AN

EVACUATION TIME ASSESSMENT

OF

NINE NUCLEAR POWER PLANTS EMERGENCY PLANNING ZONES

EXECUTIVE SUMMARY

Prepared for

FEDERAL EMERGENCY MANAGEMENT AGENCY

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INTRODUCTION

An independent assessment of evacuation times for nine nuclear power plant sites was made for the Federal Emergency Management Agency. The results of this three-month study are contained in ten volumes:

Volume I - Program Report - Evacuation Time Assessment of Nine Nuclear Power Plant Emergency Planning Zones (EPZ's)

Volume II - Bailly Nuclear Power Plant Evacuation Time Assessment

Volume III - Beaver Valley Nuclear Power Plant Evacuation Time Assessment

Volume IV - Enrico Fermi Nuclear Power Plant Evacuation Time Assessment

Volume V - Limerick Nuclear Power Plant Evacuation Time Assessment

Volume VI - Maine Yankee Nuclear Power Plant Evacuation Time Assessment

Volume VII - Midland Nuclear Power Plant Evacuation Time Assessment

Volume VIII - Millstone Nuclear Power Plant Evacuation Time Assessment

Volume IX - Shoreham Nuclear Power Plant Evacuation Time Assessment

Volume X - Three Mile Island Nuclear Power Plant Evacuation Time Assessment

This executive summary contains conclusions of the assessment for all of the nuclear power plants reported in detail in Volumes II through X above. A brief summary of the methodology, discussed in Volume I, is also provided.

Evacuation Time Assessment Versus Evacuation Plan

The assessment employs available demographic data and transportation facility information to predict the public response time to an evacuation warning on the assumption that such a warning is made within 15 minutes of an on-site nuclear incident warranting such emergency action.

The assessment provides for estimates of public response time to these warnings, assembly of family and other groups, preparation for departure, travel time on the network including consideration of capacity limitations on the network creating congestion and possibly forming queues which add to delays, and clearance of the 10-mile radius around the site. It considers the evacuation of special problem areas and groups. These would include schools, nurseries, nursing and retirement homes, hospitals, penal facilities, beaches and recreational areas, and other activities which may provide periodic or seasonal concentrations of people. Population groups without access to their own transportation or unable to provide the special transportation facilities required for evacuation are considered in the evacuation time assessment.

Evacuation time assessment methodology combines selected techniques of traffic management and planning, land use planning and operational analysis. Because some conditions prevailing during an evacuation are not well documented, modifications to some established principles were required to meet evacuation requirements. Assumptions were required in lieu of well formulated relationships because of the highly specialized problems being addressed. These assumptions were founded on professional judgement and/or extrapolation from existing knowledge. These assumptions have been specifically identified. The bases upon which the assumptions are founded are appropriately discussed.

Evacuation time assessments contain basic methodology common to evacuation plan development. However, the assessment is not an evacuation plan. The major distinction between the assessment and a plan is the extent to which the elements have been coordinated with all participant agencies and jurisdictions. For example, the assessment may assume that a specific traffic management element is established to optimize traffic operations at a specific location along an evacuation network. The feasibility of such an element in the assessment is based upon established technical principles.

