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Population Distribution Analyses for Nuclear Power Plant Siting

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Prepared by R. C. Durfee, P. R. Coleman

Oak Ridge National Laboratory

Prepared for
U.S. Nuclear Regulatory Commission

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

January 26, 1984

ERRATA SHEET

for

NUREG/CR-3056
ORNL/CSD/TM-197

POPULATION DISTRIBUTION ANALYSES FOR
NUCLEAR POWER PLANT SITING

Prepared by

Oak Ridge National Laboratory

for the

U. S. Nuclear Regulatory Commission

While the information and analyses reported in NUREG/CR-3056, "Population Distribution Analyses for Nuclear Power Plant Siting," remain valid for their intended purpose, the Commission recognized the value in the techniques which were developed for this project and ORNL has further refined them under contract to the Office of Nuclear Reactor Regulation. The more recent versions of these techniques give more accurate estimates and have been supplemented within 10 miles by interpretation of aerial photographs for all sites with operating plants. This information is available from the Site Analysis Branch of the Office of Nuclear Reactor Regulation.

In developing the improved techniques, errors of several kinds were noted. One error was with respect to the map coordinates of the operating plants. The United States Geological Survey had recently completed a check of all these locations and errors were found in the values previously used by the NRC staff and in this report. Table 1 lists those sites for which errors were found to exist and gives the correct values and the approximate magnitude of the difference between the actual location and that used in the report. In some instances this could significantly effect the populations ascribed to specific distances from the plant. The second set of errors was related to the distribution of populations and is discussed in the text. An example, Oyster Creek, is provided as Table 2 to show why more accurate distribution information should be used for serious discussions about any actual location. Please note, the analyses reported here are still valid for their original purpose. It is only their use in any other context which should be viewed with caution. For further information about populations around operating nuclear power plants contact the Site Analysis Branch, Office of Nuclear Reactor Regulation.

William R. Ott

William Ott, Section Leader
Facility Performance Section
Office of Nuclear Regulatory Research

TABLE 1
CORRECTED NPP LOCATIONS

PLANT NAME	CORRECTED LAT	CORRECTED LONG	APPROXIMATE ERROR LAT	APPROXIMATE ERROR LONG	APPROXIMATE ERROR FEET
Byron	42° 04' 30"	89° 16' 51"	0	+4"	290
Callaway	38° 45' 44"	91° 46' 54"	-4"	0	400
Catawba	35° 02' 05"	81° 04' 15"	0	-5"	410
Cherokee	35° 02' 11"	81° 30' 47"	+1"	-4"	350
Clinton	40° 10' 23"	88° 50' 03"	-4"	0	400
Comanche Peak	32° 15' 54"	97° 47' 08"	-2"	-2"	270
Fermi	41° 57' 47"	83° 15' 28"	+1"	+3"	250
Grand Gulf	32° 00' 27"	91° 02' 51"	0	+2"	170
Harris	35° 38' 01"	78° 57' 23"	-1"	-1"	130
Marble Hill	38° 36' 03"	85° 26' 44"	-3"	+9"	770
Midland	43° 35' 09"	84° 13' 23"	+1"	0	100
Palo Verde	33° 23' 17"	112° 51' 52"	+6"	-11"	980
Perry	41° 48' 03"	81° 08' 39"	+1"	-3"	250
River Bend	30° 45" 25'	91° 19' 53"	+1"	+1"	130
Seabrook	42° 53' 54"	70° 50' 59"	-1"	+6"	460
Skagit/Hanford	46° 29' 15"	119° 26' 04"	0	-7"	490
Susquehanna	41° 05' 32"	76° 08' 48"	-2"	+7"	570
Vogtle	33° 08' 29"	81° 45' 45"	+2"	+8"	710
Waterford	29° 59' 41"	90° 28' 16"	+1"	0	100
Watts Bar	35° 36' 08"	84° 47' 22"	+2"	+3"	330
Wolf Creek	38° 14' 19"	95° 41' 22"	+1"	+2"	190
WPPSS 14	46° 28' 32"	119° 19' 02"-	-29"	-11"	3,000
WPPSS 35	46° 57' 34"	123° 28' 15"	-23"	-4"	2,300

NOTE: Corrected numbers underlined.

TABLE 2
OYSTER CREEK
INCREMENTAL POPULATION DATA
COMPARISON BETWEEN NUREG/CR-3056 DATA AND STAFF ESTIMATES

DISTANCE, MILES	0 - 2		2 - 5		5 - 10		10 - 15		15 - 20		20 - 25		25 - 30	
	NUREG	STAFF EST	NUREG	STAFF EST	NUREG	STAFF EST	NUREG	STAFF EST	NUREG	STAFF EST	NUREG	STAFF EST	NUREG	STAFF EST
N	772	522	559	2946	25292	27596	25064	34012	53055	50296	25708	25290	23892	21995
NNE	0	702	528	1017	17279	15000	26232	20055	63319	65142	39174	35137	72073	78384
NE	825	519	1046	1019	3829	2000	6522	8527	4487	87	0	0	0	0
ENE	0	641	1128	459	445	75	0	0	0	0	0	0	0	0
E	519	595	570	15	473	15	0	0	0	0	0	0	0	0
ESE	0	553	0	0	286	150	0	0	0	0	0	0	0	0
SE	0	463	0	0	1001	1109	0	0	0	0	0	0	0	0
SSE	1366	500	484	500	619	789	1595	1716	0	0	0	0	0	0
S	1	125	141	500	138	450	3517	2229	4044	3800	242	0	0	0
SSW	0	0	0	3000	4937	7000	2480	3298	5456	5664	1753	667	9660	6097
SW	71	0	12	50	769	957	413	754	1223	1492	1399	1290	5609	5981
WSW	0	0	3	44	874	700	950	950	425	380	557	444	3668	3767
W	50	0	34	0	784	100	1472	1432	777	819	1887	1741	4504	3958
WNW	0	0	165	0	530	75	5376	5620	4142	3974	32125	27596	14360	14941
NW	321	0	341	0	778	424	2310	2199	197	344	12424	15484	16789	15325
NNW	0	80	299	700	921	50	7459	7473	22214	17940	8445	9594	5127	5695
TOTALS	3925	4700	5310	10250	58955	56490	83390	88265	155339	149938	123714	117243	155682	156143

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Prepared by
R. C. Durfee, P. R. Coleman

Computer Sciences
Oak Ridge National Laboratory
Oak Ridge, TN 37830

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Foreword

On July 29, 1980, an advance notice of rulemaking was published for revision of the Nuclear Regulatory Commission's (NRC) regulations for the siting of nuclear power reactors. Soon thereafter SANDIA National Laboratory began to develop a technical data base to support the rulemaking activities. The results of that work were reported in "Technical Guidance for Siting Criteria Development" (NUREG/CR-2239, December 1982). Work also began at Oak Ridge National Laboratory (ORNL) to prepare an Environmental Impact Statement for the rulemaking.

When the rulemaking was deferred pending a review of the severe accident source term and the test implementation period for the safety goal, it was decided to document the ORNL work in a series of technical reports. One of that series is this report, "Population Distribution Analyses for Nuclear Power Plant Siting" (NUREG/CR-3056).

This report describes demographic analyses which were undertaken to supplement site availability studies reported in NUREG/CR-2339. The ORNL work utilized actual 1980 census data and developed an interpolation technique to distribute the 1980 population in rural areas where the census enumeration districts are larger than the grid size used for the calculations. Because of the nature of the interpolation in rural areas, the population description around any specific location in a low population area has large uncertainties and the individual calculations of densities within five miles must be considered to be subject to significant errors. These errors are acceptable in the context of the evaluations reported here because the goal was to compare general site availability for large geographical areas with respect to specific alternative formulations for the demographic siting criteria. This means that any individual evaluation may be in error, particularly in the low population areas, but the overall trends displayed for large areas should be reliable. Details of the evaluation techniques are presented in the body of the report.

While ORNL was developing these data, the NRC staff was utilizing insights gained from the SANDIA work to formulate alternative criteria in response to the NEPA requirement for a range of reasonable alternatives to be presented in the environmental impact statement. One aim was to express in quantitative terms the admonition of 10 CFR 100 (100.11 (a)(3)) to avoid population centers. A second aim was to express the criteria in terms of density values (threshold levels leading to more intensive staff analyses), similar to those of Regulatory Guide 4.7, instead of the dose calculations presently in use. The alternative formulations are described in this report, together with regional maps which graphically display the implications of each alternative for site availability in three regions. The three regions were chosen to illustrate the effect of the criteria in the heavily populated northeast, the heavily industrialized midwest and the sparsely populated northwest.

Additionally, calculations were performed to evaluate the existing nuclear power plant sites which were not within the three regions used for

the large area illustrations. (A selective group of alternative sites was also evaluated.) These additional analyses were intended to illustrate for comparative purposes the application of the alternatives to a set of locations already approved and thus representative of the sites that would be acceptable with respect to other safety and environmental siting factors. It should be noted, however, that just because a site does not meet one or more of the alternative criteria in this study does not mean that it is not acceptable from a safety standpoint or that it does not meet NRC's regulations.

The Commission has for many years considered population statistics in reviewing nuclear power plant license applications. Both qualitative (10 CFR 100) and quantitative (Regulatory Guide 4.7, "General Environmental Site Suitability Criteria") guidance have been formally issued by the Commission. Because the existing guidance permits interplay between plant design and population considerations, some utilities chose the added expense of increased costs for engineered safety features over the costs associated with more remote siting. This has resulted in a range of population distribution and population density around existing sites. Appendix E provides a tabulation of the evaluation of existing sites in terms of the alternatives. The sites which would not meet either part of the least restrictive alternative are among those which needed additional or more effective (than usual) engineered safety features to satisfy the site licensing decision. These few sites and those which do not meet one part of the least restrictive alternative were identified by the Commission's staff in efforts to identify candidates for the first group of plants to have detailed risk assessment carried out. Thus the results of the calculations presented here are consistent with the regulatory approach already being taken with regard to populations around individual plants. The difference is that the original focus on these plants was through a review designed to enhance safety at individual plants while the development of siting criteria is intended to establish generic criteria which might, in most cases, eliminate or substantially reduce the need for costly and time-consuming custom designs associated with the design coupling to site demography.

The comparative evaluations presented in the report are intended to provide perspective as an aid to the Commission in decision making. The alternatives analyzed here can be characterized as refinements of present practice under Part 100 and Regulatory Guide 4.7. The results of the severe accident source term review may result in the consideration of additional alternatives which depart substantively from present practice. The various alternatives and analyses are one part of the decision framework that will eventually result in a clarification of the Commission's siting requirements. The actual data resulting from the calculations using the interpolated population data and real sites should only be used as input to larger discussions on statistical trends in site availability as affected by various societal changes and constraints.

Frank J Arsenault

Frank J Arsenault, Director
Division of Health, Siting, and
Waste Management
Office of Nuclear Regulatory Research

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Appreciation is also expressed to R. M. Rush, R. B. Honea and Minton Kelly of the Energy Division who sponsored, coordinated, and directed the new demographic work described in this report. Special thanks are also due R. B. Honea who was instrumental in getting the work started including technical ideas and suggestions, to R. M. Rush who coordinated and administered the work throughout the project, and to Dr. William Ott of the Nuclear Regulatory Commission who funded the work and provided technical guidance on all siting criteria evaluations.

Appreciation is also expressed to F. E. Latham for his computational help in preparing some of the displays, to Joyce Poland and Collene Ownby for accurate typing of the manuscript, and to Joy Medford for technical review and editing of the report. Other members of the Geographic Data Systems Group (e.g., S. M. Margle and S. E. Reynolds) have contributed in the preparation of auxiliary data bases and displays used in the population work and in this report (e.g., U.S. coastlines, LANDSAT images, digitized roads, etc.).

Further population distribution studies have been done by R. B. Honea, R. G. Edwards, B. L. Shumpert, S. M. Margle, J. L. Smyre, E. A. Bright, and J. F. Hines. This work involved the use of LANDSAT data, aerial photography, 1980 census tract boundaries, and 1980 enumeration district maps to improve the distributions and compare estimates. The results of this work will be reported in future papers.

POPULATION DISTRIBUTION ANALYSES FOR NUCLEAR POWER PLANT SITING

R. C. Durfee and P. R. Coleman
Computer Sciences

ABSTRACT

The Nuclear Regulatory Commission is in the process of reviewing guidelines and regulations associated with population distribution criteria around nuclear power plant sites. The purpose of this paper is to describe the methodology for calculating population distributions in the U.S. and then evaluating specific population criteria and their effect upon the selection of future nuclear power plant sites. Through the use of computer systems, different alternatives may be evaluated for individual sites or for major regions of the country to determine their restrictiveness on siting nuclear plants. Two types of criteria were used. They involved the analysis of population distributions radially out from each possible site and the study of angular distributions around each site. Results are presented in both tabular and graphic form using national, regional, and site-level computer maps.

1. INTRODUCTION

The Nuclear Regulatory Commission is in the process of reviewing guidelines and regulations associated with population distribution criteria around nuclear power plant sites. The purpose of this paper is to describe the methodology for calculating population distributions in the U.S. and then evaluating specific population criteria and their effect upon future nuclear power plant siting and licensing. Through the use of computer systems, different alternatives may be evaluated for individual sites or for major regions of the country to determine their restrictiveness on siting nuclear plants.

Several steps were required to carry out the evaluation, including preparation of population data bases for the whole U. S., calculation of population density distributions, calculating acceptable and nonacceptable geographic zones based upon the siting criteria, evaluating individual sites, and producing computer maps and numeric output for analysis. The siting criteria involved two different types of calculations. The first was to look at specific density levels (or the corresponding number of people) in circular areas of specified radii about all possible plant sites. Since population centers are not necessarily spread homogeneously around potential sites, a second criteria was calculated based upon the angular distribution of people in 16 sectors around each site. The body of the paper describes each of these steps and includes displays primarily for the northeastern U.S. while Appendix A includes displays for the Midwest and the Northwestern portion of the U.S. as well.

Other factors are also important in the siting of nuclear power plants, such as the availability of water for cooling purposes, earthquake zones, off-site hazards, etc. Complementary work has been carried out on some of these factors to study how the siting patterns would be restricted across the U. S. when a number of factors are applied simultaneously. This paper describes work done only on population criteria, however, with the end result being output, maps, and statistics to aid in evaluating the different options. The work was initially begun using 1970 census data, then updated to include preliminary 1980 population data, and finally modified to incorporate final 1980 census data. These steps are described in the next section. Another consideration, which has not been addressed in this paper, is the development of future projections of population and their effect on proposed guidelines. Work on future projections has been carried out for a few specific sites as part of another project. The analyses in this report are restricted to studying distributions where people live, not where the working population is located. Nor are transient populations considered such as might occur in recreational areas near reactor sites.

The basic population criteria were expressed in terms of the sector and circular zones mentioned previously. The circular zones consider overall density levels around plant sites, while the sector criteria consider the angular distribution of population centers around the sites. Figure 1 shows the geometry used around each possible site. Table 1 presents a typical alternative of the population criteria expressed in terms of the radial and sector zones. This particular alternative is

ORNL-DWG 82-11059

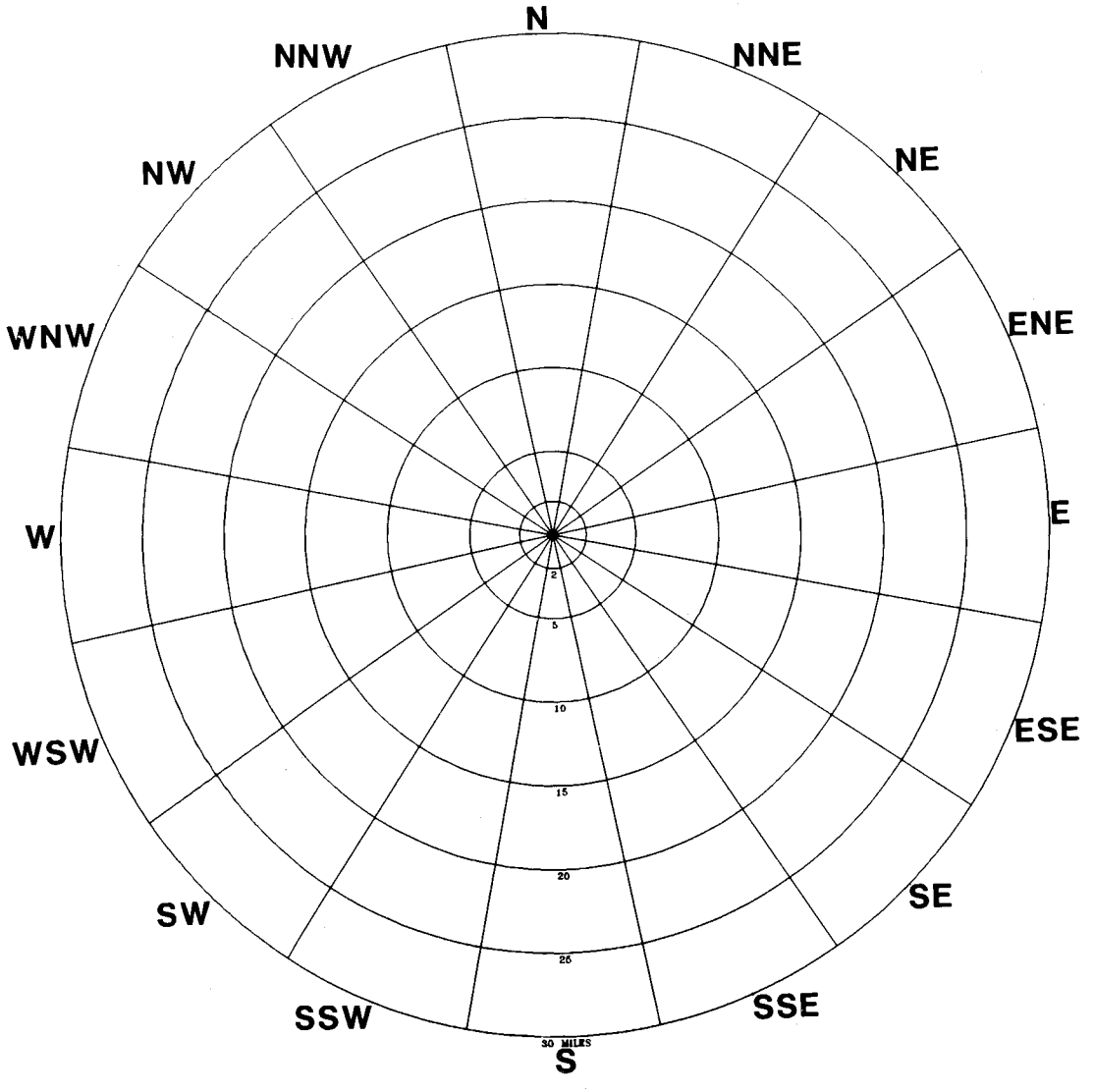


Fig. 1. Radial and Sector Geometry Used in Population Criteria for Nuclear Power Plant Sites.

