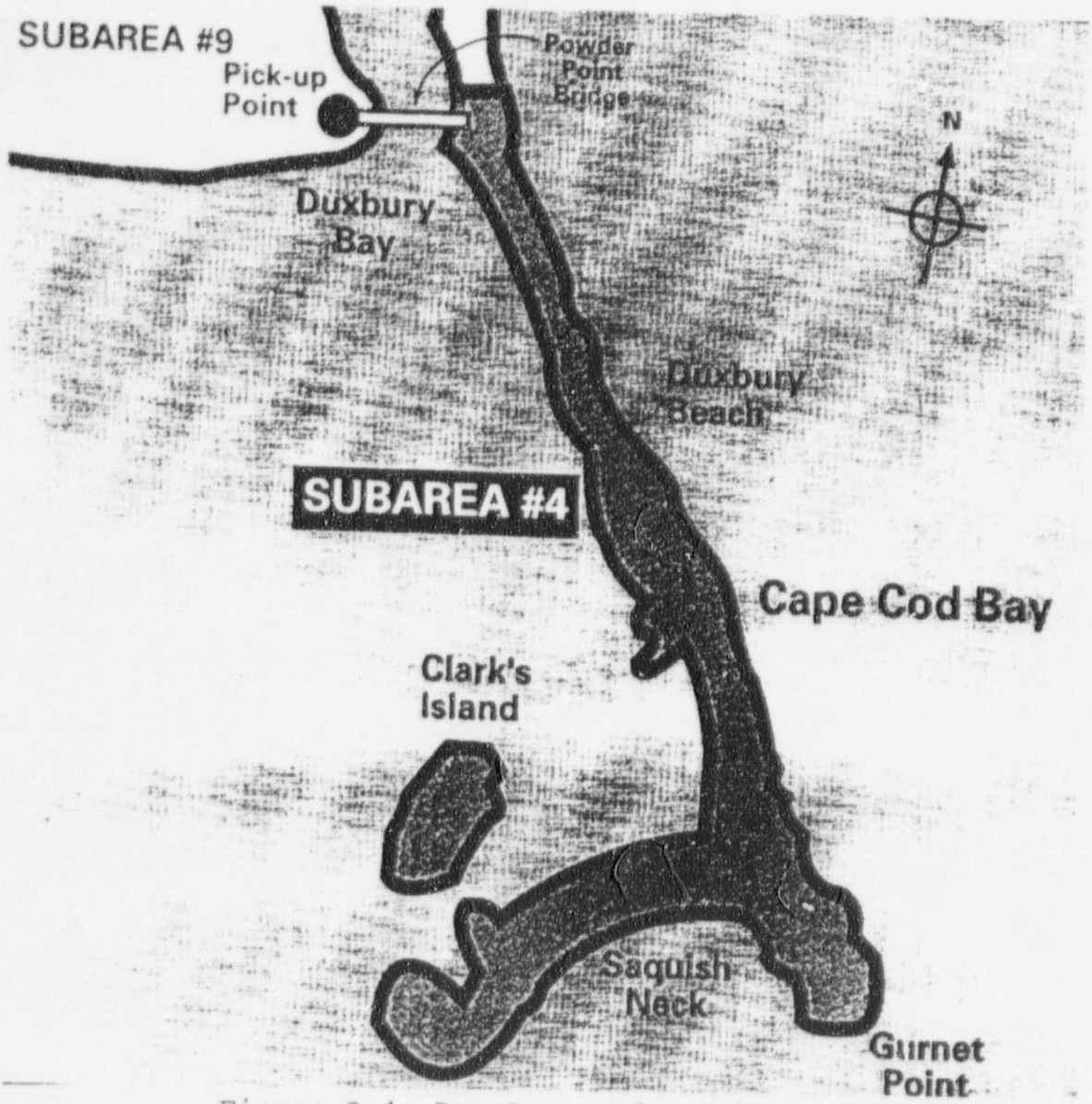

Figure O-4. Bus Routes for Subarea 4

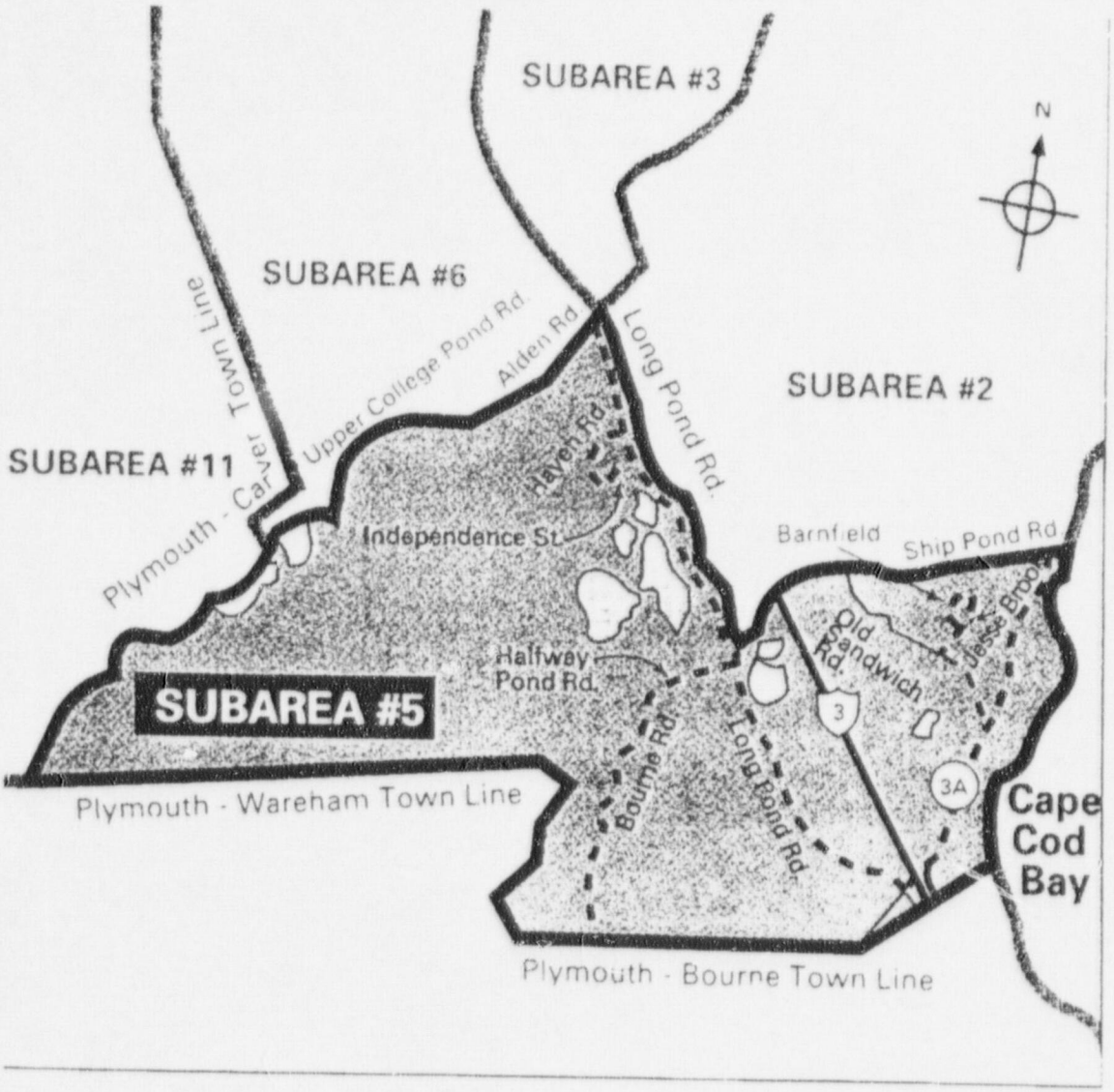

Figure O-5. Bus Routes for Subarea 5

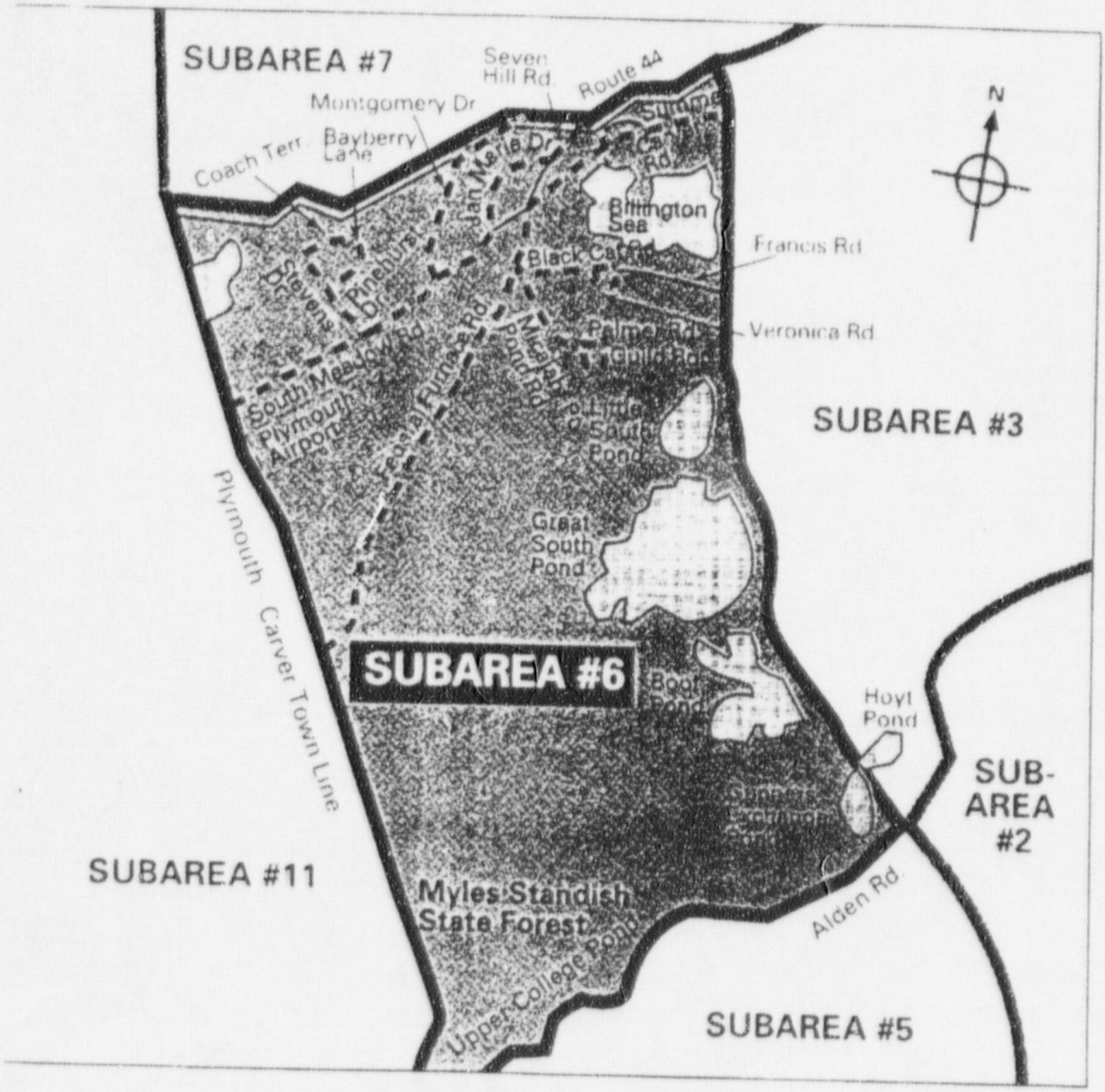

Figure O-6. Bus Routes for Subarea 6

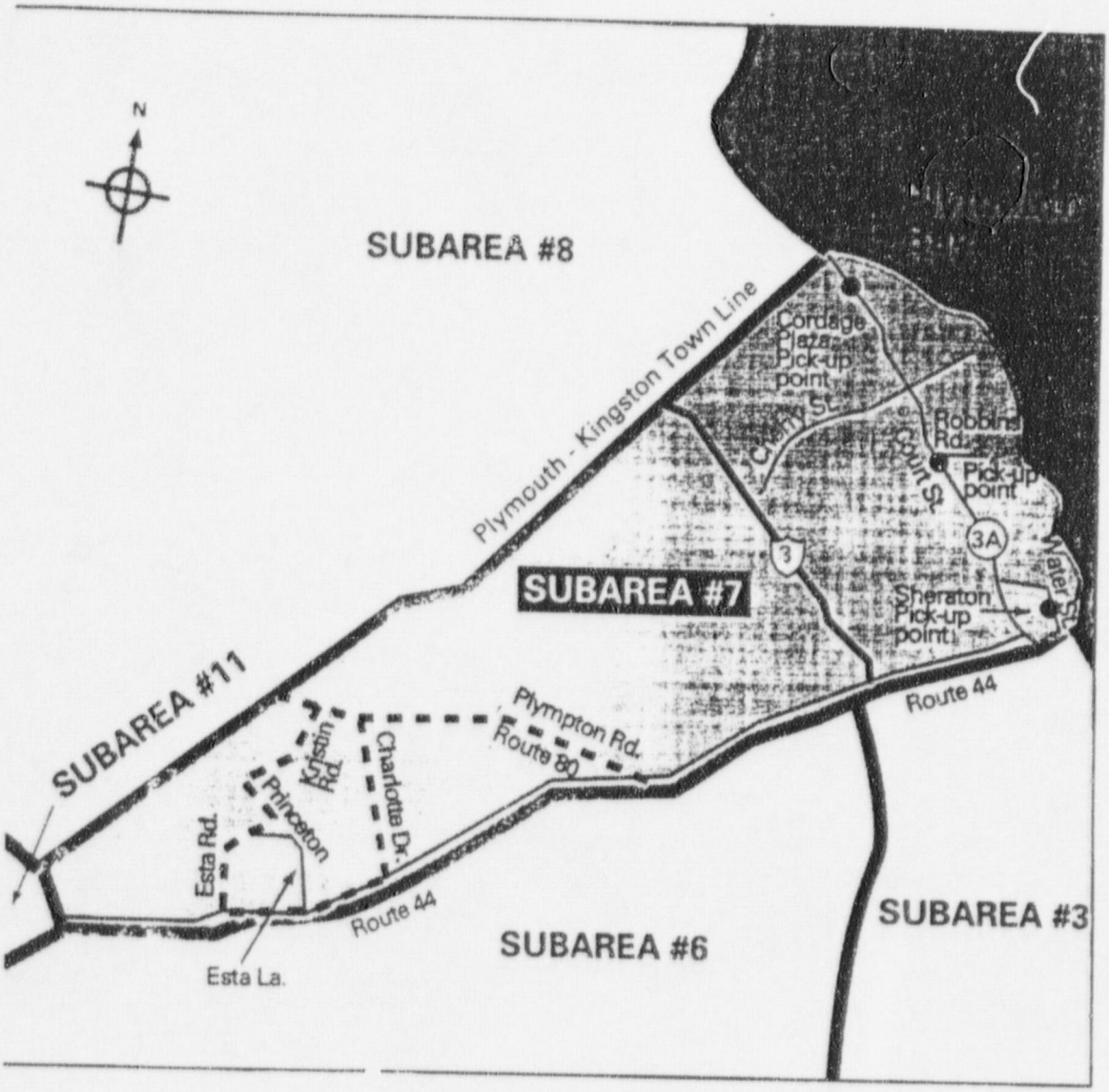

Figure O-7. Bus Routes for Subarea 7

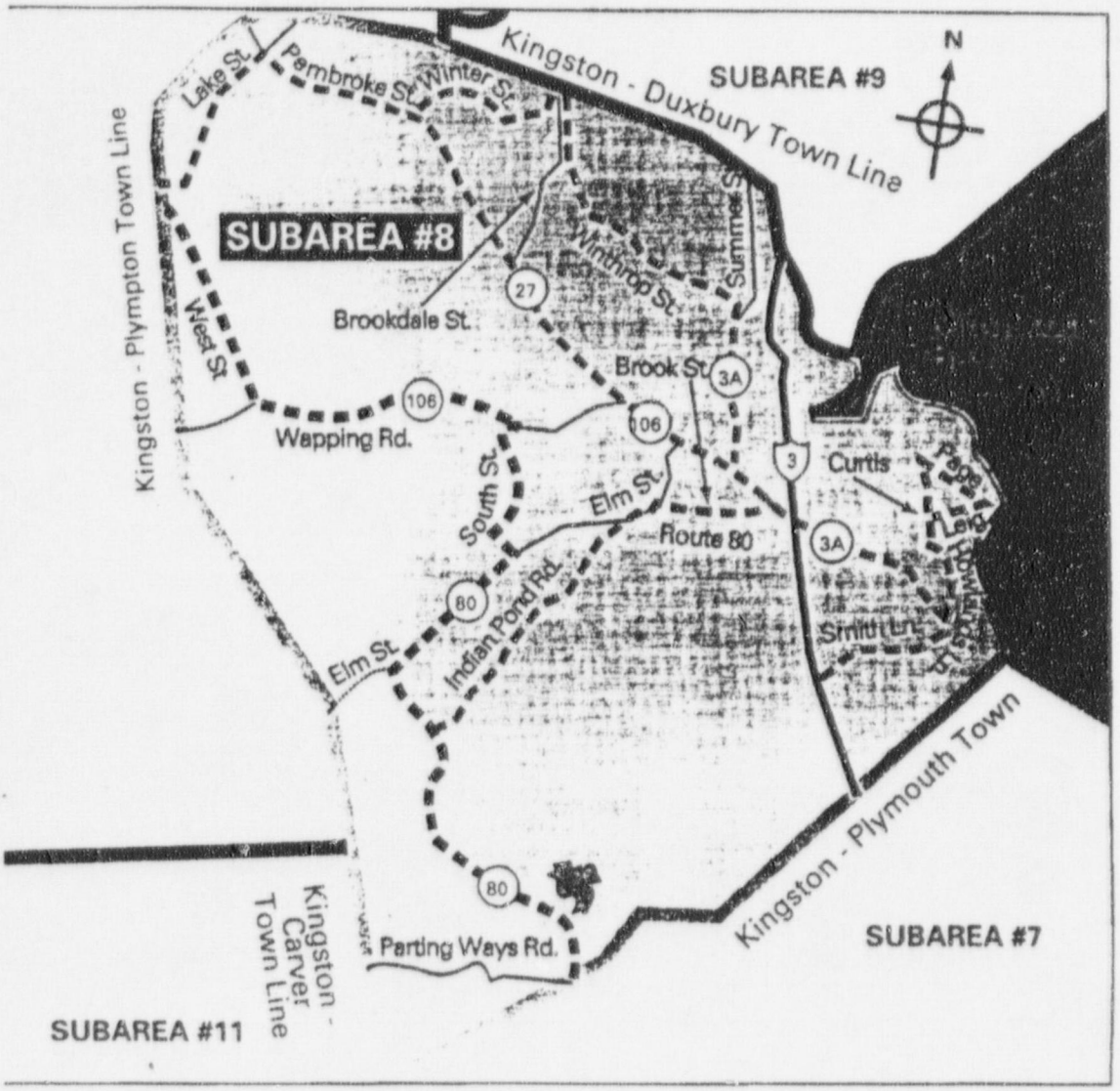

Figure O-8. Bus Routes for Subarea 8

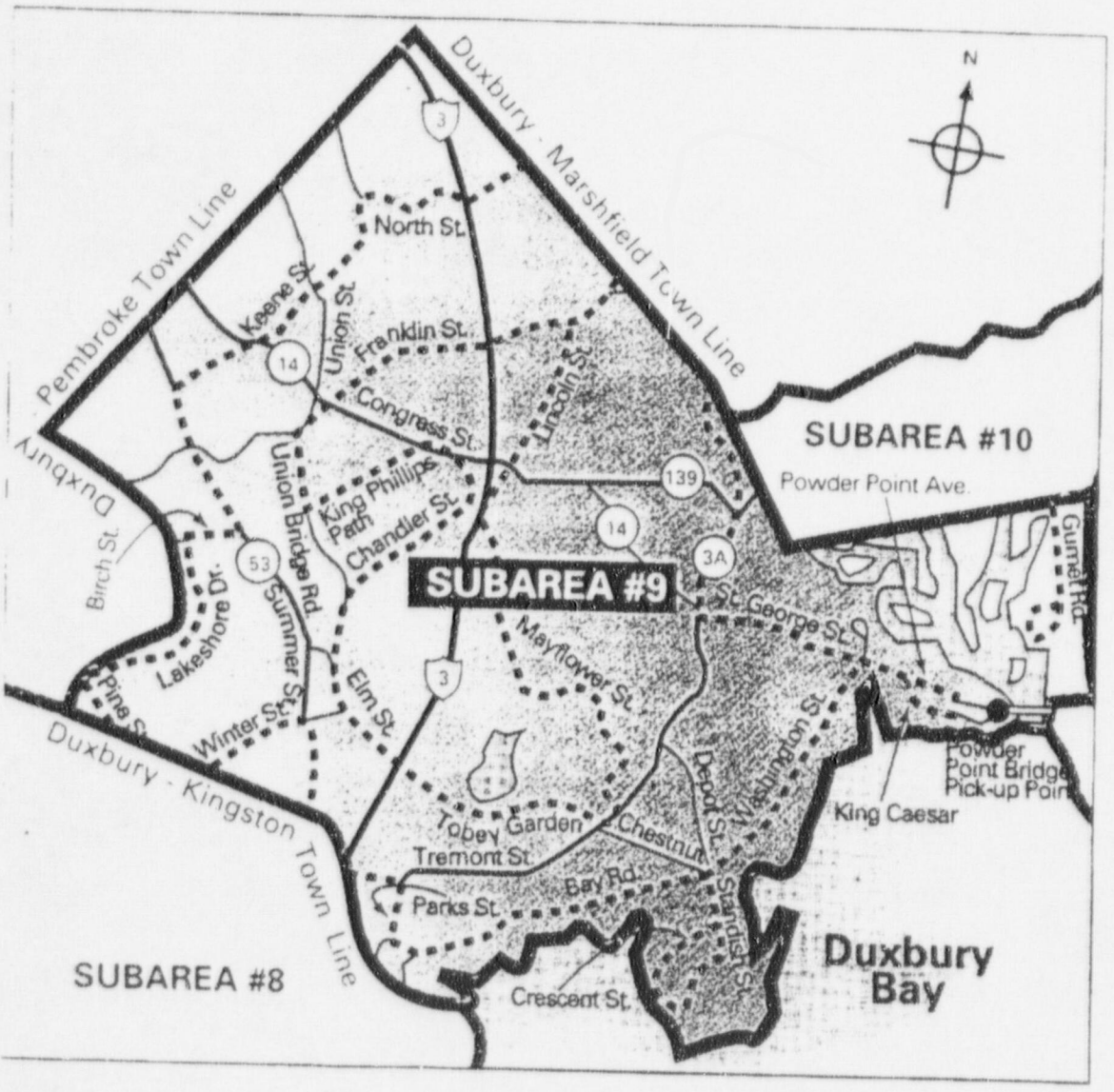

Figure O-9. Bus Routes for Subarea 9