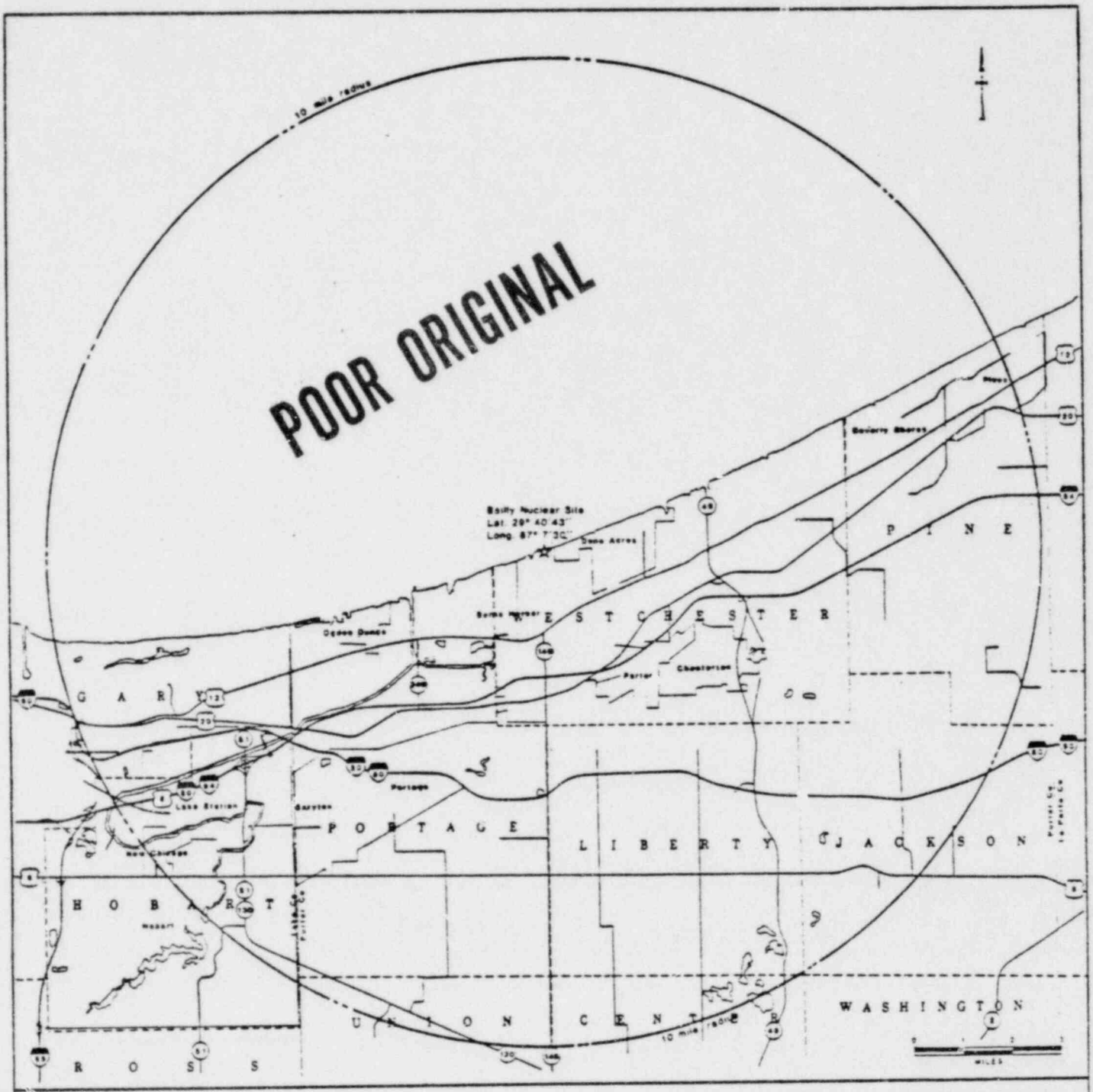
However, the elements have not been coordinated with specific law enforcement agencies to establish what agency would exercise the element control and management nor identify the type and number of personnel to be required. The study time allotted makes such coordination impossible. This assessment identifies what is required for the evacuation time to be realized, and assumes that such an element would be implemented.

EVACUATION TIME ASSESSMENT PROGRAM

The assessment of evacuation times was performed in the nine Emergency Planning Zones (EPZ's) illustrated in Figures 1 through 9. The general procedures entailed the development of planning zones within these areas, from local sources, the assembly of demographic data related to those planning zones and the analysis of the existing highway facilities serving those zones. The population to be evacuated in each of these zones was subdivided into population centroids, based upon the highway facilities available to serve as evacuation routes.

An evacuation route was determined by traffic engineering analyses to evacuate the centroid population to a point intersecting the 10-mile radius of the EPZ. Network links were identified for each of these routes. Link characteristics of distance, speed and capacity were identified for each evacuation route. Centroid population was translated to vehicles leaving each centroid by an appropriate car occupancy value.