Table 1. Population Threshold Levels Expressed as Total Counts Around a Site (Alternative Case 4).

Radial Distance (Miles)	Radial Criteria[a]	Sector Criteria[b]
	Cumulative Population Out to Radial Distance	Cumulative Population Within Two Adjacent 22-1/2° Sectors
0-2	3,142	785
0-5	52,622	13,155
0-10	229,336	57,334
0-15	523,890	130,965
0-20	936,193	234,048
0-25	1,466,336	366,584
0-30	2,114,288	528,572

[a] Based on population density of 250/mi^2 from 0-2 miles and 750/mi^2 beyond.

[b] Based on 1/4th the maximum radial criteria population being allowed within two adjacent 22-1/2° sectors.

referred to as Case 4 in later sections of the report. When population counts exceed the threshold levels, then a site is noted as being part of a possible exclusion zone. A detailed description of the radial-sector criteria is given in Section 4.1. By implementing the analyses on the computer, it was possible to test a number of alternatives for large regions as well as for individual sites. The next four figures (Figs. 2a, 2b, 3, and 4) present the general results as calculated for an area in the Northeast identified as the PJM region (Pennsylvania, New Jersey, Maryland Interconnection). Figure 2a displays the calculated population densities for specific contour levels within the PJM area. Figure 2b presents the gridded population densities as a 3-D perspective surface viewed from the Southeast with the peaks corresponding to urban areas and the valleys or flat surfaces corresponding to rural areas. Figure 3 shows within a large region all zones exceeding the threshold levels (in red) based upon one criteria alternative (Case 4). Figure 4 shows reactor sites operating, under construction, or planned, within this area superimposed on this same map to see what the effect would be on these previously selected sites. A few of the current plant sites fall within the red zones indicating they would be subjected to additional staff analyses under this particular alternative. The general methodology is outlined below:

(1) Census population data were prepared at the enumeration district level for the whole U. S. (1970, preliminary 1980, and final 1980 data used).

(2) Population density values were calculated for a grid of latitude-longitude cells by interpolating from the enumeration district census data.

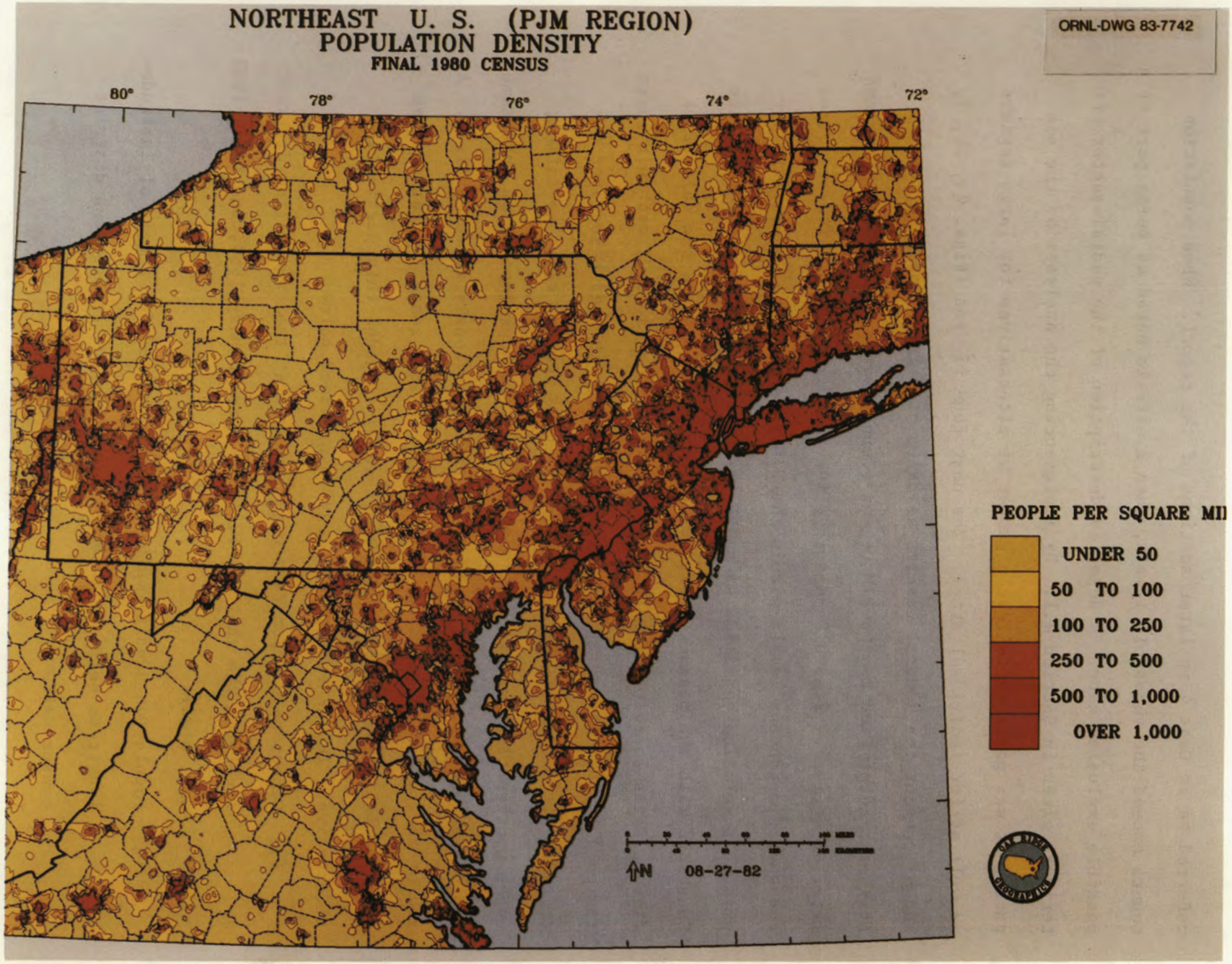


Fig. 2a. Population Density Contours in PJM Region.

POPULATION DENSITY (PEOPLE/SQ. MILE)
NORTHEAST U. S. (PJM REGION)

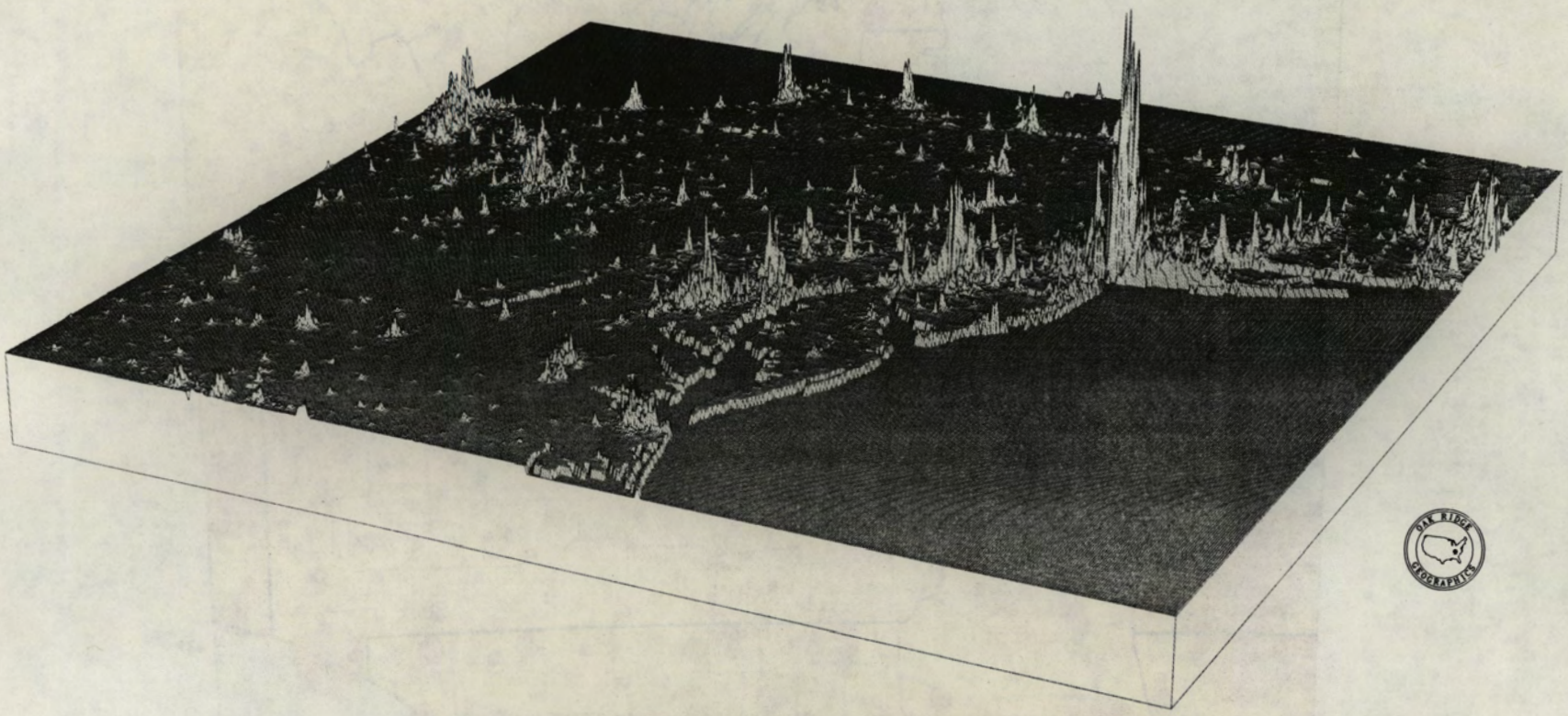


Fig. 2b. 3-D Perspective Display of Population Density in the PJM Region As a Spatial Surface.

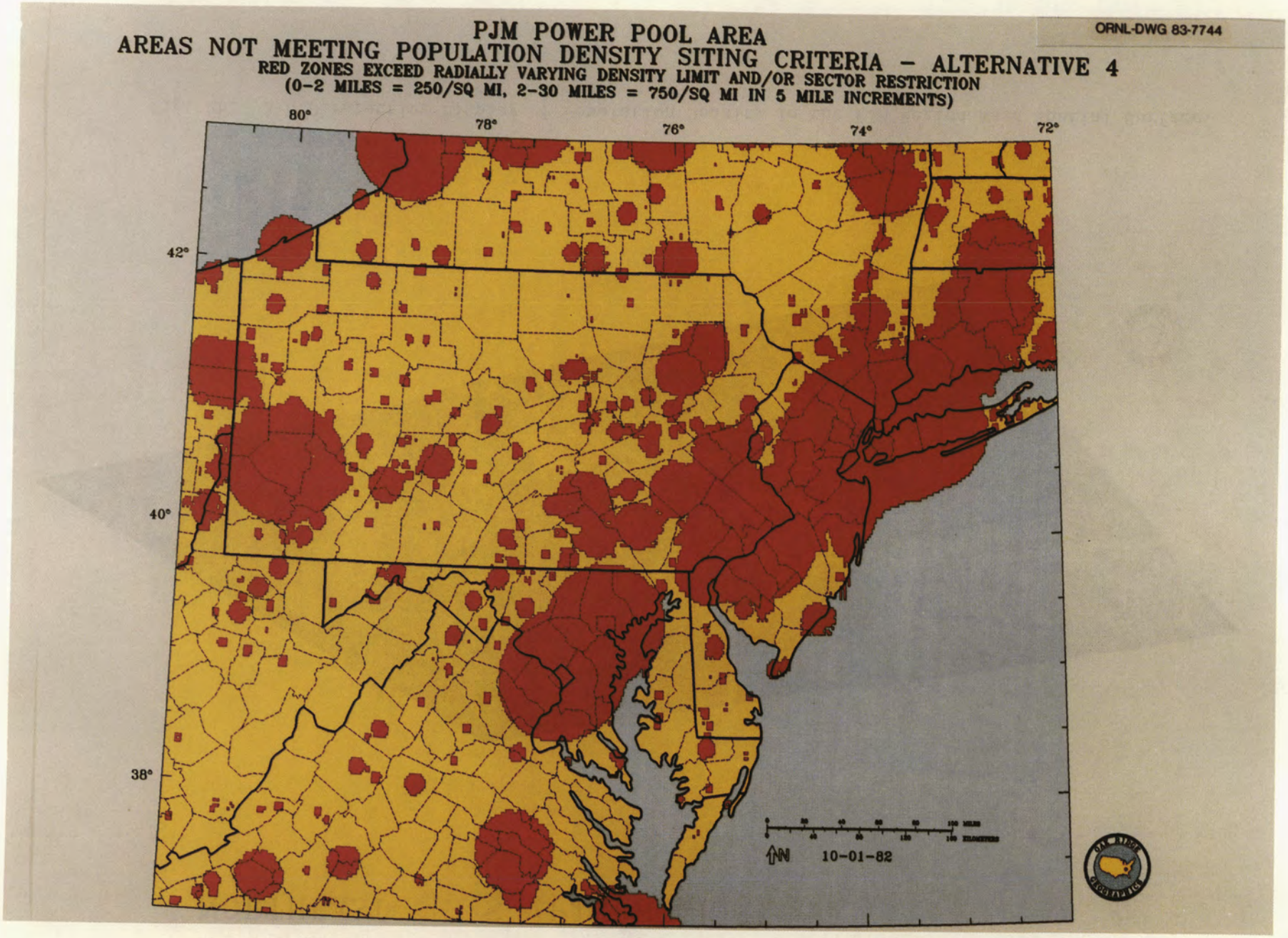


Fig. 3. Unfavorable Zones for Nuclear Sites Based on Population Criteria.