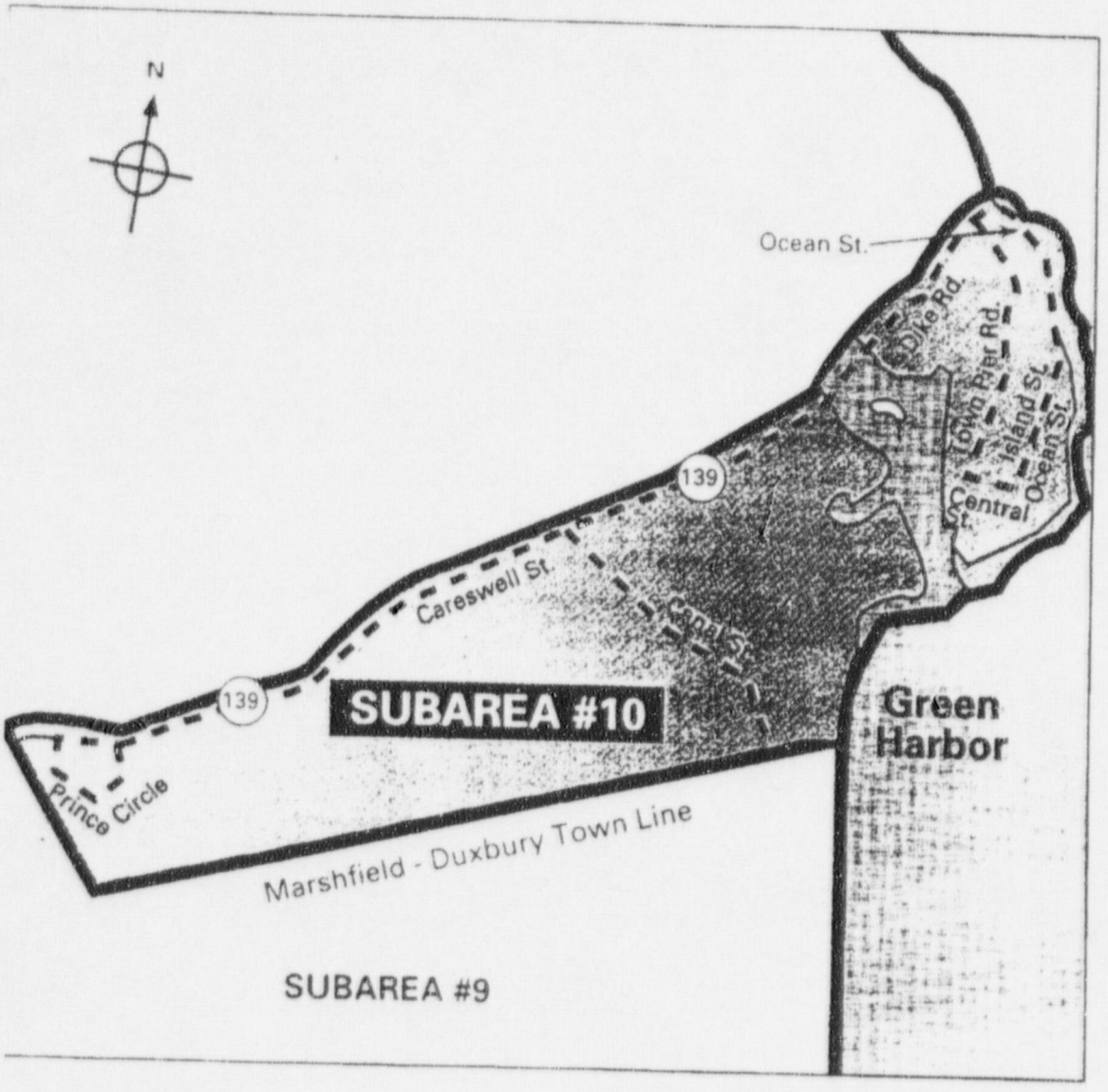

Figure O-10. Bus Routes for Subarea 10

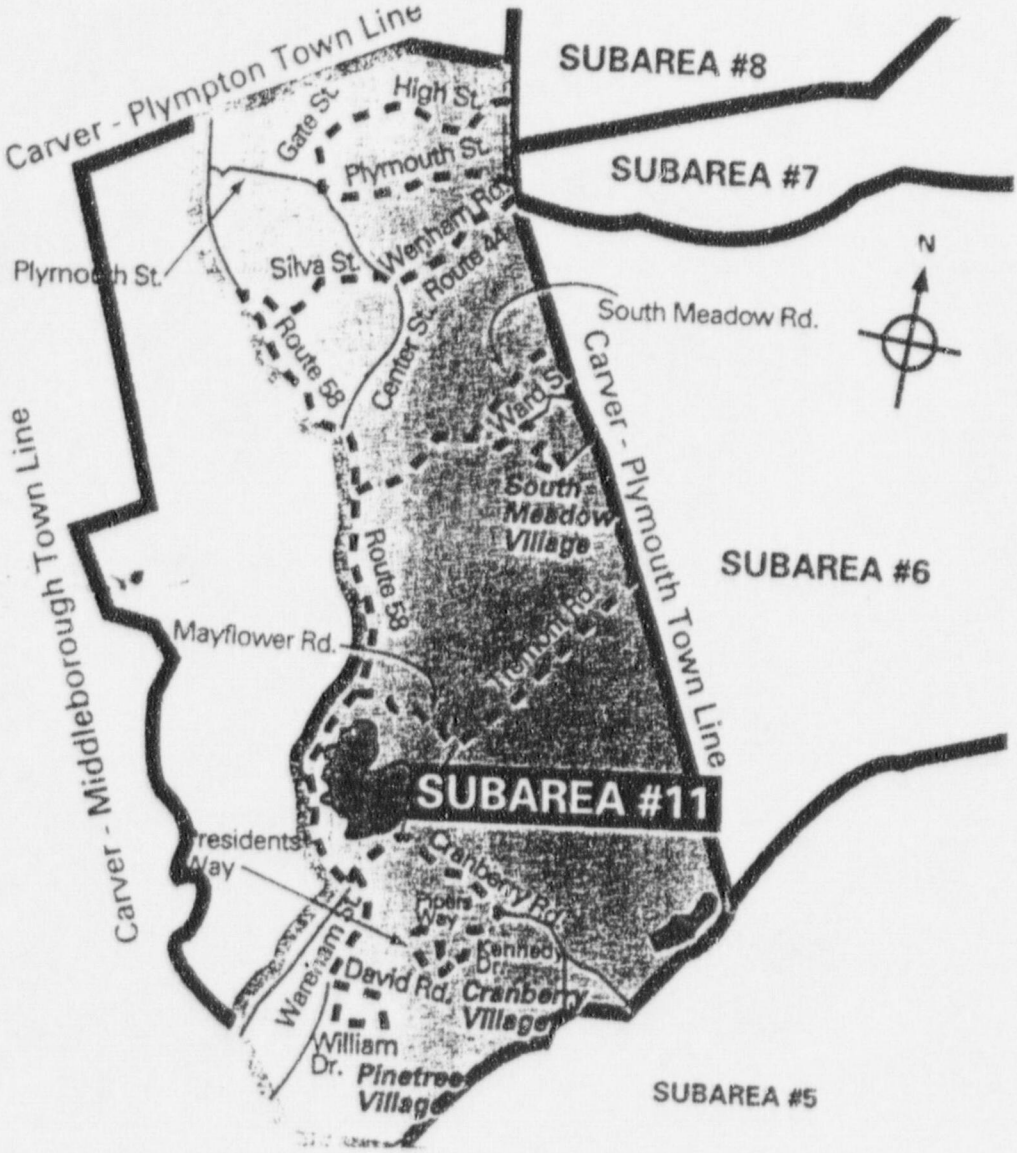

Figure O-11. Bus Routes for Subarea 11

The following tables present proposed bus schedules for each of the transportation staging areas as well as the four bus pick-up points. Analysis of bus operations in Chapter 10 indicated that the evacuation of transit dependents can be accomplished over the same period of time as the evacuation of the