These data were analyzed by a computer program which represented the evacuation network. Public response to an evacuation warning was statistically divided into four basic activities: (1) receive warning, (2) leave present non-home based location, (3) travel time non-home location to home, and (4) evacuate home. These responses were time distributions relating the percent of the population responding to these various reactions as a function of time after the warning was issued. Analysis programs were then used to develop selected combinations of these reactions which fit the conditions of four scenarios-- normal workday, nighttime, summer peak and bad weather. These combinations represented the total distribution of time for vehicles to enter the evacuation route from each centroid.



STUDY SITE LOCATION
EVACUATION TIME ASSESSMENT

BAILLY

FIGURE 1

STUDY SITE LOCATION
EVACUATION TIME ASSESSMENT

BEAVER VALLEY

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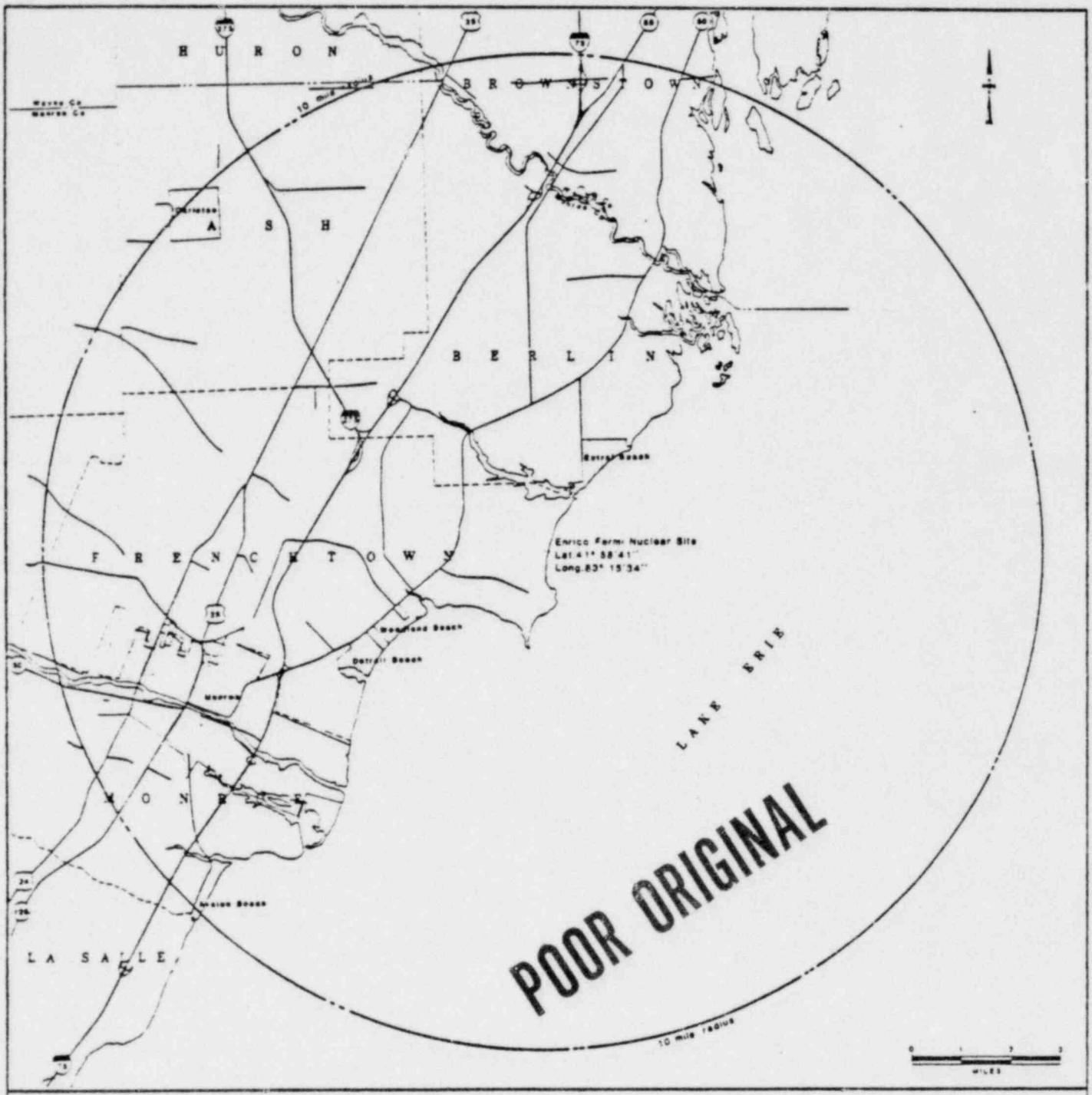
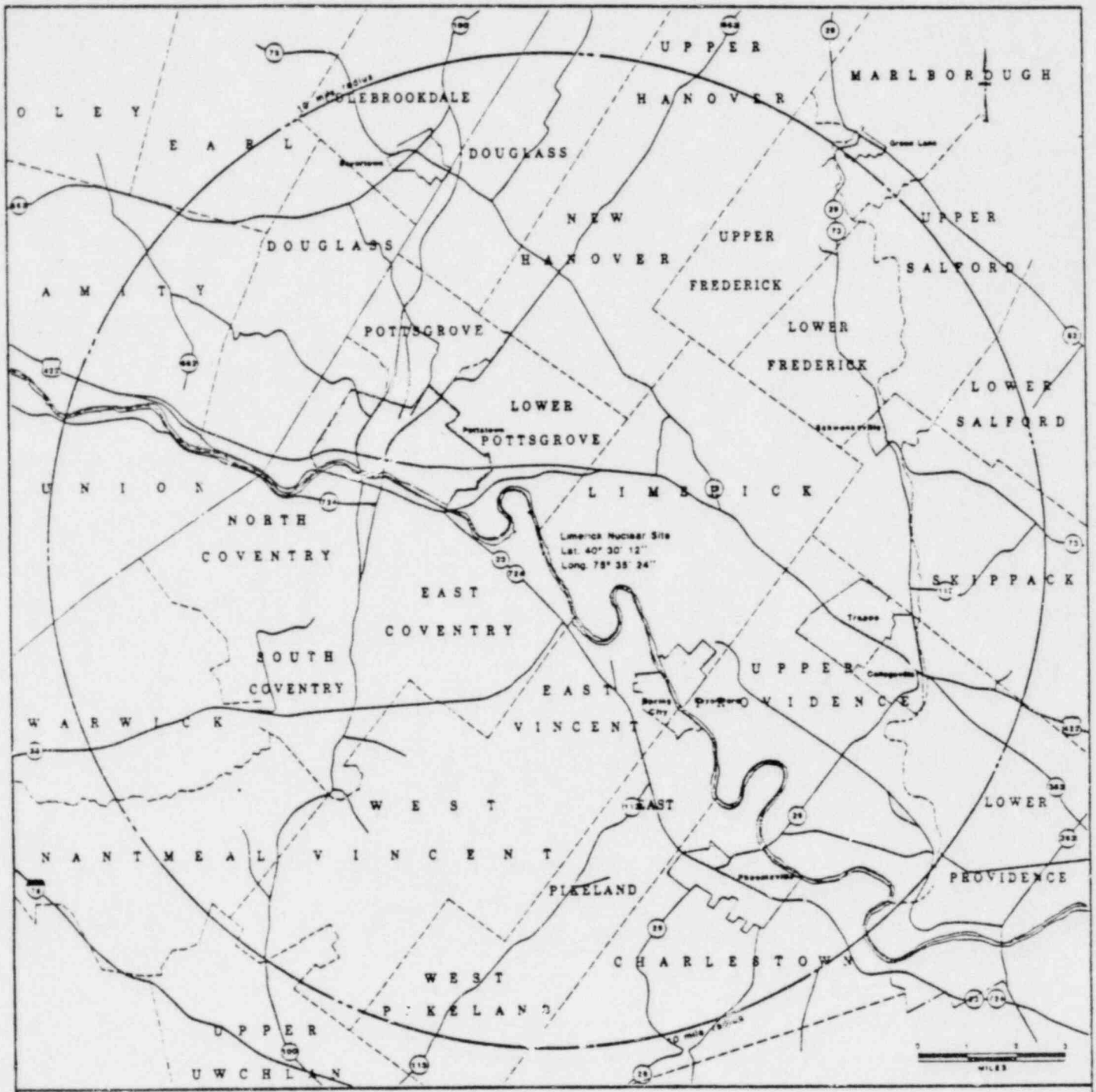
FIGURE 2