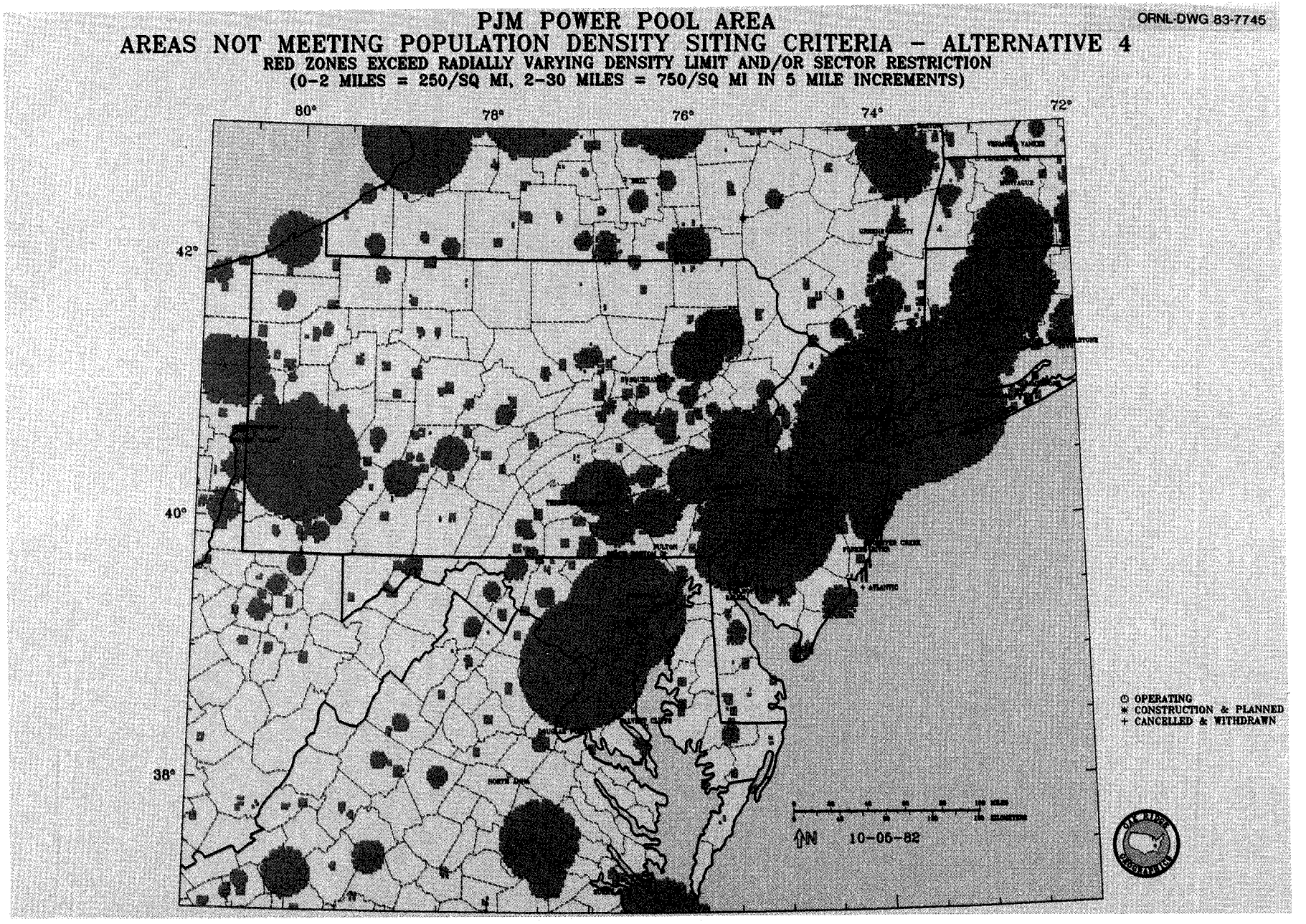


Fig. 4. Nuclear Power Plant Sites Superimposed on Unfavorable Zones.

(3) The population levels were calculated for each of the different siting criteria and individual cells were evaluated as possible sites for three major regions in the U.S.

(4) The results of the siting calculations were displayed in map form showing zones where the threshold levels were exceeded. Tabular statistics were also printed.

(5) Preliminary calculations were performed with a set of primary and secondary nuclear sites using the different siting criteria, and preliminary tabular results printed.

The three major regions used to represent different parts of the U.S. in step 3 above were the PJM region in the Northeast, a region centered in Chicago for the Midwest, and the Washington-Oregon region in the Northwest. Sample results from each of the three regions are presented in the body of the report with complete sets of all results contained in Appendix A. Six different alternatives of siting criteria were used throughout the calculations, as explained in Sections 4.3 and 4.4.

Although the brief outline above is an oversimplification of the process, each of the steps is discussed in more detail in the following sections. The techniques for calculating spatial distributions of the population are discussed in Section 3. These techniques become important especially when calculations are done within a few miles of the plant sites to determine site acceptability. The reader who is only interested in the siting criteria results may wish to skip to Section 4 and review the figures and accompanying text. The last section of the paper discusses related population distribution work that might be beneficial to these types of calculations and associated risk assessments.

2. DESCRIPTION AND PREPARATION OF INPUT POPULATION DATA

Population data are collected by the Census every ten years and are made available at several different geographical levels, such as state, county, minor civil division, census tract, etc. In attempting to calculate a population distribution over geographical areas, it is important to utilize input data at the finest degree of spatial resolution available. For the 1970 census the enumeration districts (referred to as block groups in urban areas) were the lowest level for which geographic location information was available with complete coverage of the whole U. S. (urban and rural). These have traditionally been areas that could be covered by a census enumerator in counting people and in the past were in the range of around a thousand people. There is only one spatial unit smaller than an enumeration district (or block group), and it is defined only in urban areas as blocks, representing the individual streets. A partial hierarchy in descending order for rural areas consists of states, counties, minor or civil divisions, and, finally, enumeration districts. A similiar hierarchy for urban areas consists of states, counties, census tracts, block groups, and blocks. To aid the reader, block groups will be included with the enumeration districts in the discussion and they will all be referred to as enumeration districts. There are other census classifications associated with populated areas (e.g., standard metropolitan statistical areas, urbanized areas, incorporated places, census designated areas, center cities, etc.); but they are all a good bit bigger than enumeration districts, and in many cases are not subsets of each other. There are approximately 350,000 enumeration districts in the country, as compared to around 43,000 census tracts (35,000 for 1970).

A portion of a typical enumeration district map is shown in Fig. 5 for the area around the Sequoyah Nuclear Plant site northeast of Chattanooga, Tennessee. The area shown is around 15-20 miles on a side with the power plant in the center (ED15) and Chickamauga Dam in the lower left corner creating the Chickamauga reservoir upstream. The boundaries of these districts (identified as ED15, ED4, ED16B, ...) are not available in machine-readable form. Instead, the Census digitized centroids as a single latitude-longitude point within each district for the 1970 census. These points are supposed to correspond to population centroids within the districts. These centroids are shown in Fig. 6 for the PJM area to give an idea of the large number of centroids in the Northeast. There are literally thousands of them. The enumeration districts changed for the 1980 census, thus requiring a new set of centroids to geographically represent these districts. To date, new centroids have not been digitized and distributed by the Census so approximations have been made to extrapolate from the 1970 centroids.

In order to compute population densities for a grid system covering the area, it is necessary to do an interpolation from these centroid points to all cells in the grid system. The interpolation itself may utilize either the number of people or the population density of people. In the first case, the number of people is known for the enumeration district represented by its centroid and has to be shared out to all grid cells. The gridded value can then be divided by the area of the cell to determine a population density. In the second case, if the area of the enumeration district can be approximated, the density can be calculated for the district. Then the interpolation can be done directly on the density levels

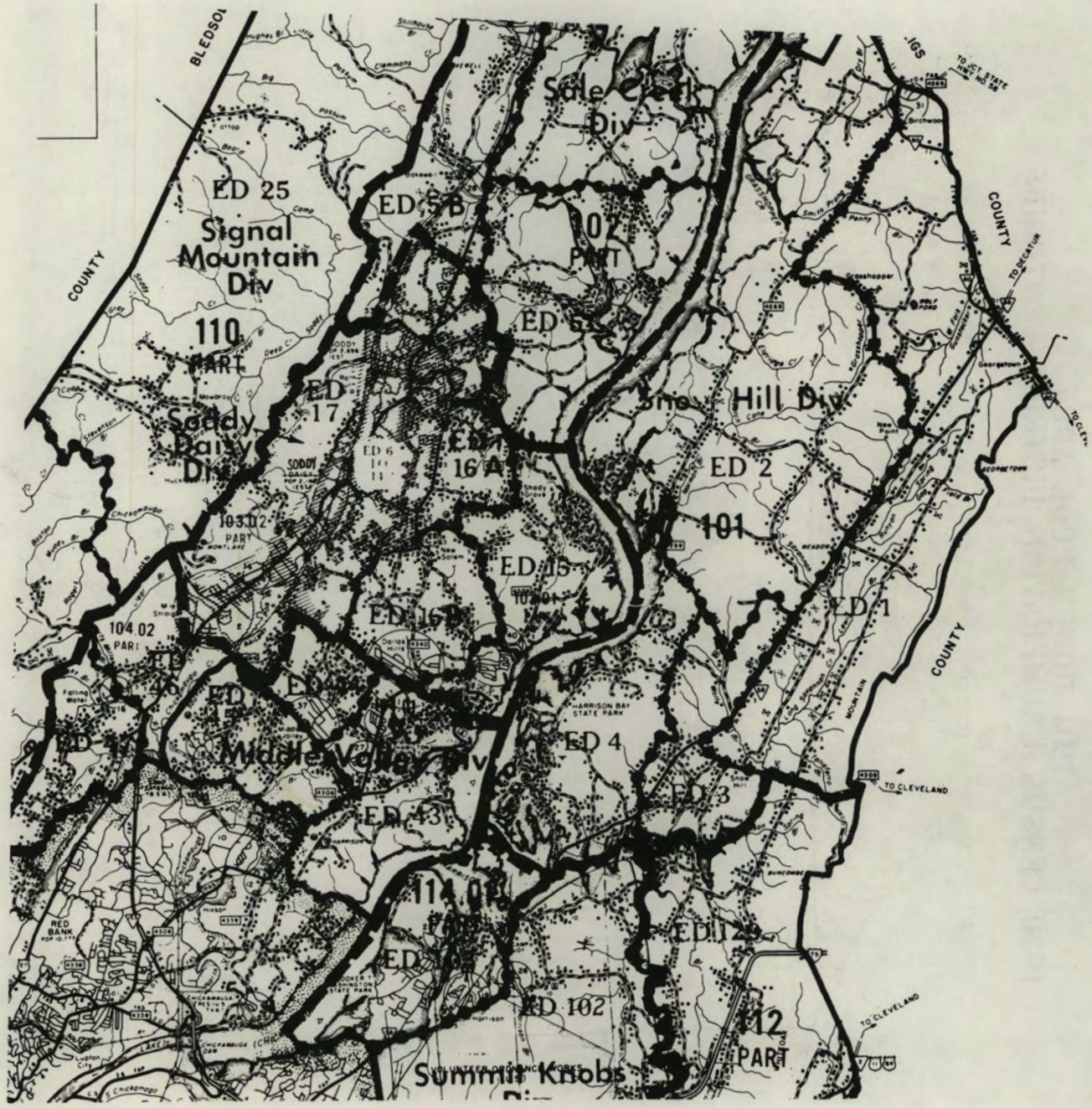


Fig. 5. Enumeration District Map in Vicinity of Sequoyah Nuclear Plant.

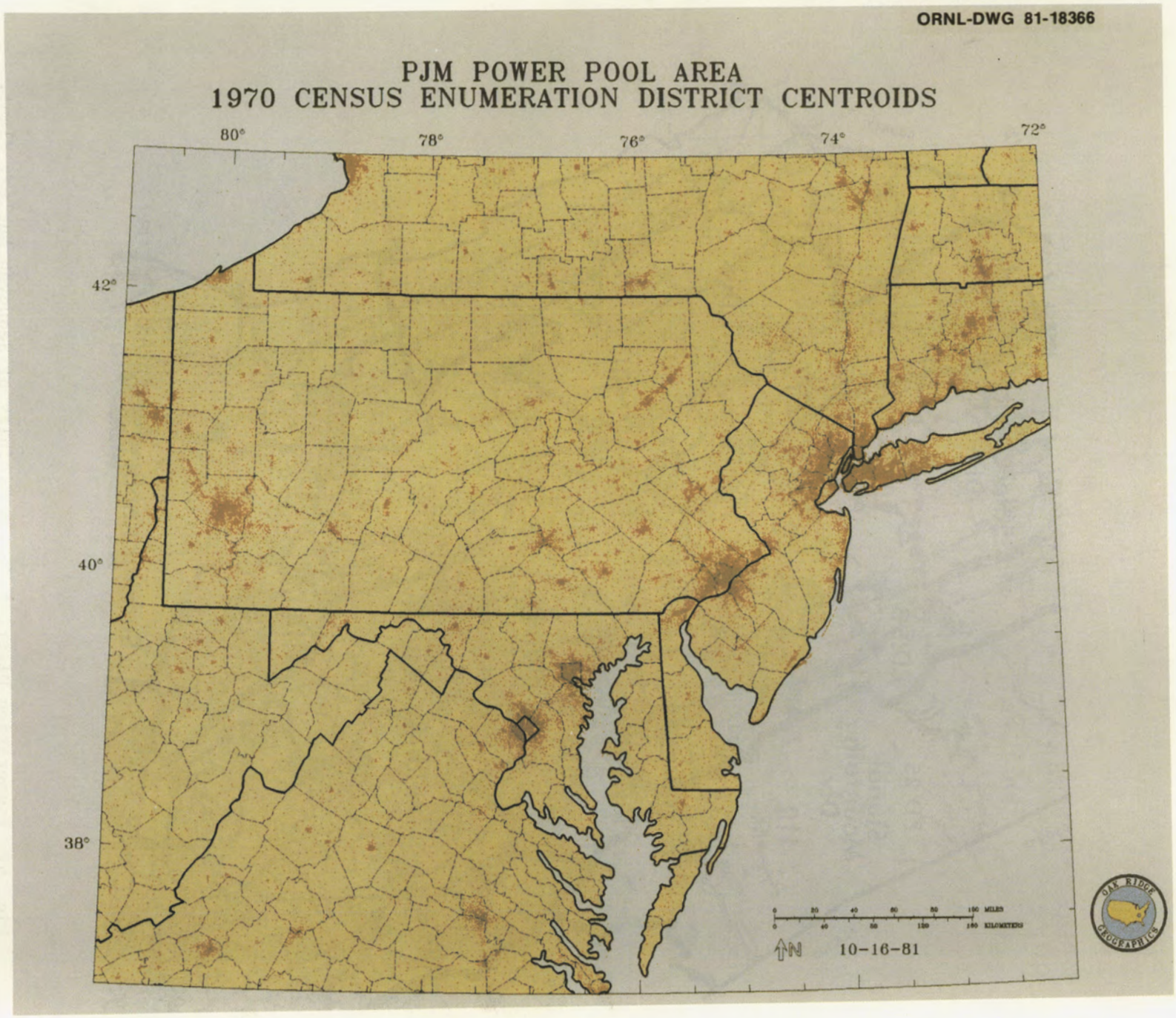


Fig. 6. Population Centroids of 1970 Enumeration Districts in PJM Region.

without having to divide by the cell area later. The density is normally calculated as number of people per square mile.

At the time this project was begun, the 1980 census data had been collected and were available in preliminary report form, but no data tapes were available. To incorporate 1980 data from the preliminary reports, the number of people and houses were keypunched directly for all counties in the U.S. Figure 7 presents the 1980 county level population over the U.S. with the size of each circle proportional to the number of people in the county. Figure 8 shows the percent change from 1970 to 1980, with the blue areas decreasing and the red areas increasing. Notice the movement to the South and Southwest. In order to approximate 1980 data at the subcounty level, a procedure was developed to share the county populations out to all the 1970 enumeration districts within the county. This was done on a basis proportional to the increase or decrease in population over the ten-year period. This sharing out of the 1980 county data to enumeration districts is an approximation of the real change in population that occurred, but was the best that could be done with existing data at the time in order to incorporate 1980 counts. In the later phases of this study the final 1980 census data became available so that the population calculations were able to be redone using the same techniques with the improved data. In a few areas the differences are as much as 4% or more between the preliminary numbers and the final counts given out by the census. However, most of the differences are normally in the .2-2% range at the aggregate levels.

As the machine readable data become available for the more refined spatial units, it may be possible to improve these approximations. The key to this refinement depends on the availability of geographic locations for

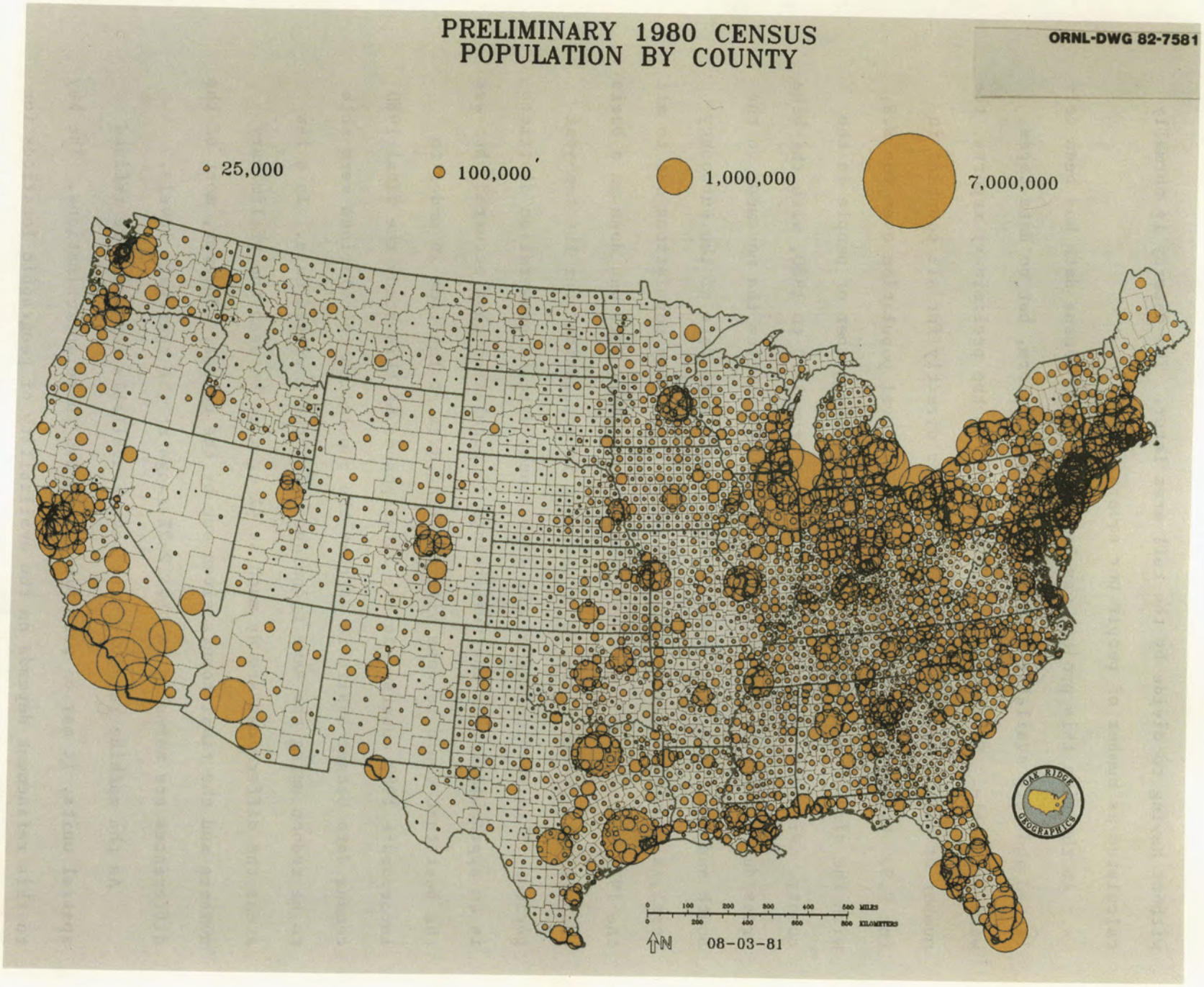


Fig. 7. County Population from Preliminary 1980 Census Data.