general public. As a result, bus headways presented in the following tables are designed so that the last bus run for each route ends about the same time evacuation is completed. Further, the longest bus headway was fixed at 30 minutes.

These bus schedules are to be considered advisory. The staging area dispatchers may modify the bus schedules to shorten headways if conditions warrant.

In the event an evacuation directive is issued and buses have been prestaged to transportation staging areas, the first bus run should be initiated approximately 30 minutes after public notification of the protective action. This period of time allows evacuees to perform the necessary preparatory activities and proceed to their bus routes.

Table O-1: Proposed Bus Run Schedules:
Scusset Beach Staging Area

Bus Run Number	Elapsed Time (Hrs., Mins.) From The Start Of The First Bus Run	
	Run Start Time	Run Completion Time
P-1.1	0:00	2:04
P-1.2	0:15	2:19
P-1.3	0:30	2:34
P-1.4	0:45	2:49
P-1.5	1:00	3:04
P-1.6	1:15	3:19
P-1.7	1:30	3:34
P-2.1	0:00	2:04
P-2.2	0:15	2:19
P-2.3	0:30	2:34
P-2.4	0:45	2:49
P-2.5	1:00	3:04
P-2.6	1:15	3:19
P-2.7	2:00	3:34
P-3.1	0:00	1:36
P-3.2	0:20	1:56
P-3.3	0:40	2:16
P-3.4	1:00	2:36
P-3.5	1:20	2:56
P-3.6	1:40	3:16
P-3.7	2:00	3:36
P-4a.1	0:00	1:39
P-4a.2	0:30	2:09
P-4a.3	1:00	2:39
P-4a.4	1:30	3:09
P-4a.5	2:00	3:39
P-4b.1	0:00	1:43
P-4b.2	0:30	2:13
P-4b.3	1:00	2:48
P-4b.4	1:30	3:23
P-4b.5	2:00	3:58