STUDY SITE LOCATION
EVACUATION TIME ASSESSMENT

ENRICO FERMI

FIGURE 3



STUDY SITE LOCATION
EVACUATION TIME ASSESSMENT

LIMERICK

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FIGURE 4

STUDY SITE LOCATION
EVACUATION TIME ASSESSMENT

MAINE YANKEE

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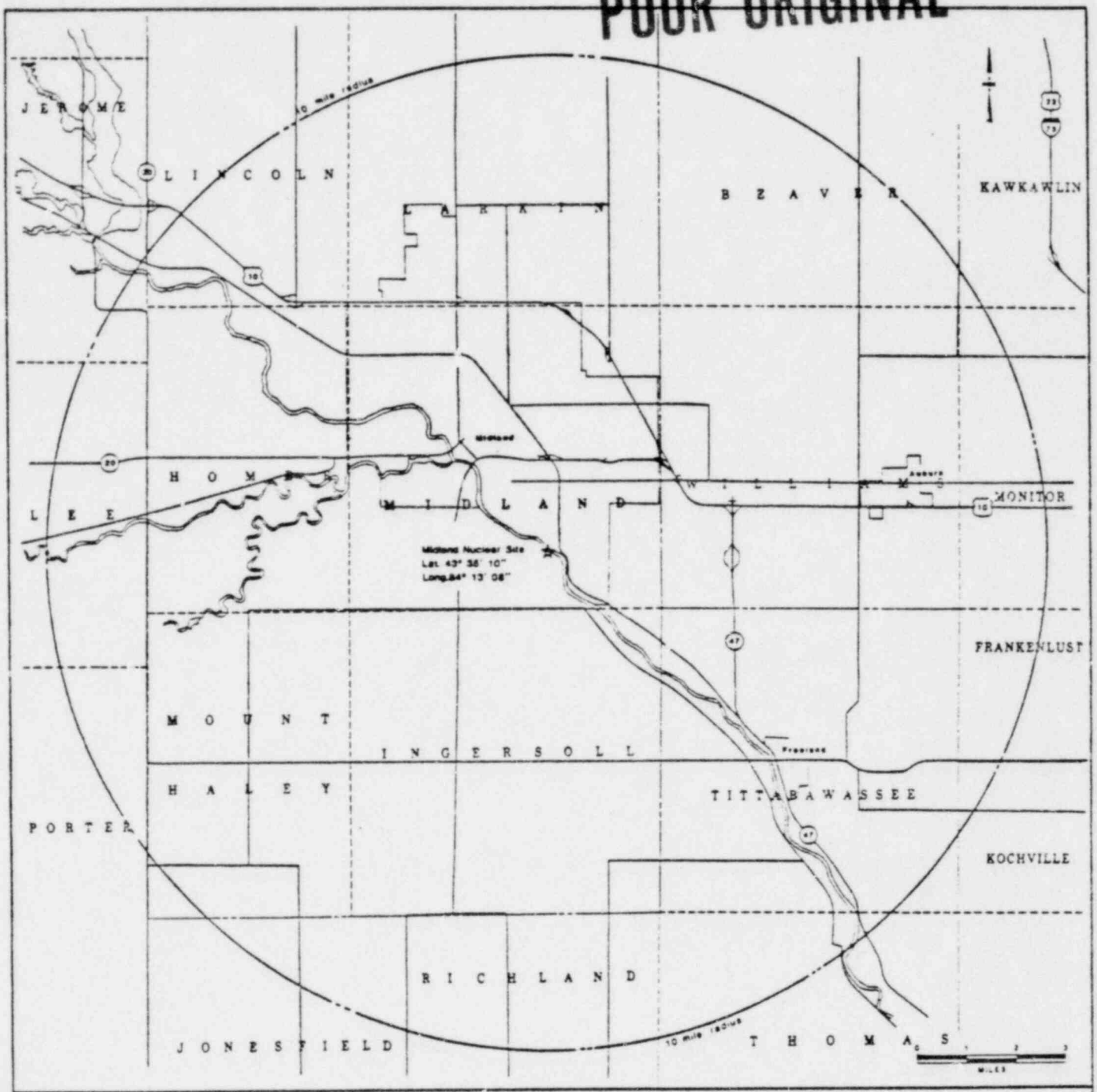
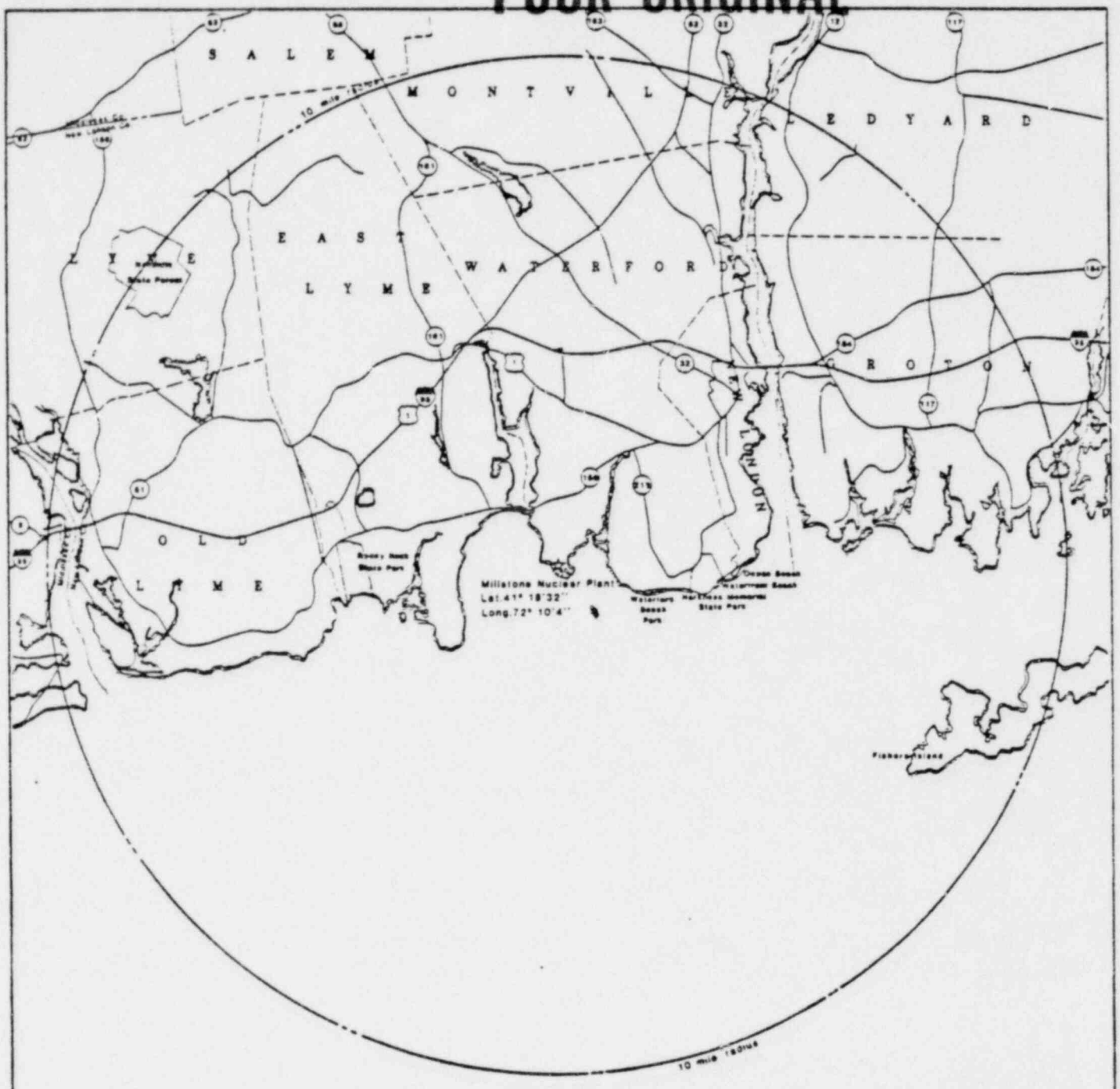
FIGURE 5