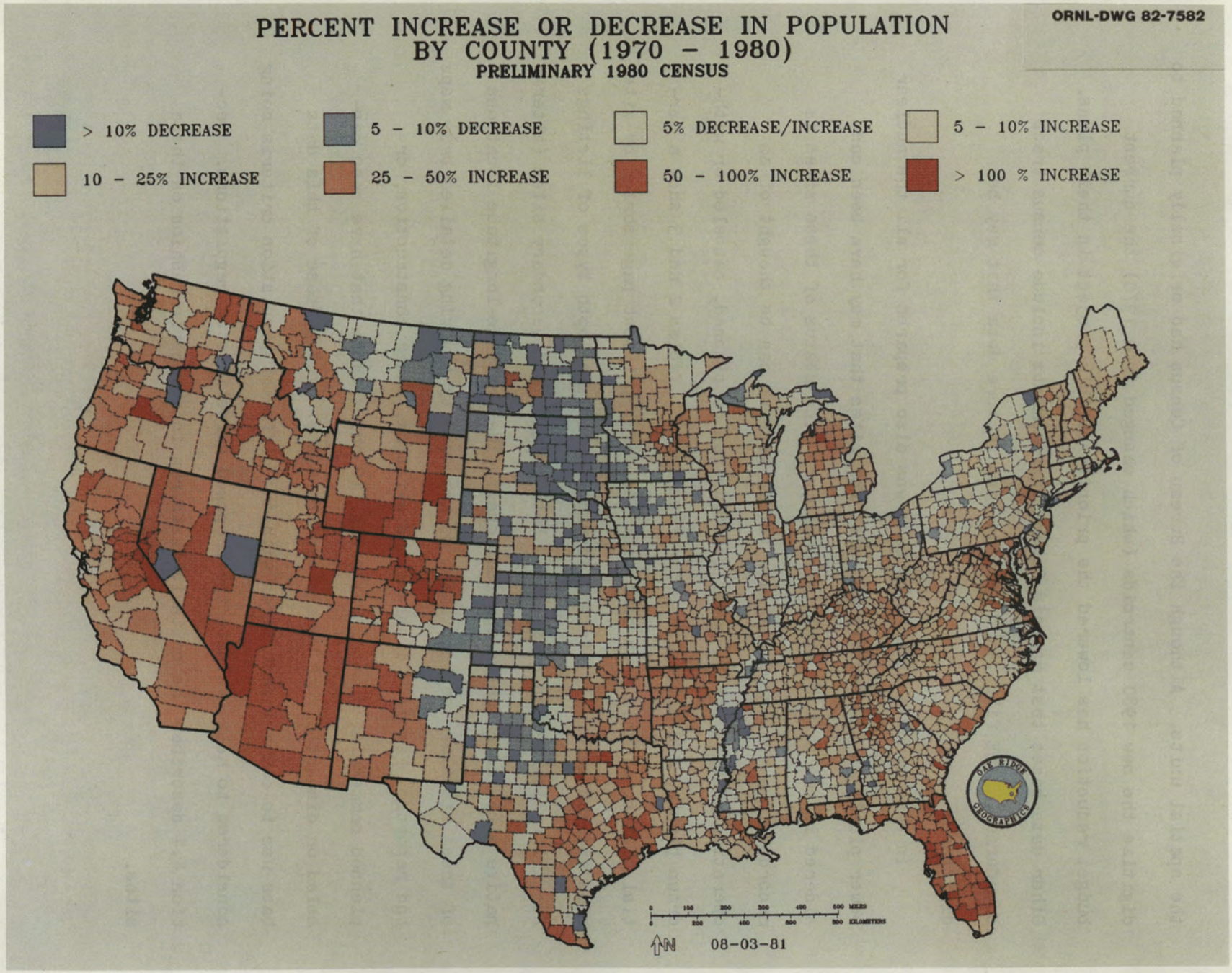


Fig. 8. 1970 to 1980 Population Change on County Basis.

the spatial units. Although the Bureau of Census had originally planned to digitize the new 1980 centroids (which changed from 1970) the current budget reduction has lowered the priority of this project in their plans. Other data bases that may aid future improvements include census tract boundaries, DIME files, and various land feature data that may be digitized.

In this study another data base was also prepared for all the nuclear power plants in the country and also for sites that may have been considered in the past by utility companies. The status of these sites is recorded in a number of classes, but in general can be thought of as operating plants, plants under construction or planned, canceled or withdrawn plants, and alternate sites considered. Tables 2 and 3 show a partial listing of this data base with the first printout page sorted by site name and the second by state. Appendix B contains both types of listings for all nuclear sites considered, both primary and secondary sites (alternative sites or canceled applications). The latitude-longitude locations of these sites are continuing to be improved by studying detailed base maps and reports. Figure 9 displays the existing, under construction, or planned commercial plants, while Fig. 10 shows those that have been canceled or dismantled, or were alternate sites. The purpose of this data base was to compare past sites with the different population criteria being considered to help evaluate the proposed guidelines or regulations. Section 4.4 describes the criteria tests run in a generic fashion on these sites.

Table 2. Nuclear Power Plant Sites in U.S. Sorted by Plant Name.

ORNL-DWG 83-8014

NOV 16, 1982 COMMERCIAL NUCLEAR POWER REACTOR SITES SORTED BY REACTOR NAME PAGE 1

STATE CODE	NAME	PRIMARY SITE	LATITUDE dd-mm-ss	LONGITUDE ddd-mm-ss	STATUS
TX	ALLENS CREEK	YES	29-40-43	96-06-15	Application for construction permit pending (docketed)
AR	ARKANSAS	YES	35-18-36	93-13-51	License in effect for operating reactors
IA	ARNOLD	YES	42-06-02	91-46-38	License in effect for operating reactors
WV	ARROYO (ERIE)		40-34-	80-39-	Alternate site
OH	ASHTABULA E (PERRY)		41-55-	80-44-	Alternate site
NY	ATHENS (PASNY)		42-16-	73-50-	Alternate site
NJ	ATLANTIC		39-28-20	74-15-20	Application withdrawn
MI	AU GRES		44-06-40	83-34-50	Hypothetical site
TX	BAFFIN BAY		27-12-00	97-32-00	Hypothetical site
IN	BAILLY	YES	41-38-30	87-07-30	Inactive construction permit application, cancellation announced
MD	BAINBRIDGE (MD)		39-36-45	76-05-35	Alternate site
AL	BARTON		32-45-00	86-24-00	Inactive construction permit application, cancellation announced
MA	BEAR SWAMP (NEP)		42-42-	72-53-	Alternate site
OH	BEAVER (ERIE)		41-25-30	82-15-30	Alternate site
OR	BEAVER (TRJN)		46-10-	123-11-	Alternate site
PA	BEAVER VALLEY	YES	40-37-19	80-26-02	License in effect for operating reactors
NY	BELL		42-36-30	76-37-55	Application withdrawn
AL	BELLEFONTE	YES	34-42-32	85-55-38	Construction permit in effect and operating license docketed
MD	BELVEDERE (DOUG)		38-14-	76-36-	Alternate site
PA	BIG BEND HILL (ERIE)		41-18-	80-21-	Alternate site
IN	BIG GRAHAM CR (MRBL)		38-56-53	85-33-05	Alternate site
MI	BIG ROCK POINT	YES	45-21-33	85-11-41	License in effect for operating reactors
OK	BLACK FOX	YES	36-07-01	95-32-54	Application for construction permit pending (docketed)
TX	BLUF HILLS		31-08-39	93-41-32	Inactive construction permit application, cancellation announced
OR	BOARDMAN		45-40-35	119-49-00	No application (not listed)
CA	BODEGA BAY		38-18-00	123-03-18	Application withdrawn
CA	BOLSA ISLAND		33-42-30	118-01-54	Application withdrawn
DE	BOWERS (SUSM)		39-03-	75-23-	Alternate site
OR	BRADWOOD (TRJN)		46-10-	123-27-	Alternate site
IL	BRAIDWOOD	YES	41-14-37	88-13-44	Construction permit in effect and operating license docketed
AL	BROWNS FERRY	YES	34-42-15	87-07-07	License in effect for operating reactors
NC	BRUNSWICK	YES	33-57-30	78-00-38	License in effect for operating reactors
PA	BUCKINGHAM MT (LIM)		40-19-	75-01-	Alternate site
NJ	BURLINGTON		40-04-36	74-52-47	No application (not listed)
IL	BYRON	YES	42-04-30	89-16-55	Construction permit in effect and operating license docketed
MO	CALLAWAY	YES	38-45-40	91-46-54	Construction permit in effect and operating license docketed
MD	CALVERT CLIFFS	YES	38-26-05	76-26-31	License in effect for operating reactors
MD	CANAL (FULT)		39-32-	75-49-	Alternate site
IL	CARROLL COUNTY		42-02-01	90-03-46	No application (not listed)
MD	CARROLL POND (DOUG)		38-12-	76-23-	Alternate site
SC	CATAWBA	YES	35-03-05	81-04-10	Construction permit in effect and operating license docketed
WA	CENTERVILLE (SKGT)		45-42-	121-04-	Alternate site

Table 3. Nuclear Power Plant Sites Sorted by State.

ORNL-DWG 83-8015

NOV 16, 1982 COMMERCIAL NUCLEAR POWER REACTOR SITES GROUPED BY STATE PAGE 1

NAME	PRIMARY SITE	LATITUDE dd-mm-ss	LONGITUDE ddd-mm-ss	STATUS
ALABAMA				
BARTON		32-45-00	86-24-00	Inactive construction permit application, cancellation announced
BELLEFONTE	YES	34-42-32	85-55-38	Construction permit in effect and operating license docketed
BROWNS FERRY	YES	34-42-15	87-07-07	License in effect for operating reactors
FARLEY	YES	31-13-22	85-06-45	License in effect for operating reactors
ARIZONA				
PALO VERDE	YES	33-23-23	112-51-43	Construction permit in effect and operating license docketed
ARKANSAS				
ARKANSAS	YES	35-18-36	93-13-51	License in effect for operating reactors
CALIFORNIA				
BODEGA BAY		38-18-00	123-03-18	Application withdrawn
BOLSA ISLAND		33-42-30	118-01-54	Application withdrawn
DIABLO CANYON	YES	35-12-42	120-51-16	Construction permit in effect and operating license docketed
HUMBOLDT BAY		40-44-28	124-12-33	License in effect for operating reactors
HUNTER LIGGETT		35-43-50	121-17-10	Hypothetical site
MALIBU		34-02-06	118-44-30	Application withdrawn
MENDOCINO		38-55-25	123-43-05	Application withdrawn
NEEDLES		34-20-40	114-11-30	Hypothetical site
RANCHO SECO	YES	38-20-40	121-07-12	License in effect for operating reactors
SAN JOAQUIN		35-39-35	119-29-25	No application (not listed)
SAN ONOFRE	YES	33-22-13	117-33-25	License in effect for operating reactors
SUNDESERT		33-27-07	114-47-00	Inactive construction permit application, cancellation announced
VIDAL		34-10-25	114-27-46	No application (not listed)
COLORADO				
FORT ST VRAIN	YES	40-14-41	104-52-28	License in effect for operating reactors

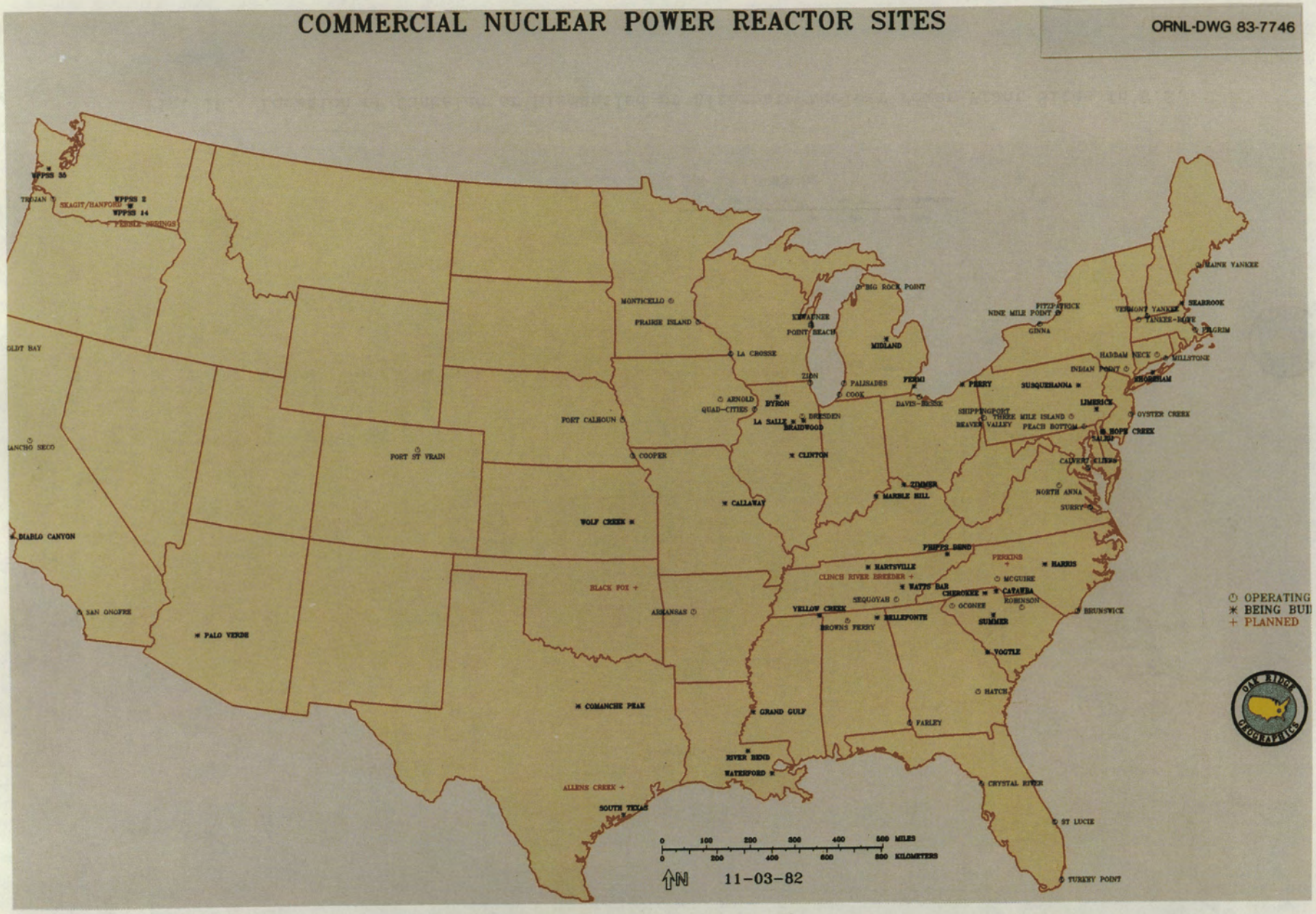


Fig. 9. Location of Commercial Nuclear Power Plant Sites in U.S.