Table O-2: Proposed Bus Run Schedules:
Carver Town Hall Staging Area

Bus Run Number	Elapsed Time (Hrs., Mins.) From The Start Of The First Bus Run	
	Run Start Time	Run Completion Time
C-1.1	0:00	2:05
C-1.2	0:30	2:35
C-2.1	0:00	2:58
C-2.2	0:00	2:58
C-2.3	0:12	3:10
C-2.4	0:12	3:10
C-2.5	0:24	3:24
C-3.1	0:00	2:19
C-3.2	0:30	2:39

Table O-3: Proposed Bus Run Schedules:
Silver Lake High School Staging Area

Bus Run Number	Elapsed Time (Hrs., Mins.) From The Start Of The First Bus Run	
	Run Start Time	Run Completion Time
K-1.1	0:00	1:20
K-1.2	0:25	1:45
K-1.3	0:50	2:10
K-1.4	1:15	2:35
K-1.5	1:40	3:00
K-1.6	2:05	3:25
K-2.1	0:00	2:05
K-2.2	0:15	2:20
K-2.3	0:30	2:35
K-2.4	0:45	2:50
K-2.5	1:00	3:05
K-2.6	1:15	3:20

Table O-4: Proposed Bus Run Schedules:
Martinson Jr. High School Staging Area

Bus Run Number	Elapsed Time (Hrs., Mins.) From The Start Of The First Bus Run	
	Run Start Time	Run Completion Time
M-1.1	0:00	1:47
M-1.2	0:30	2:17
M-1.3	1:00	2:47
M-2.1	0:00	1:05
M-2.2	0:30	1:35
M-2.3	1:00	2:05
M-3.1	0:00	1:38
M-3.2	0:30	2:08
M-3.3	1:00	2:38
M-4.1	0:00	1:55
M-4.2	0:30	2:25
M-4.3	1:00	2:55

Table O-5: Proposed Bus Run Schedules:
Bus Pick Up Points

Bus Run Number / Pick Up Point	Elapsed Time (Hrs., Mins.) From The Start Of The First Bus Run: Run Start Time	Run Completion Time
Cordage Park		
CP-1	Buses depart Pick Up Points when they are filled with evacuees	
CP-2		
CP-3		
CP-4		
CP-5		
Robbins Road		
RR-1	The last bus to leave a Pick Up Point should depart approximately 4:30 after the directive to to evacuate is issued	
RR-2		
RR-3		
RR-4		
RR-5		
Sheraton Plaza		
SP-1		
SP-2		
SP-3		
SP-4		
SP-5		
Powder Point Bridge		
PP-1		
PP-2		
PP-3		

APPENDIX P

Review of Highway Construction Affecting Evacuation Routes

Review of Highway Construction Affecting Evacuation Routes Calendar Year 1999-2000-2001

Discussions were held with officials of the agencies listed below. In each case, the named party was asked if there were any highway construction or repair projects that are scheduled for the next three construction seasons that would potentially impact an evacuation from the Pilgrim EPZ. The responses and impacts on the ETE are discussed below.

Plymouth Department of Public Works
Leighton Peck
(508)747-1620

No construction activities anticipated.

Kingston Highway Department
(Vacant)
(617)585-0513

No construction activities anticipated

Carver Department of Public Works
William Halunen
(508)866-3425

No construction activities anticipated

Duxbury Department of Public Works
Walter Tonaszuck
(781)934-6586

Route 3/3A bridge replacement, 1998. No impacts to Route 3; reduced capacity along Route 3A at the construction site.

Route 3/Route 14 Rotary construction (April, May through December 1999). No impacts to Route 3; reduced capacity along Route 14 at the construction site.

Marshfield Department of Public Works
Joseph Roderick, Highway Supervisor
(781)834-5596

No construction activities anticipated

Massachusetts Department of Public Works
District 5
Bill Dalton - District Project Coordinator
(508)824-6633

Route 3/Route 44 Connector at Exit 7 Bids opened April 1998, construction scheduled to begin in August 1998. A limited access connector between Route 3 in Plymouth and the two lane section of Route 44 (leading to Middleborough) which starts at Route 58 in Carver will be built. Since this construction is a new road, no impacts on evacuation times are anticipated. Once the road is completed, it must be incorporated into any future plan updates.

Route 3 repaving from Duxbury to Hingham (Summer, 2000)- no adverse impacts anticipated.

Replacement of Sagamore Rotary - Project scheduled beyond 2001.

APPENDIX Q

EVACUATION TIME ESTIMATE SENSITIVITY TESTS

Sensitivity Tests

As discussed in Section 9, a Planning Basis was adopted for calculating the ETE. It is important to explore the effects, on ETE, of variations about this basis. This discussion presents the results of such analyses. All comparisons are based upon the ETEs estimated in Revision 0.

Slower Rates of Accident Escalation

As the period of time between the General Emergency declaration (siren activation) and the Directive to Evacuate increases, more people are afforded the opportunity to be ready to evacuate when the directive is issued. Consequently, it is expected that the ETE (measured from the Directive to Evacuate) will lessen as the elapsed time between the General Emergency declaration and the Evacuation Directive increases.

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

- Twenty-five percent of the population who are ready to evacuate prior to the Directive to Evacuate would evacuate before or to the issuance of the Evacuation Directive.
- The remaining 75 percent will prepare for evacuation, as determined for the Planning Basis, but will await the Directive to Evacuate before commencing the evacuation trip.

A total of 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 directed to evacuate). Associated with these escalation rates are varying elapsed times between the Declaration of a General Emergency and the Directive to Evacuate, as follows:

- Ten minutes (see Chapter 4 for a discussion of the Planning Basis)
- One Hour and Ten Minutes
- Two Hours and Ten Minutes
- Three Hours and Ten Minutes

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

Elapsed Time from the Declaration of a General Emergency to the Evacuation Directive	ETE for Evacuation from Within the Indicated Areas around the Pilgrim Station, Referenced from the Evacuation Directive			
	2 miles	5 miles	10 miles	EPZ
0:10 (Planning Basis)	3:35	4:20	4:35	4:40(Rev.0)
1:10	2:35	3:40	3:45	3:45
2:10	1:40	3:15	3:20	3:25
3:10	1:40	3:10	3:15	3:15

As indicated, the longer the elapsed time between the General Emergency Level and the Evacuation Directive, the lower the associated ETE. This sensitivity is pronounced: there is roughly one minute of reduction in ETE for every minute of increase in the elapsed time, over the first two hours. The rate of decrease in ETE falls off after the elapsed time between the General Emergency announcement and the Evacuation Directive exceeds about two hours.

As the elapsed time increases to about 3:10, the ETE settles down to approximately 3:15. By this time all evacuees are ready to depart and 25 percent of them have already evacuated.

Effects of Traffic Accidents

Since traffic accidents[1] are "rare events", an analysis of their impact on a specific event -- emergency evacuation -- is prone to subjective judgment. The domain of postulated events is unbounded; that is, one can always postulate the occurrence of any combination and type of events with the argument that the postulate is "possible".