STUDY SITE LOCATION
EVACUATION TIME ASSESSMENT

MIDLAND

FIGURE 6



STUDY SITE LOCATION
EVACUATION TIME ASSESSMENT

MILLSTONE

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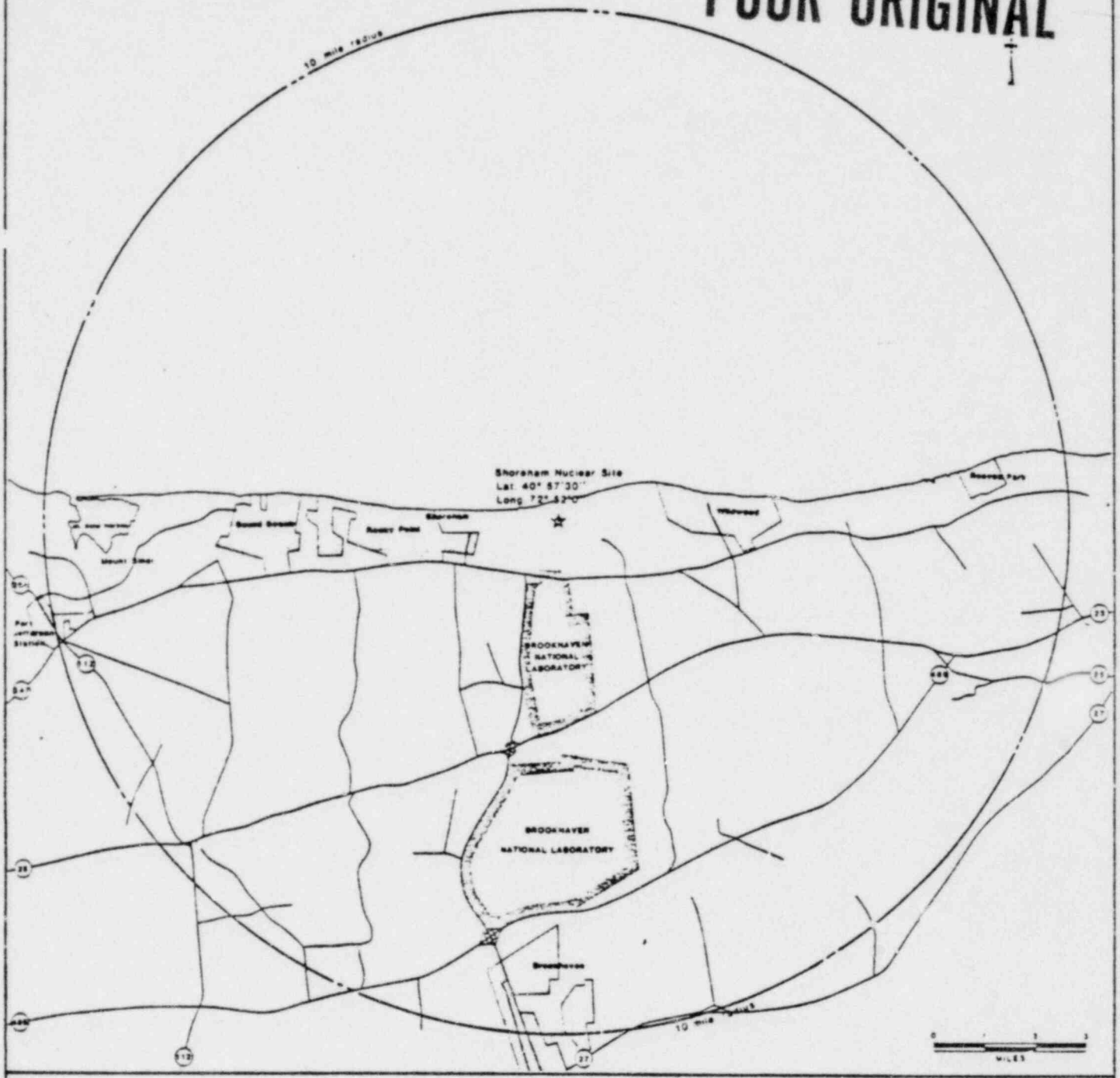
FIGURE 7