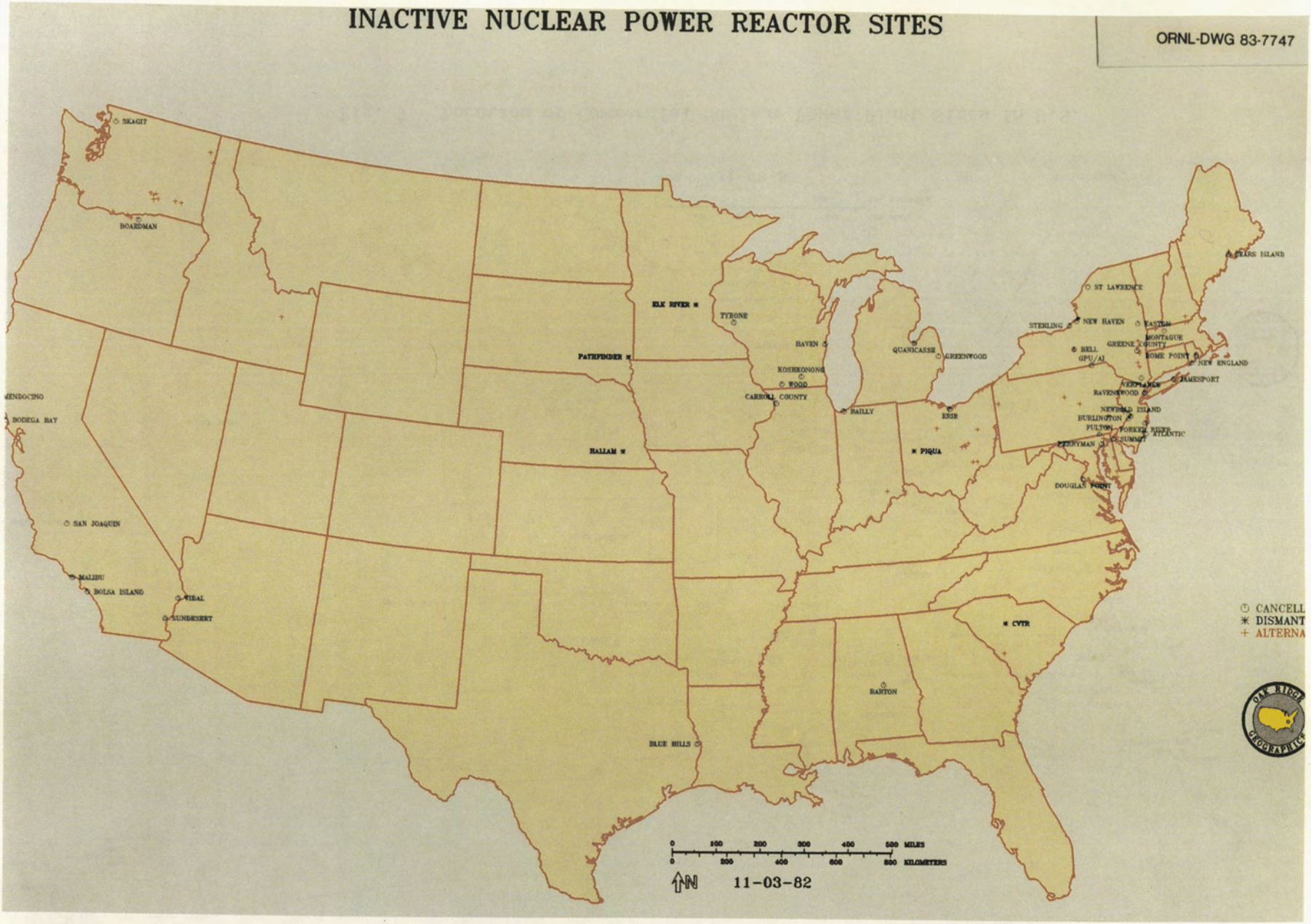


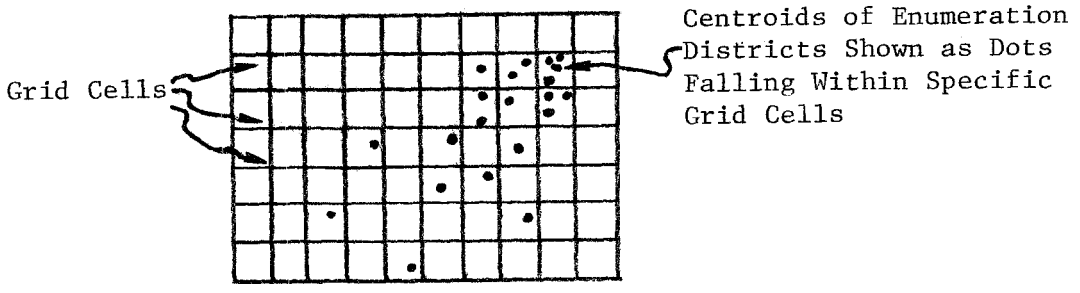
Fig. 10. Location of Canceled or Dismantled or Alternate Nuclear Power Plant Sites in U.S.

3. CALCULATION OF GRIDDED POPULATION DENSITY

The calculation of population counts and densities for the appropriate grid system is an extremely important step in the demographic analyses. It forms the foundation for all evaluations of the siting criteria. For example, if the geographic distribution procedures assign too many people to urban areas and underestimate the rural areas (or vice versa), the calculation of exclusion zones will be distorted in the same manner. Several techniques are discussed in this section for calculating the population levels for a latitude-longitude grid system from the enumeration districts as represented by their population centroids. The data bases in this study are stored with latitude-longitude coordinates to correctly represent information on the earth's surface. Transformations to specific map projections (such as Albers Equal-Area) are performed during execution when needed for distance or area calculations, or for digitizing or mapping. A few enhancements are also discussed, such as incorporating the U.S. coastline, so that people are distributed to land areas only. The reader who is primarily interested in the siting results calculated from these population densities may wish to skip to Section 4 since the density techniques discussed in the next few subsections are rather detailed.

3.1. Traditional Centroid-Assignment Technique

The easiest and most commonly used technique (called the "centroid-assignment" technique[1]) is to assign each centroid and its population count to the particular grid cell inside of which it falls. When two or more centroids fall within a given cell, the sum of the populations is calculated for that cell. The diagram below shows the geographic arrangement:



The total number of people in each cell is divided by the area of the cell to calculate a density level. This technique works fairly well for large cell sizes when the whole U.S. or major urban regions of the U.S. are being considered. However, there is a disadvantage in the rural areas because all the people associated with an enumeration district get assigned to one cell (even if the district really covers several cells) thus creating a larger density spike than should exist in that cell. This technique is very cell size dependent. When smaller sizes are used, some cells have no centroids falling in them thus giving zero people; and other cells have density values that are too high because artificially small cell areas are used in the denominator. This effect is shown in Figs. 11a and 11b where two different cell sizes have been used in the New York area and the corresponding density contours mapped. When the cell size of 2.5 minutes in Fig. 11a is cut in half (1.25 minutes in Fig. 11b), the result produces considerably more individual spikes across the area rather than a more continuous surface representing the urban distribution of people.

When this technique is used for the whole U.S., with a larger cell size, reasonable results are obtained at this national scale, as shown in Figs. 12 and 13. Figure 12 presents contours of several density levels with the maximum being greater than 500 people per square mile. Figure 13

ORNL-DWG 81-6793

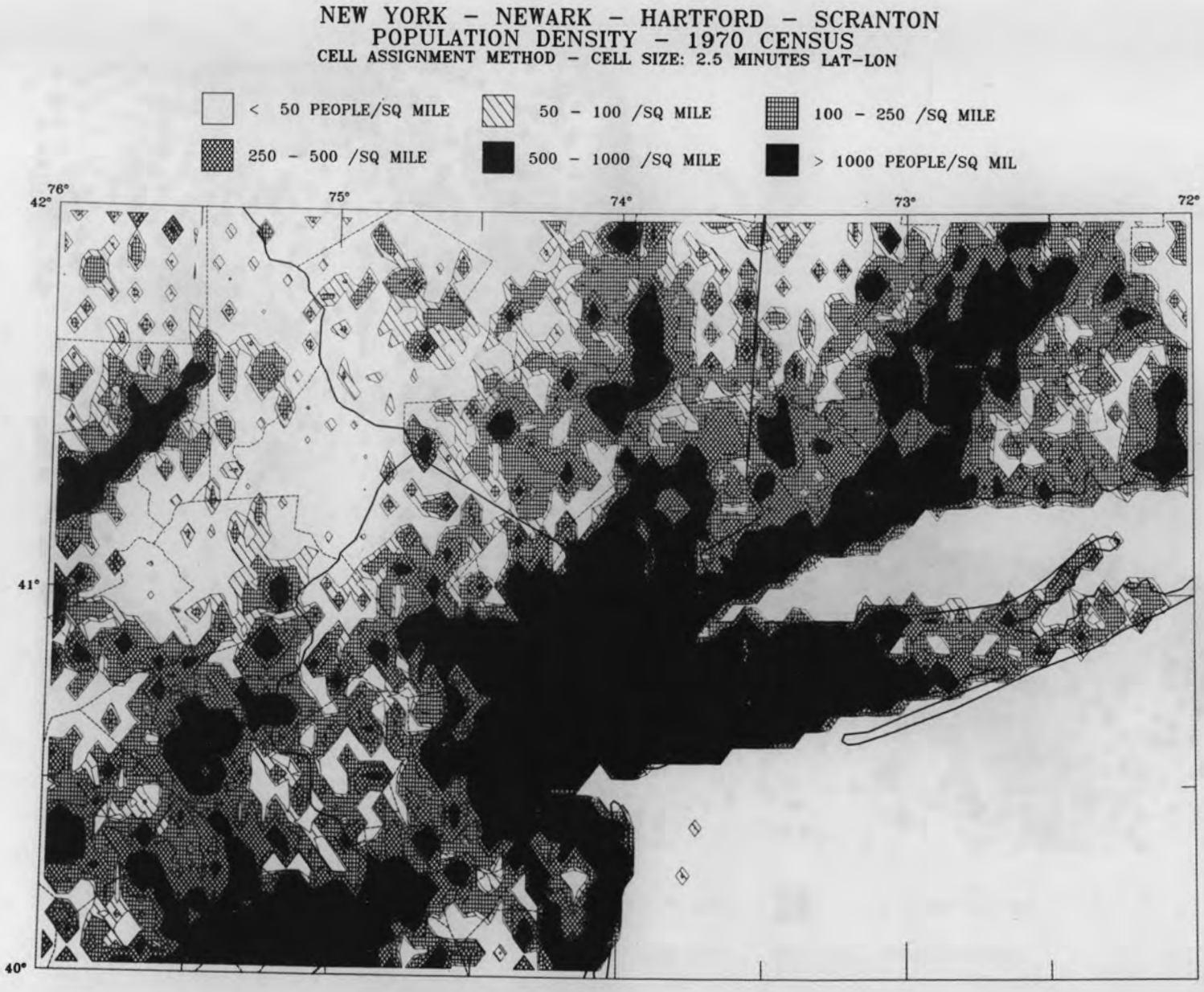


Fig. 11a. Population Density Contours Using Centroid-Assignment to Grid Cells (cell size = 2.5 minutes latitude-longitude).

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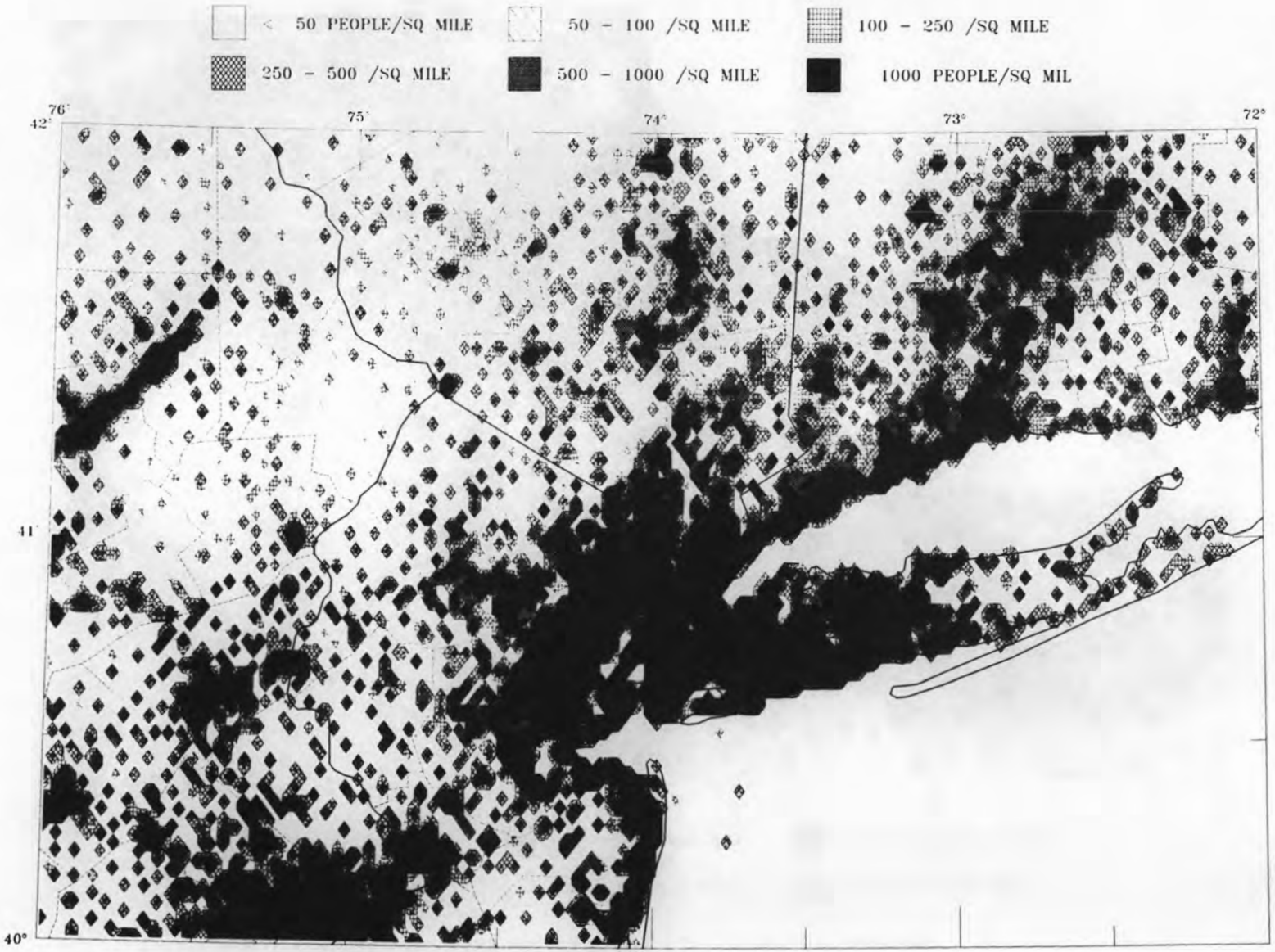


Fig. 11b. Population Density Contours Using Centroid Assignment to Grid Cells (cell size = 1.25 minutes latitude-longitude).

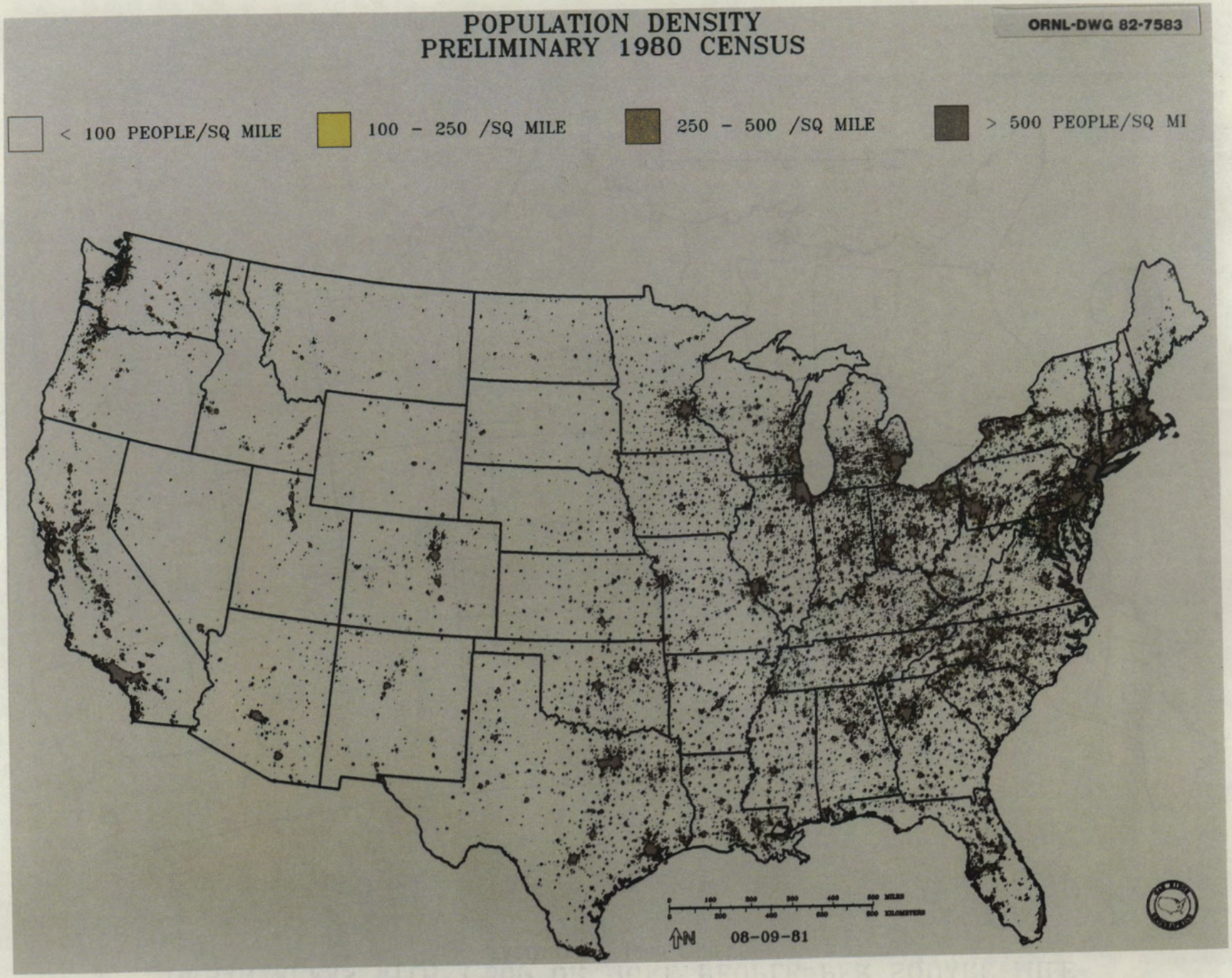


Fig. 12. U.S. Population Density Contours from Preliminary 1980 Census.