Even an analysis based on aggregate empirical statistics is subject to criticism on the basis that the process of evacuation during a radiological emergency is "different" than ordinary traffic operations. On one hand, it can be argued that the heightened state of motorist anxiety during evacuation could promote unsafe driving activities. On the other hand, it could be argued that the low travel speeds characteristic of the expected congested conditions precludes the prospect of serious accidents and that a state of motorist anxiety translates into increased attentiveness.

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[1] For this purpose, we extend the concept of "accident" to include any event which can block, either completely or partially, a lane of traffic, for some interval of time.

While the available data does not support the thesis that traffic operations during an evacuation differs materially from that during normal congested conditions, it is not our intent to address these behavioral issues here. Rather, we will apply a "reasonable" approach to estimating the number of accidents that could occur during an evacuation, and then utilize the simulation tool to calculate their impact on evacuation time.

Referencing the 1987 Edition of "Accident Facts" published by the National Safety Council yields the following statistics

Number of Vehicle-Miles	1,861 Billion
Number of Accidents:	
Property Damage	16,500,000
Injury	1,250,000
Fatal	42,300
Total	17,792,300

Consequently, an overall accident rate may be estimated:

One accident per 105,000 vehicle-miles

Evacuation of the entire population of the EPZ during a summer, weekend, midday scenario will generate approximately 515,000 vehicle miles of travel within the EPZ. By multiplying this figure by the above rates, the expected number of accidents during evacuation may be estimated:

Expected number of accidents = 5

The procedure used to determine the impact of the five expected accidents was as follows:

1. Randomly assign these accidents to different roadway sections on the evacuation network, subject to the condition that these roadway sections are heavily traveled.

2. The time of initiation of these incidents was fixed at about one hour after the beaches begin clearing. It was further asserted that three of the blockages prevailed for two hours and two of the blockages prevailed for one hour.

3. If the roadway section consisted of one lane of travel, then capacity for that lane would be reduced by 50 percent, based on the premise that evacuation vehicles would bypass the blockage by traveling on the shoulder or encroaching into the opposing lane. If the roadway section consisted of two or more lanes, then it was assumed that one lane was removed from service during the blockage period.

This procedure was replicated a total of five times. Each replication utilized a different set of links for the placement of blockages. Results of these studies indicated that the presence of these incidents might increase the ETE by between 5 and 20 minutes.

Careful examination of the computer output revealed that the roadway blockage did, in fact, impede traffic. These impedances, however, were in some cases less than the impedances produced downstream of the accidents, by the heavy congestion (i.e., excess of demand relative to available capacity). Consequently, while the presence of road blockage affected the spatial location of delay within evacuation network, as well as the details of the temporal distribution of delay at those locations influenced by these transient accidents, the overall effect, relative to the base condition of no accidents, was not significant.

As discussed at the beginning of this section, it is always possible to postulate roadway blockages "strategically" so as to guarantee an impact on evacuation travel. Such an approach might be useful, in our view, as part of an evacuation exercise, to test the response of personnel to such an unscheduled event.

Our study, however, had the objective of assessing expected events and their impact; such an objective mandates the application of random events, as described above.

On the basis of this study, it can be concluded that a limited number of transient blockages randomly dispersed in time and space, will probably have little, if any, impact on evacuation travel time.

Effects of Varying Snowfall Intensity Levels

Weather is one of the many major factors which influence highway capacity. Each type of influencing weather condition is addressed separately within the ETE. Highway capacity reductions of 20 and 25 percent for rain and snow respectively were utilized in the ETE. These figures are responsive to the guidelines established by the 1985 Highway Capacity Manual.

A contention has been voiced that the winter snow scenarios presented in the ETE does not represent "severe winter storms" conditions. Using data presented in the National Cooperative

Highway Research Program Report 127, it is possible to estimate the meteorological conditions which would cause a 25 percent reduction in highway capacity. Figure Q-1 presents the relationships between snowfall intensity, asymptotic free flow speed factor and highway capacity factor. The underlying assumption used to develop this graph is that the indicated rate of snowfall extends over at least

five hours and that no snow plowing occurs during the snowfall. As indicated, a 25 percent reduction in capacity corresponds to a snowfall of one inch per hour over a period of at least five hours.

Two sensitivity tests were conducted with the off-season, midweek, midday, snow scenario for the evacuation of the entire EPZ.

Using Figure Q-1, two snowfall conditions were defined: a "light" snowfall of 1/2 inch per hour over five hours; and, the Planning Basis snowfall of one inch per hour, over five hours. The results of these sensitivity tests are shown below:

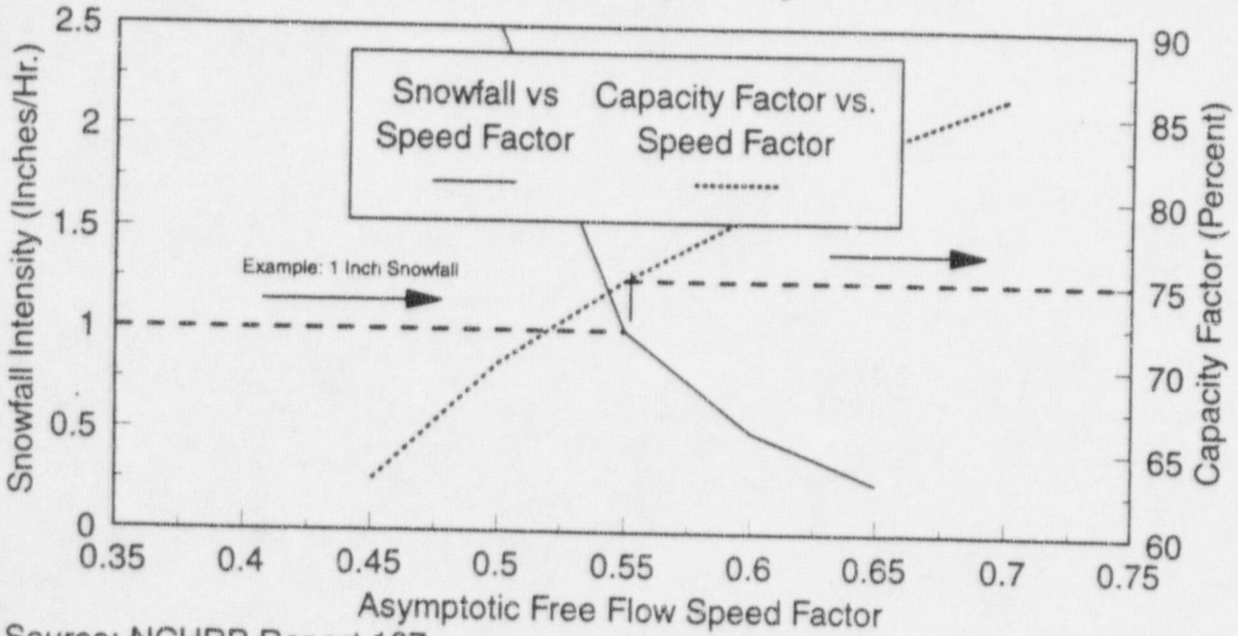
Snowfall Intensity	Capacity Factor	Evacuation Time Estimate for the Entire EPZ
0.5	81%	5:55
1.0	75%	5:55 (Planning Basis) Rev.0

Note that the planning basis conservatively assumes that half of an average month's snowfall, of about 10 inches, falls in only 5 hours.