STUDY SITE LOCATION
EVACUATION TIME ASSESSMENT

SHOREHAM

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FIGURE 8

POOR ORIGINAL

STUDY SITE LOCATION
EVACUATION TIME ASSESSMENT

THREE MILE ISLAND

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FIGURE 9

The program then distributed vehicles leaving the centroid in four basic time increments as determined by total combined distribution. Travel time and the delay time resulting from congestion that might occur on any link of the evacuation route due to its limited capacity in relation to the assigned volume was computed, and summed with the mobilization time.

The evacuation time for each centroid to the external point where its evacuation route leaves the 10-mile radius of the EPZ was the output of the analysis program providing the basic information for the evacuation time assessment.

Special problem areas such as beaches, hospitals, schools, nursery schools, jails, employment centers and other areas of population concentration were identified. In some cases, such as beaches and employment centers, centroids were created in the network and appropriate population statistics were assigned for certain scenario evaluations. Evacuation of hospitals, schools, nursery schools and jails were analyzed in the assessment.

The assessment study also considered several mechanisms for confirming evacuation of the area. Recommendations for the improvement in evacuation time were also provided.

CONCLUSIONS

A summary of the maximum evacuation time by the four scenarios of normal workday, nighttime, summer, and bad weather are presented in Table 1, along with the identification of the problem area experiencing the time shown. It must be recognized that evacuation begins within a short time and many areas have completely evacuated by the times indicated. Therefore, these times represent the worst case conditions in the respective plant areas.

The maximum evacuation time relative to the scenarios for all nine areas occurs in the Maine Yankee centroid for the bad weather scenario. Because of local conditions, this scenario assumed that a fog occurs on a summer afternoon while large crowds are at the beaches. In other scenarios, bad weather was defined as an ice storm which disrupted highway operations. In the same EPZ, the same problem area, Southport Island, could be evacuated in 130 minutes under normal workday conditions.

Beaver Valley had the longest workday evacuation time of 245 minutes, related to the evacuation of an area in Aliquippa. The evacuation of this area was seriously limited by available highway facilities. The same area had 230 minutes nighttime evacuation time.

Millstone had the highest summertime evacuation time of 319 minutes. The problem area was South New London, where increased summertime resident population and beach visitors combined with high density of the area and limited highway facilities to produce this condition.

Special problem areas were evaluated. A study of literature indicated that evacuations are more likely to be performed by the family as a group. School children were to be delivered

Table 1

MAXIMUM CENTROID EVACUATION TIME SUMMARY BY SCENARIO

(Minutes)

SITE	NORMAL WORKDAY		NIGHTTIME		SUMMER		BAD WEATHER	
	Time	Problem Area	Time	Problem Area	Time	Problem Area	Time	Problem Area
Bailly	180	Portage, Ind.	165	Portage, Ind.	294	Ind. Dunes State Park	190	Portage, Ind.
Beaver Valley	245	Aliquippa, Pa.	230	Aliquippa	No Change*		250	Aliquippa, Pa.
Enrico Fermi	115	Monroe, Mich.	100	Monroe, Mich.	No Change*		125	Monroe, Mich.
Limerick	190	East Coventry Township	175	East Coventry Township	No Change*		190	East Coventry Township
Maine Yankee	130	Southport Island	115	Southport Island	299	Southport Island	355	Southport Island
Midland	145	N.E. Ingersoll Township	130	N.E. Ingersoll Township	147	N.E. Ingersoll Township	175	N.E. Ingersoll Township
Millstone	185	So. New London, Conn.	170	So. New London, Conn.	319	So. New London, Conn.	205	So. New London, Conn.
Shoreham	155	South Beach Area	140	South Beach Area	176	South Beach Area	175	South Beach Area
Three Mile Island	180	Steelton, Pa.	165	Steelton, Pa.	No Change*		200	Steelton, Pa.

*Summertime population is the same as normal conditions. Evacuation time is therefore unaffected.