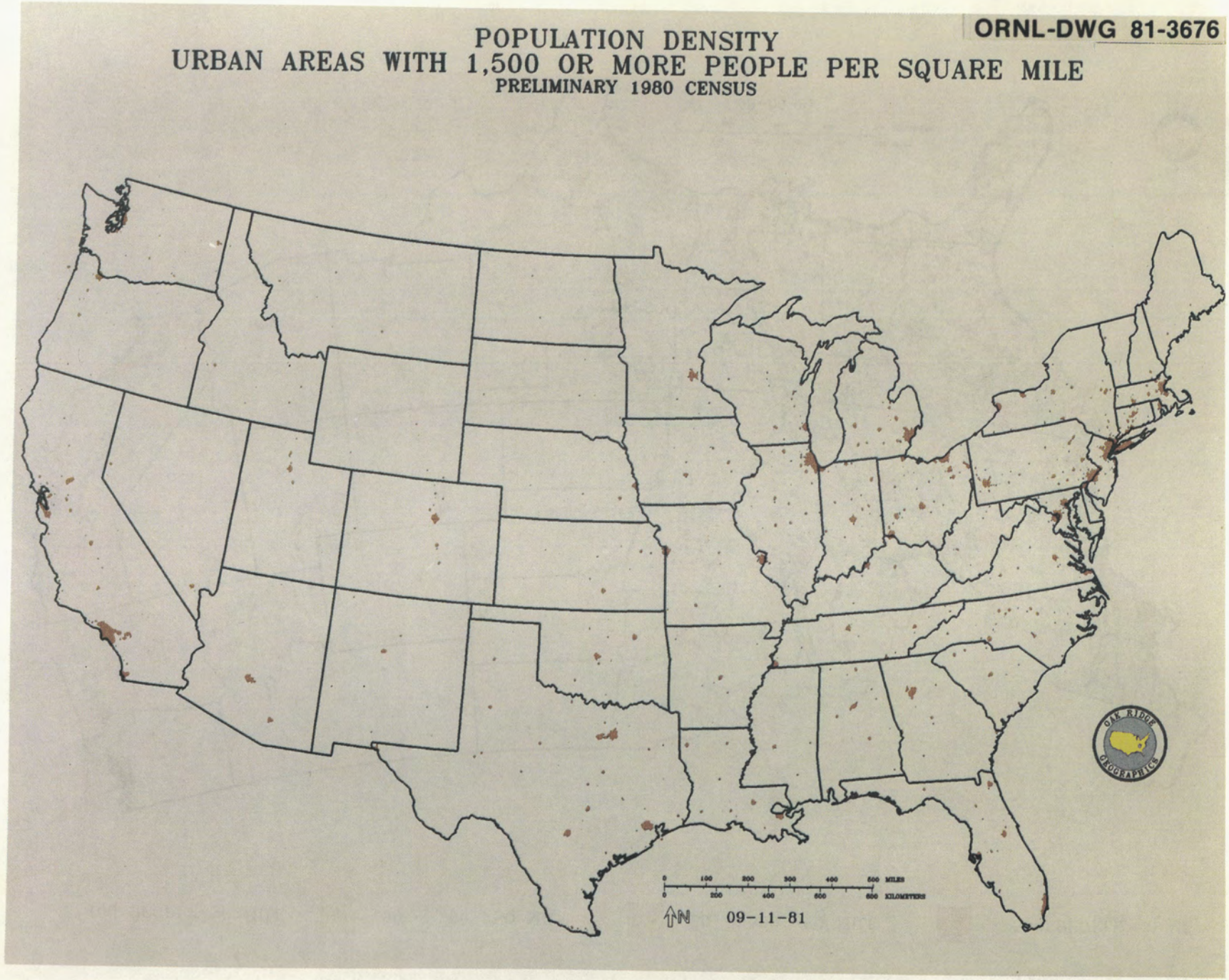
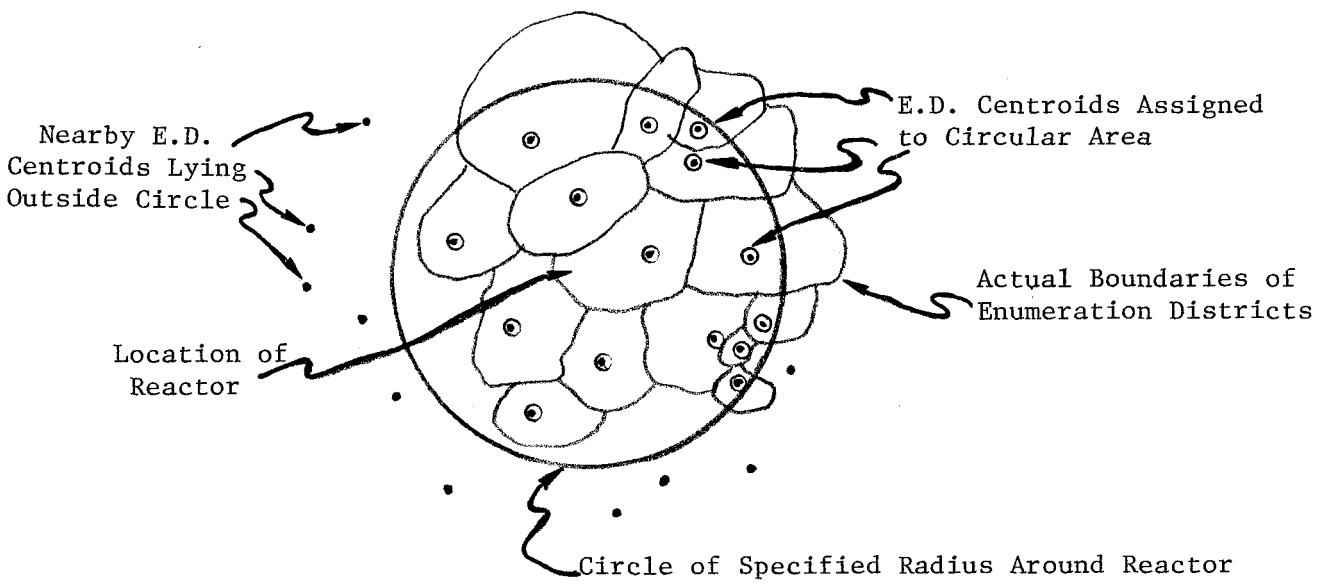


Fig. 13. Populated Areas Greater than 1500 People/mi^2.

shows just those areas that are greater than 1500 people per square mile. This would represent the inner cities and higher density suburban areas.

The centroid-assignment technique can also be used with circles or annuli about a specific site to estimate the number of people within a given radius[2]. The geographic arrangement is shown below:



As before, there is a good bit of error introduced by assigning all the people in a district to one centroid point on the ground. Centroids inside the circle may actually contain some people who are outside the circle. Likewise, districts whose centroids are outside the circle and are thus ignored, may contain people who live within the circle. This problem is greatest for calculations within a few miles of the site. By dividing the population count by the area of the circle, a density can be computed. This same centroid-assignment technique can be used for estimating population within each of the 16 sectors around the site although the problem is somewhat more severe since actual enumeration districts may lie in several adjoining sectors, although they are artificially assigned to only one sector.

This approach has been used by other groups[3,4] in carrying out similar computations of population criteria effects on nuclear power plant siting. Due to the unavailability of 1980 census data at the time of these studies, population estimates for 1980 were obtained from the National Planning Data Corporation in Ithaca, New York. The approach was then to assign the circular populations calculated as described above to grid cells that were 5 km (approximately 3.125 miles) on a side. Each grid cell could then be considered as a potential reactor site. It is important to note that the grid cell values are not the number of people in the cell, but are the number of people in a specified circle around the center of the grid cell.

When incremental radii are used, thus creating annuli about the site (e.g., 0-2 miles, 2-5, 5-10, 10-15,...25-30 miles), the computer calculations may be fairly time-consuming in urban areas since the centroid data base is processed repeatedly for each potential cell in a region. Some improvement can be obtained by sorting the centroids so that only a portion of the file need be processed for each new grid cell. (This was done in the study[3,4] mentioned previously.) The size of the gridded data bases (if stored) would be fairly large when incremental radii are involved, since several population values would need to be stored for each cell (a value for each radii or annuli).

3.2. Normalized Global Interpolation with Distance-Weighting

A much improved technique was developed by R. G. Edwards for calculating density values in each cell as a function of all the enumeration district centroids within a user specified latitude-longitude window. For each cell this interpolation technique weighted all surrounding centroids

as a function of distance so that the closer centroids contributed much more to the interpolation. Since all centroids were used each time, the procedure is referred to as a global technique. Normalizations were used to account for the distance-weighting and also to insure that all the people within the window were accounted for exactly. An extra strip of area (a buffer) was also included around the study region to insure that the interpolation produced satisfactory results at the edge of the window. The following equations by R. G. Edwards present the calculation:

$$D_i = N\,\overline{p}_i/A_i = \text{Population density for grid cell } i$$

where: j designates enumeration district centroids = 1, 2, ..., n

i designates grid cells = 1, 2, ..., m

p_j = population of enumeration district j

a_i = area of cell i

r_{ij} = distance from cell i to centroid j

$$A_i = 1\Big/\left(\sum_j 1/r_{ij}^2\right)\left(\begin{array}{c}\text{with closest centroid to}\\ \text{cell i left out of sum}\end{array}\right)$$

$$\overline{p}_i = \left(\sum_j p_j/r_{ij}^2\right)\Big/\left(\sum_j 1/r_{ij}^2\right)$$

$$N = \sum_j p_j \Big/ \left(\sum_j \overline{p}_i\, a_i/A_i\right) = \text{Normalization Factor}$$

The p_i term for grid cell i is a function of the population counts for all enumeration districts in the study window, weighted by $(1/r^2)$ in such a way that the influence of nearby districts have much more effect. The use of a sum of $1/r^2$ in the denominator of the $\overline{p}_i$ term causes the units to be in

population counts. The A_i term has the units of area and the normalization factor is unitless so that D_i is in units of people/mi^2. The normalization factor is calculated so that all of the people associated with centroids inside the study window will be accounted for exactly in the population densities, D_i. Sample output using this technique is shown in Fig. 14 for the New York area. Since the earlier "centroid-assignment" calculations were done using 1970 data, the same data were used in Fig. 14 for comparison with Figs. 11a and 11b.

This technique was designed and works well for relatively small regions, normally 2000 mi^2 or less, with enumeration districts that are not extremely different in size. However, in very large regions with wide variations in the size and the population levels of enumeration districts, there is some distortion. The density estimates in the highly populated cities tend to be too high and the rural estimates tend to be low. This is because there are so many centroids clustered so tightly in dense urban areas that their joint effect tends to reinforce the population estimates too much. In an opposite manner the centroids are spaced so sparsely in the rural areas with long distances between them that the distance weighting tends to drive the rural estimates too low. Overall, the results are still significantly better than using "centroid-assignments". However, a technique that spreads people out from a centroid while using only counts from nearby (or local) areas to improve the spreading would be best. This is the technique described in Section 3.4.

NEW YORK – NEWARK – HARTFORD – SCRANTON POPULATION DENSITY – 1970 CENSUS

ORNL-DWG 81-6804

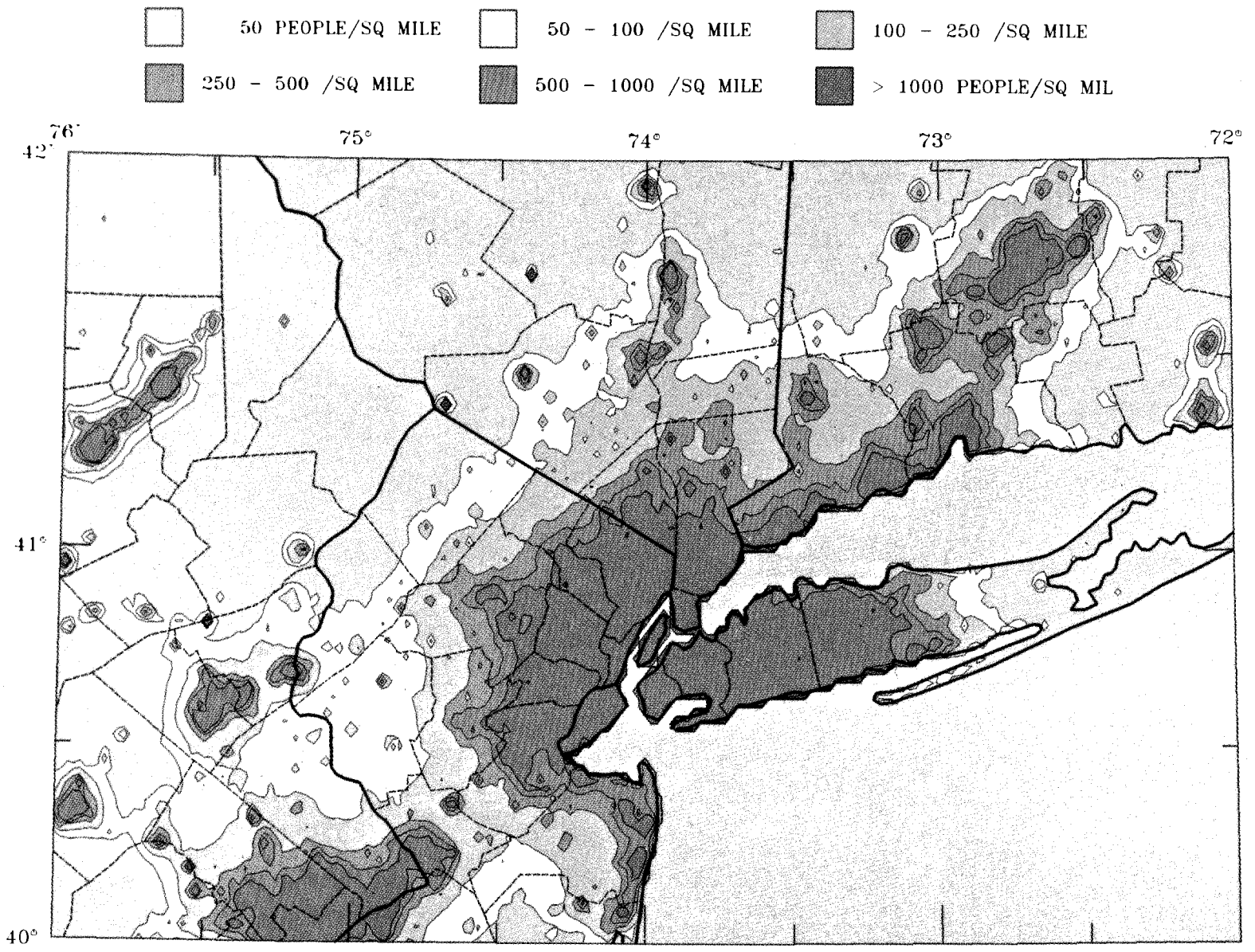


Fig. 14. Population Density Contours Using Normalized Global Interpolation.

3.3. Enhancements to Population Distribution Calculations

Several enhancements have been developed to improve the calculation of population distributions and the efficiency of computer execution for large areas. These improvements have been incorporated in the different interpolation techniques where appropriate. One problem when using interpolation techniques to spread out the population from centroids involves nearby water bodies, especially for urban areas along the coastlines. Without using any information to identify land areas, the distribution of people continues into the ocean off the coastline because the grid system covers the complete area. During the early calculations discussed in the last section (global interpolation) people were distributed as much as 8-10 miles out into the water. Thus one improvement was to intersect the coastline with the gridded calculations and assure that the distribution was made correctly on land areas only. This improvement was incorporated in the distributions shown in Fig. 14.