Effects of Varying Capacity Factors

Traffic engineers have known for some time that under congested traffic flow conditions, the vehicular service volume may be less than capacity. Empirical studies on freeways have indicated that the service volume under congested conditions ranges from 75 to 100 percent of the freeway capacity operating in undersaturated conditions. We have adopted a value of 85 percent as part of the Planning Basis. (Note: in NUREG/CR-4873, a study was conducted at a single site which yielded the conclusion that no reduction in capacity was experienced there.)

Figure Q-1. Relationship Between Snowfall Intensity and Highway Capacity Factor



Source: NCHRP Report 127

(Snowfall extends over at least 5 hours with no plowing)

A sensitivity study was conducted to assess the sensitivity of the ETE to a range of capacity factors. The study was conducted utilizing Region 22, Scenario 1 data. The results are shown below:

Capacity Factor	ETE for the Entire EPZ
95%	4:35
85%	4:40 (Rev.0)
75%	5:10

Effects of Late Manning of Traffic and Access Control Points

A sensitivity study was performed to determine the effects of delays in manning traffic and access control points upon the ETE. The study utilized Region 22, Scenario 1 as a basis.

Current planning assumptions call for the implementation of access control and diversion along Route 3 in Weymouth and Sagamore starting at the Site Area Emergency Classification. Traffic control measures are implemented when the Evacuation Directive is issued. The following scenarios were studied:

Base Case - Route 3 access control is initiated at the Site Area Emergency Classification. EPZ Traffic Control is initiated at the issuance of the Evacuation Directive.

Case 1 - Route 3 access control is initiated as scheduled. EPZ Traffic Control is initiated 35 minutes after the Evacuation Directive is issued.

Case 2 - Route 3 access control is delayed by 1 hour and it is initiated 35 minutes after the Evacuation Directive is issued. EPZ Traffic Control is initiated 35 minutes after the Evacuation Directive is issued.

The following ETEs were noted:

Base Case	Case 1	Case 2
4:40 (Rev.0)	4:45	5:20

The absence of traffic control within the EPZ for the first 35 minutes of evacuation causes little effect on the overall ETE. A more pronounced effect is evident if traffic is not diverted from Route 3 in a timely manner. Note that EPZ Traffic Control is not assumed to increase traffic capacity; the absence of traffic control will result in less efficient routing by evacuees.

Effects of Commuter Traffic

A number of concerns have been raised about the treatment of commuter traffic in the development of the ETE. The effects of commuter traffic may be felt in two areas: estimates of highway capacity, and the development of trip generation times.

Estimates of highway capacity on two-lane, two-way roads depends, to an extent, upon the directional split of traffic on the road. As a planning basis, the ETE assumes that, over the course of the evacuation, about 90 percent of traffic will be moving in the outbound direction. During the first 1.5 hours of the evacuation, when 85 percent of homebound commuters have arrived home, the directional split may be different than this value, thus affecting the capacity of evacuation routes.

It has further been noted that commuters returning home to prepare for evacuation may experience traffic congestion which lengthens their work-to-home travel time. Should such congestion occur, then the evacuation trip generation process would lengthen for families with commuters.

It is, therefore, prudent to investigate these effects. The case chosen to study the effects of commuter traffic was Region 22, Scenario 3 (Summer, Midweek, Midday, Good Weather), a scenario which combines full employment with a large number of transients in its population mix. The following assumptions were made:

1. Due to congestion, home-to-work travel time for the portion of the commuter trip which is within the EPZ would double. Travel times for the portion of the commuter trip which takes place outside the EPZ does not change. Once the public has been notified of an emergency, persons can be expected to defer discretionary trips to areas within the EPZ. Thus returning commuters may find these roads less heavily traveled and their travel times (for this portion of the trip) unaffected. This assumption was used to modify the distribution of Time to Travel Home (Distribution 3) in Section 3. The procedures in Section 3 were applied to generate a revised Distribution F describing the trip generation characteristics of permanent resident households including commuters who experience delay. The revised Distribution F increased the trip generation time for this population group by 15 minutes, from 4:10 to 4:25.

2. The directional split of traffic on two-lane, two-way roads will vary with time. At the start of evacuation, a significant volume of inbound traffic representing

returning commuters can be expected. Based on the distribution of Section 4, it is estimated that the directional splits of traffic (i.e. the ratio of outbound evacuating vehicles, to inbound commuters) over time, are as follows:

Directional Split Outbound/Inbound	Duration (Minutes)	Percent of Outbound Roadway Capacity, Relative to Planning Basis (90/10 split)
45/55	30	65
55/45	30	79
68/32	30	91
83/17	30	98
98/2	Thereafter	104

These capacity reductions were applied to the following major commuting routes: Route 139, Route 14, Route 44, Route 3A North, Route 3A South, Route 58, Route 53, Route 27, Route 106, Route 80, and Tremont Road in Carver, where traffic control is not specified. Where traffic control is specified, capacity is determined by the allocation of service time to competing traffic flows. The effects of directional split at these locations is explicitly considered in the allocation of service times.

The results of this sensitivity analysis indicate that, under the indicated conditions, the ETE is unchanged when the effects of commuters on roadway capacity are considered explicitly.

The relative insensitivity of the Planning Basis ETE is consistent with traffic theory. The increase in trip generation time from 4:10 to 4:25 is significantly less than the Planning Basis ETE of 5:05. Hence, the ETE is more dependent on the capacity constraint of the roadway system than on trip generation time. See NUREG/CR-4874 for a fuller description. The reduction in capacity during the initial 1.5 hours of evacuation is partially offset by the effects of the lengthened trip generation time. Since commuters are delayed in returning home, there is a delay in the start of the evacuation trip for families with commuters. During the 1.5 hours when capacity is affected by the different directional split, 9 percent fewer evacuation trips are begun by families with commuters. Thus to some extent, the reductions in capacity during this period is offset by reduced vehicular demand.

The net effect, as shown is nil. This sensitivity test demonstrates that a more refined treatment of commuter flow is not warranted; the effect on ETE falls well within the computational uncertainties associated with any planning analysis of this type.