Another improvement allowed very large areas to be broken into sections that could be computed separately and then merged together with correct continuity maintained across the border. This aided in the computer execution time for large areas, since thousands of centroids would have to be processed for thousands of grid cells. Figure 14 for the larger New York area also incorporated this improvement with no evidence of section borders appearing, even though the calculation was done in four pieces. The PJM population contours previously shown in Fig. 2a also incorporated these types of improvements. Twelve sections were automatically merged in the PJM calculation. There were around 130,000 cells in the area, each one 1.25 minutes of longitude by 1.25 minutes of latitude (around 1-1/2 square miles per cell).

Another improvement was made during the early phases of the project to calculate a maximum potential exclusion area for any density level. This would define just those cells that needed further computations done to evaluate the siting criteria. An example is shown in Fig. 15 for the New York area in which a standoff distance is computed as a ring or zone around the 500 people/mi^2 contour. This would mean that all cells outside the potential exclusion zone would be acceptable sites for criteria involving this density level and distance. Only the cells inside the shaded exclusion zones would need to be processed in evaluating the radial siting criteria, thus saving on computer execution time.

3.4. Local Interpolation Using Thiessen Polygon Networks

Although the previously described global interpolation technique gave better results than the centroid-assignment method, it was determined that a new technique could be developed to give even more accurate results in much less execution time. This procedure involves the use of triangulation techniques to calculate what are referred to as Thiessen polygons[5] around each centroid. These polygons are an approximation of the enumeration district boundaries which were never computerized. Figure 16 shows the Thiessen polygons representing enumeration districts for a small area (approximately 22 miles by 22 miles around the Sequoyah Nuclear Plant north of Chattanooga, Tennessee). It's interesting to note that the sides of all Thiessen polygons are perpendicular bisectors of imaginary lines drawn between pairs of the centroids. If these imaginary lines were actually drawn on the plot, then a multitude of triangles would be created with the centroids as vertices. There are many useful properties of such a triangular network that make computer processing of spatial relationships very fast.

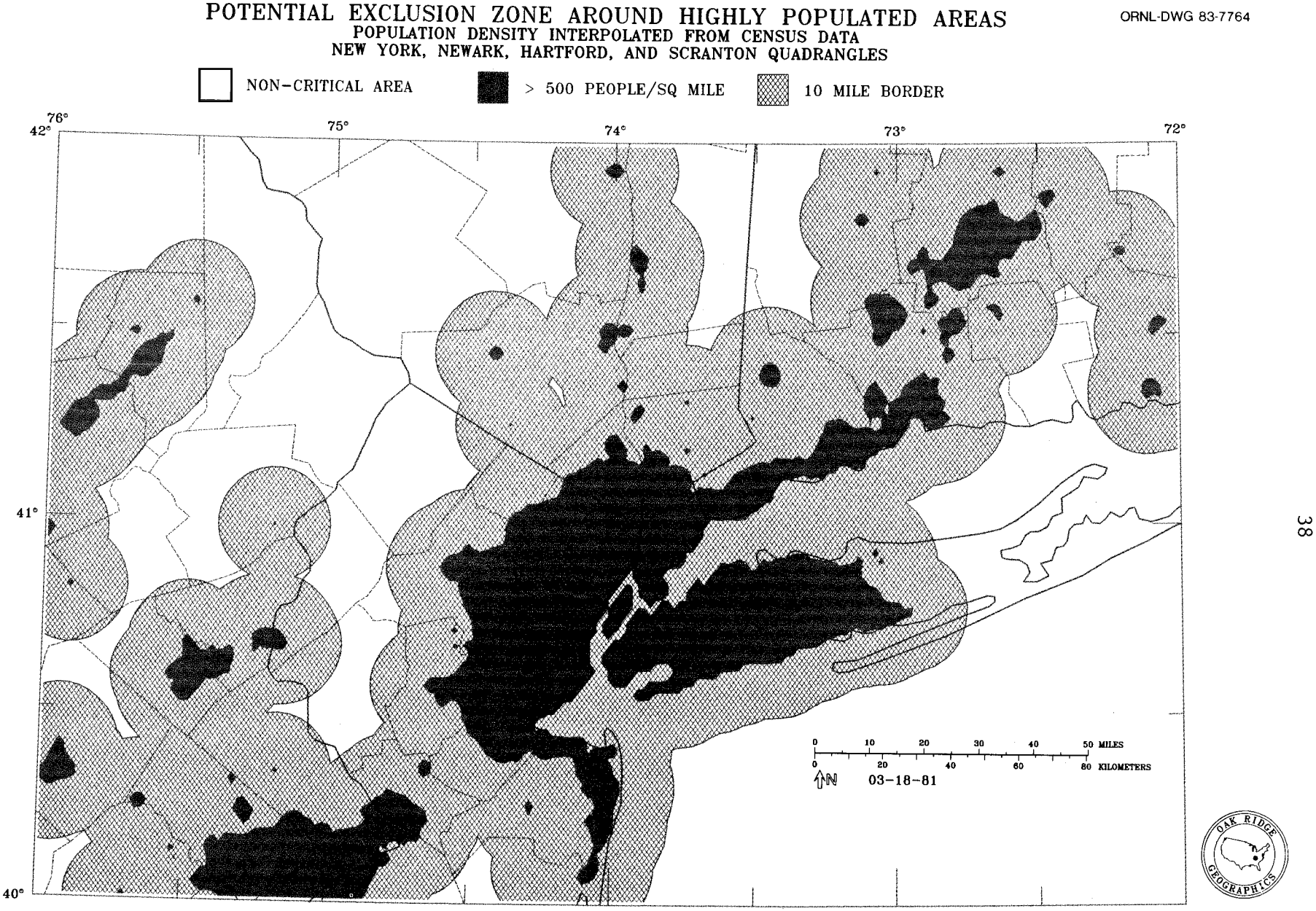


Fig. 15. Potential Exclusion Zone Computed Around 500 people/mi^2 Contour.

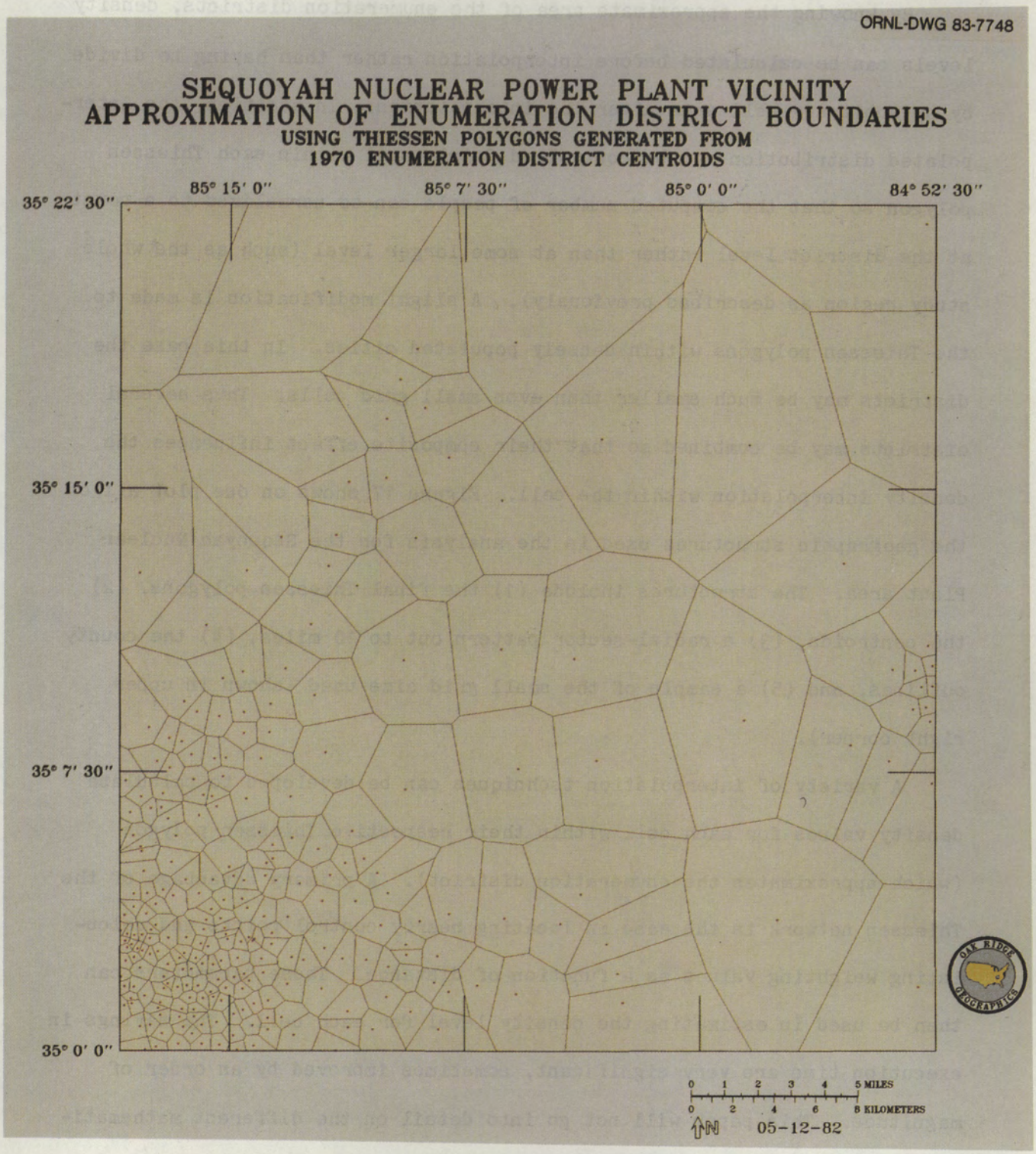


Fig. 16. Approximation of Enumeration District Boundaries Using Thiessen Polygons Computed Around E.D. Centroids.

By knowing the approximate area of the enumeration districts, density levels can be calculated before interpolation rather than having to divide by an arbitrary cell area after the interpolation. In addition, the interpolated distribution can be controlled fairly well within each Thiessen polygon so that the computed number of people can be normalized to a count at the district level rather than at some larger level (such as the whole study region as described previously). A slight modification is made to the Thiessen polygons within densely populated cities. In this case the districts may be much smaller than even small grid cells. Thus several districts may be combined so that their composite effect influences the density interpolation within the cell. Figure 17 shows on one plot all of the geographic structures used in the analysis for the Sequoyah Nuclear Plant area. The structures include (1) the final Thiessen polygons, (2) the centroids, (3) a radial-sector pattern out to 10 miles, (4) the county outlines, and (5) a sample of the small grid size used (shown in upper right corner).

A variety of interpolation techniques can be developed to calculate density values for each cell within their respective Thiessen polygon (which approximates the enumeration district). A primary advantage of the Thiessen network is the ease in locating nearby control points and calculating weighting values as a function of distance. These parameters can then be used in estimating the density level for each cell. The savings in execution time are very significant, sometimes improved by an order of magnitude. This paper will not go into detail on the different mathematical techniques used for interpolation except to mention that eight to ten different techniques were tested. The results were compared to actual

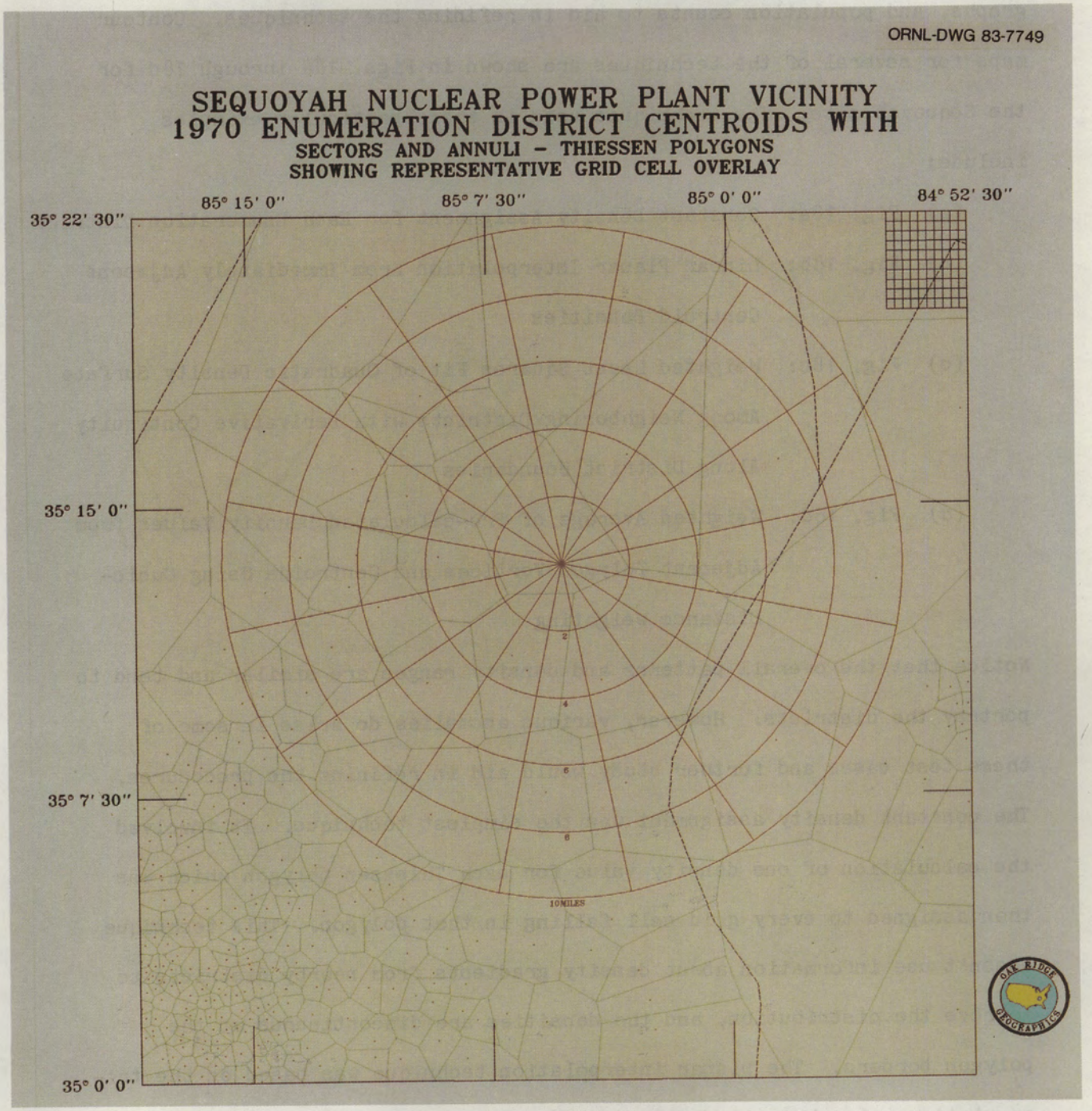


Fig. 17. Geographic Data Structures Used in Vicinity of Sequoyah Nuclear Plant for Population Analyses.

enumeration district maps, quad maps, satellite imagery, aerial photographs, and population counts to aid in refining the techniques. Contour maps for several of the techniques are shown in Figs. 18a through 18d for the Sequoyah site. The techniques used in these particular examples include:

(a) Fig. 18a: Constant Density Assignment for Each Enumeration District

(b) Fig. 18b: Linear Planar Interpolation from Immediately Adjacent Centroid Densities

(c) Fig. 18c: Weighted Least Squares Fit of Quadratic Density Surface Among Neighboring Districts with Derivative Continuity Along District Boundaries

(d) Fig. 18d: Weighted Average of Pre-calculated Density Values from Adjacent Polygon Vertices and Centroids Using Cubic-Distance Weighting

Notice that the overall patterns and density ranges are similar and tend to portray the districts. However, various anomalies do arise in some of these test cases and further study would aid in refining the procedures. The constant density assignment was the simplest technique. It involved the calculation of one density value for each Thiessen polygon which was then assigned to every grid cell falling in that polygon. This technique doesn't use information about density gradients from nearby districts to improve the distribution, and the densities are discontinuous at the polygon borders. The planar interpolation technique was based on the triangulation network mentioned previously. By knowing the density values at the vertices of the triangles, a density value can be calculated very quickly for any grid cell falling inside the triangle. The triangle can be

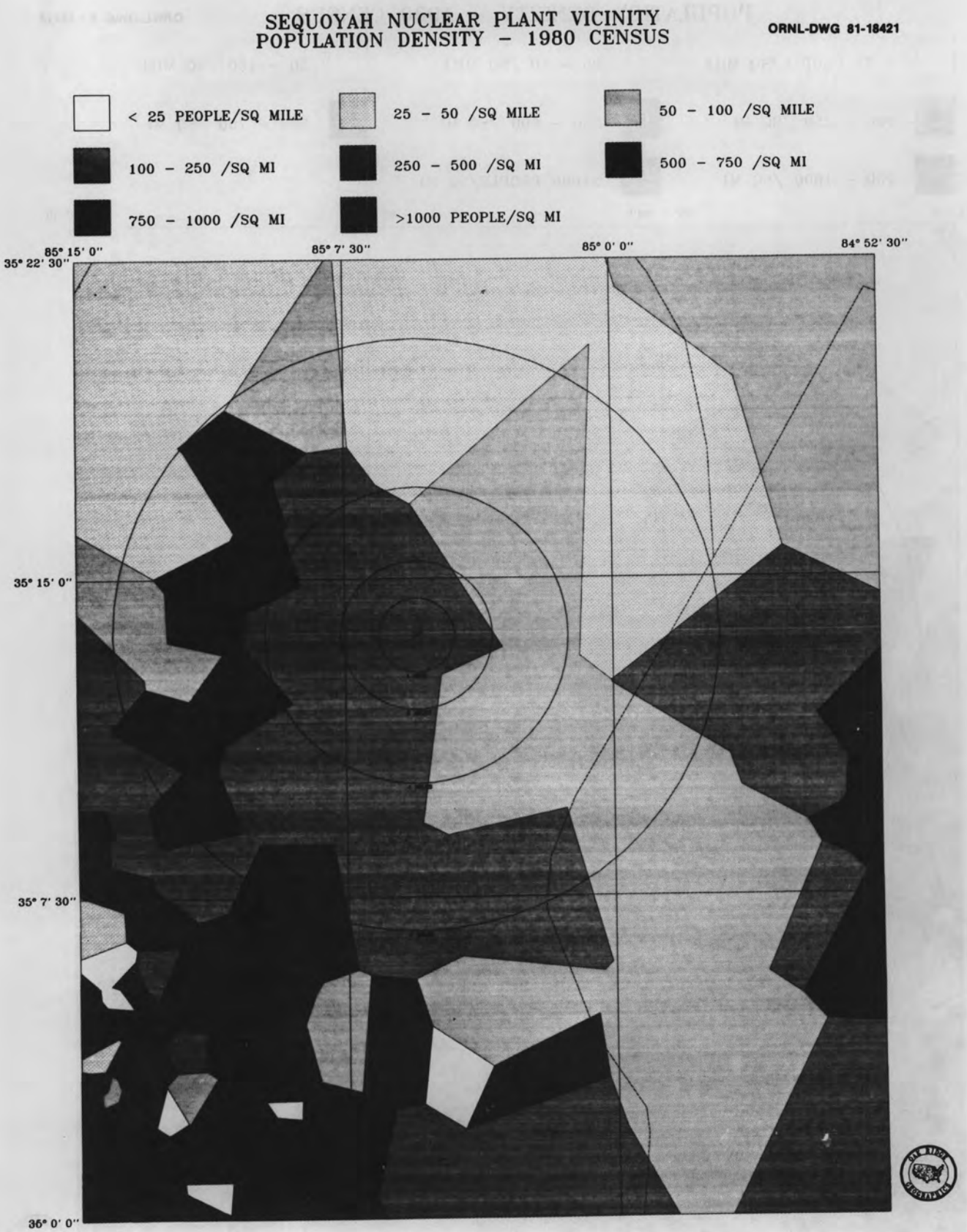


Fig. 18a. Constant Density Assignment for Each Enumeration District.

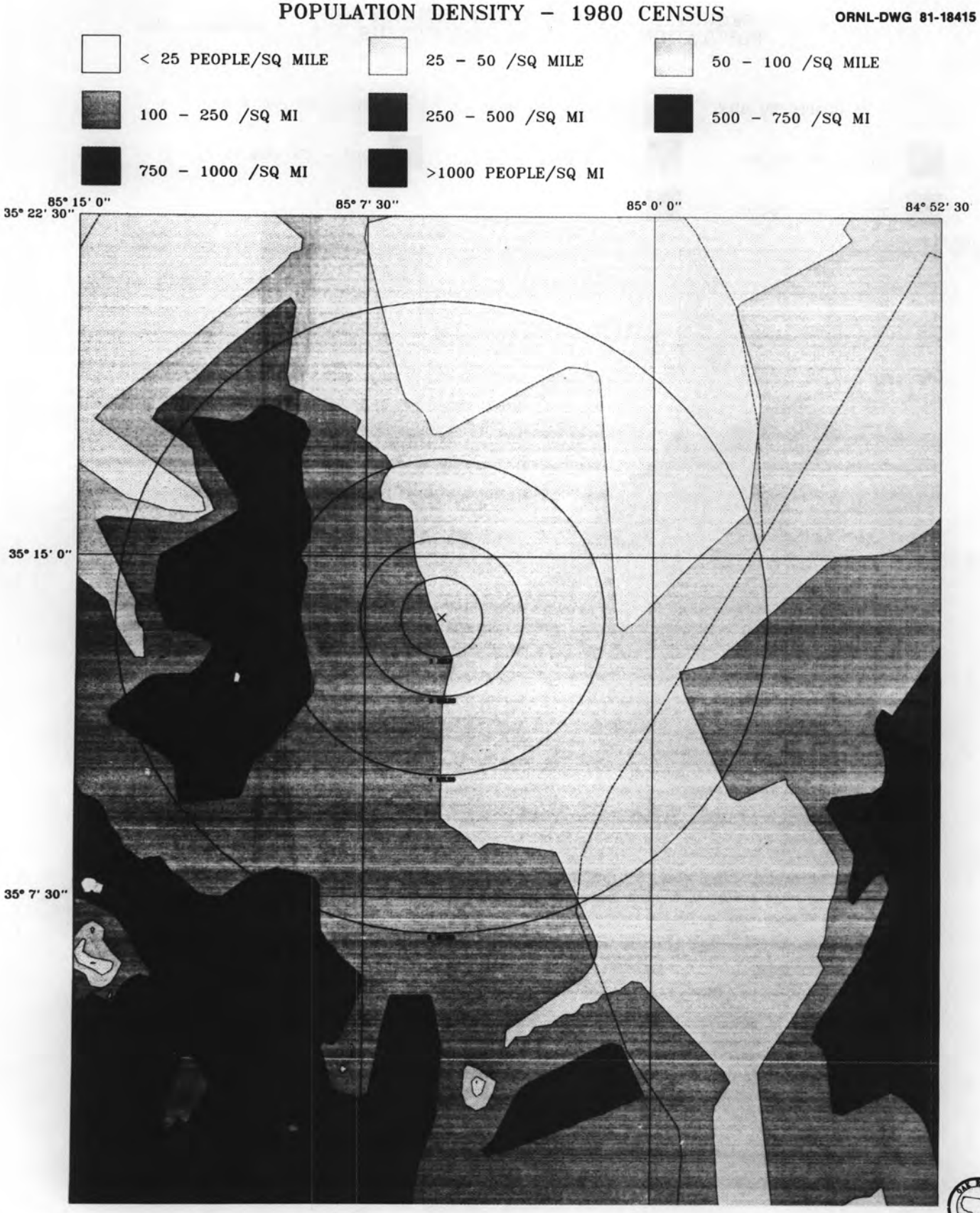


Fig. 18b. Linear Planar Interpolation from Centroid Densities.

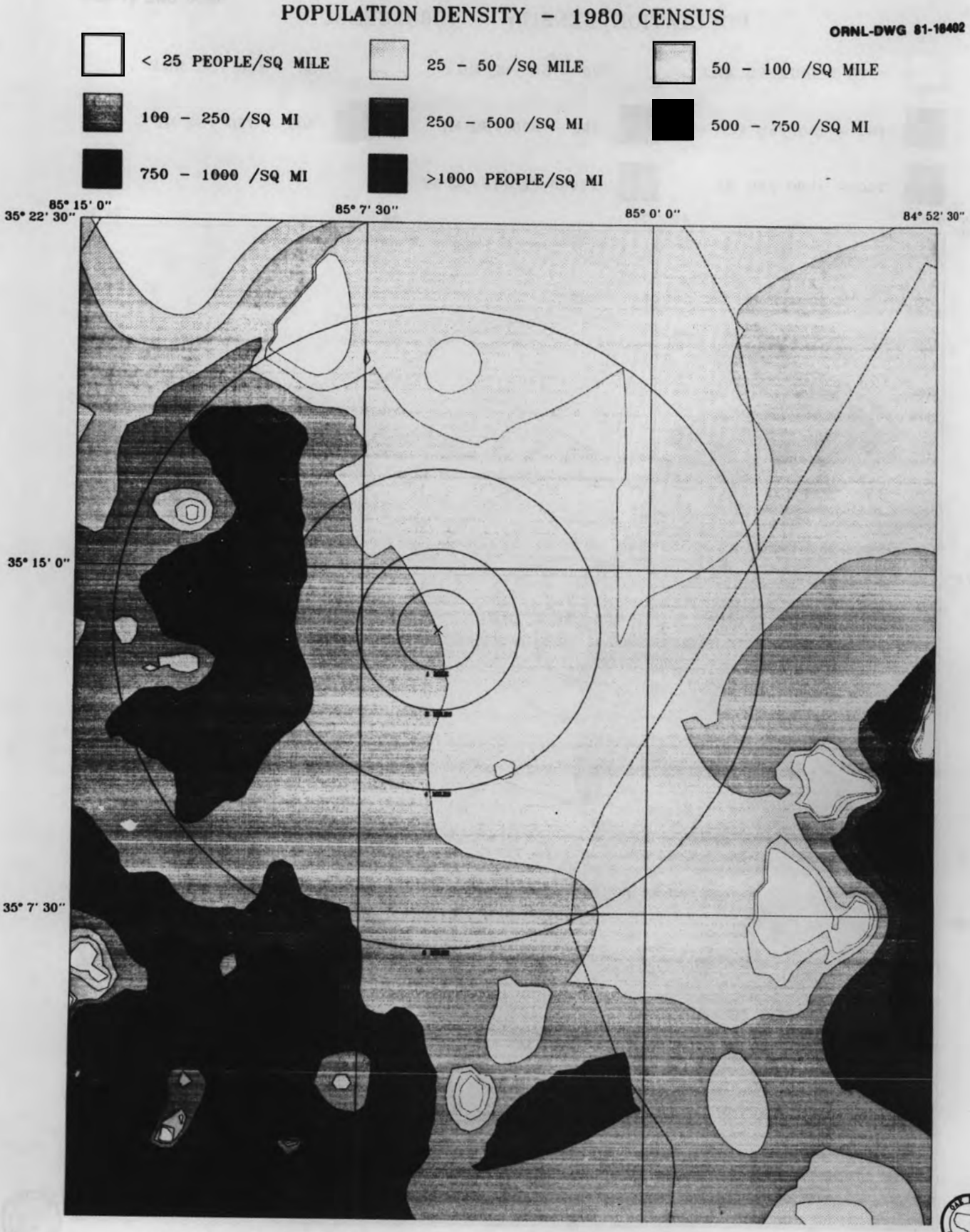


Fig. 18c. Weighted Least Squares Fit of Quadratic Density Surface.

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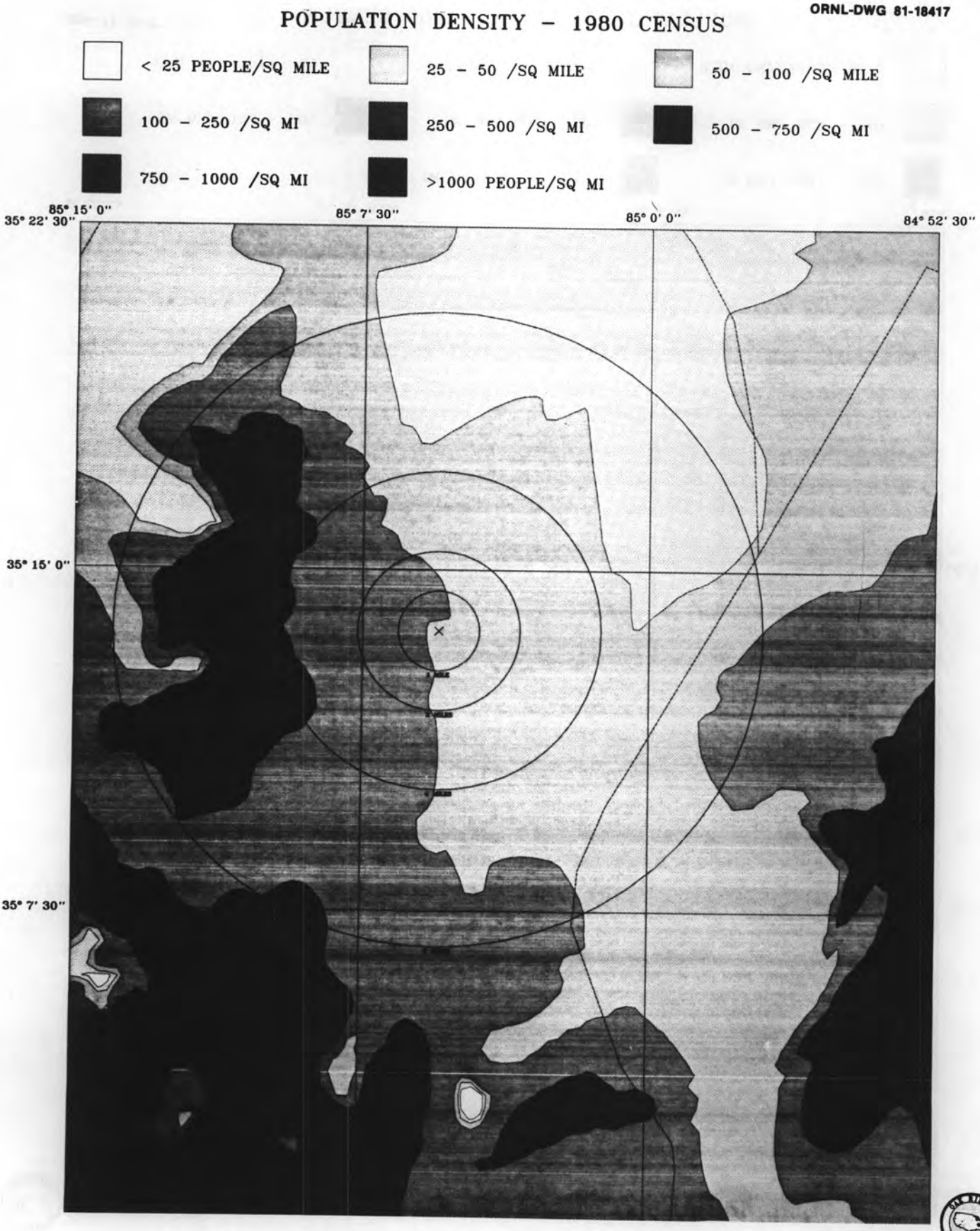

Fig. 18d. Weighted Density Average from Polygon Vertices and Centroids Using Cubic-Distance Weighting.

thought of as a tilted plane in space whose height above any grid cell corresponds to the density of that cell. Various artificial aberrations were created at different locations within the study area with this technique. The least squares fit involved the fitting of a quadratic surface to the Thiessen polygon densities with appropriate weights applied to the data points depending on distances. The surface function and its derivatives were continuous across polygon borders. This technique created "hot spots" in the surface that were either too high or too low. The weighted averaging technique required the computation of densities at all vertices of the polygons as well as the centroids. Then an average value was computed for each grid cell as a function of these nearby control points weighted with a cubic relationship to distance. The weighting technique along with the precalculated control points guaranteed that the density function was continuous along the polygon borders. The best results to date have been with the cubic-distance weighting of Fig. 18d. In addition to giving more accurate results for distributing the population, the execution time is significantly faster than using the global technique.

The final step needed in this type of population density interpolation is to normalize the gridded densities so that all the people are accounted for properly. The initial normalization consisted of adding up the population counts for all enumeration districts in the study window and comparing it with the population total calculated from all the grid cells (cell density x cell area = cell population). When they differed, a single multiplication factor was applied to all grid cells so that the gridded total equaled the actual total for the study region as a whole. This left room for some error, especially with large multi-state regions like PJM, since

poor estimates in one part of the region caused a correction to be applied to the whole region. Thus, a better normalization technique has been implemented at the enumeration district level. As the gridded densities are calculated within each Thiessen polygon, interpolation adjustments are made in an iterative fashion to assure that the gridded total in the polygon equals the actual total for that enumeration district. The technique also assures that the total density surface is continuous across the polygon borders. In this way the gridded population estimates will more accurately reflect the true population counts at the enumeration district level, the county level, and the study region level. At the county level some distributions were improved by as much as 30% or so with this new normalization. It's still important to point out that more detailed data (such as base maps, aerial photographs, or actual house counts) are really needed for accurate results within several miles of a specific site, especially if there are unique features near the site. For example, any interpolation technique will assign a certain number of people to every cell, unless cells are specifically excluded. Other approaches and possible improvements for distribution population are discussed in Section 5. Results from a few examples are also given including more accurate distributions using quad maps and aerial photos digitally within 10 miles of a site.

Computations have been performed for several study regions around the country, both in the East and West, to consider urban versus rural effects. Unless otherwise noted, all computations have incorporated the latest interpolation and normalization techniques described in this section. The PJM density contours shown in Fig. 2a used the most recent "local

interpolation" with the "enumeration district normalization." For comparison purposes Figs. 19a and 19b are included to show population density contours in the Washington-Oregon area using the global technique (Section 3.2) and the local technique (Section 3.4). The siting results shown in the next section are based upon the most recent improvements.

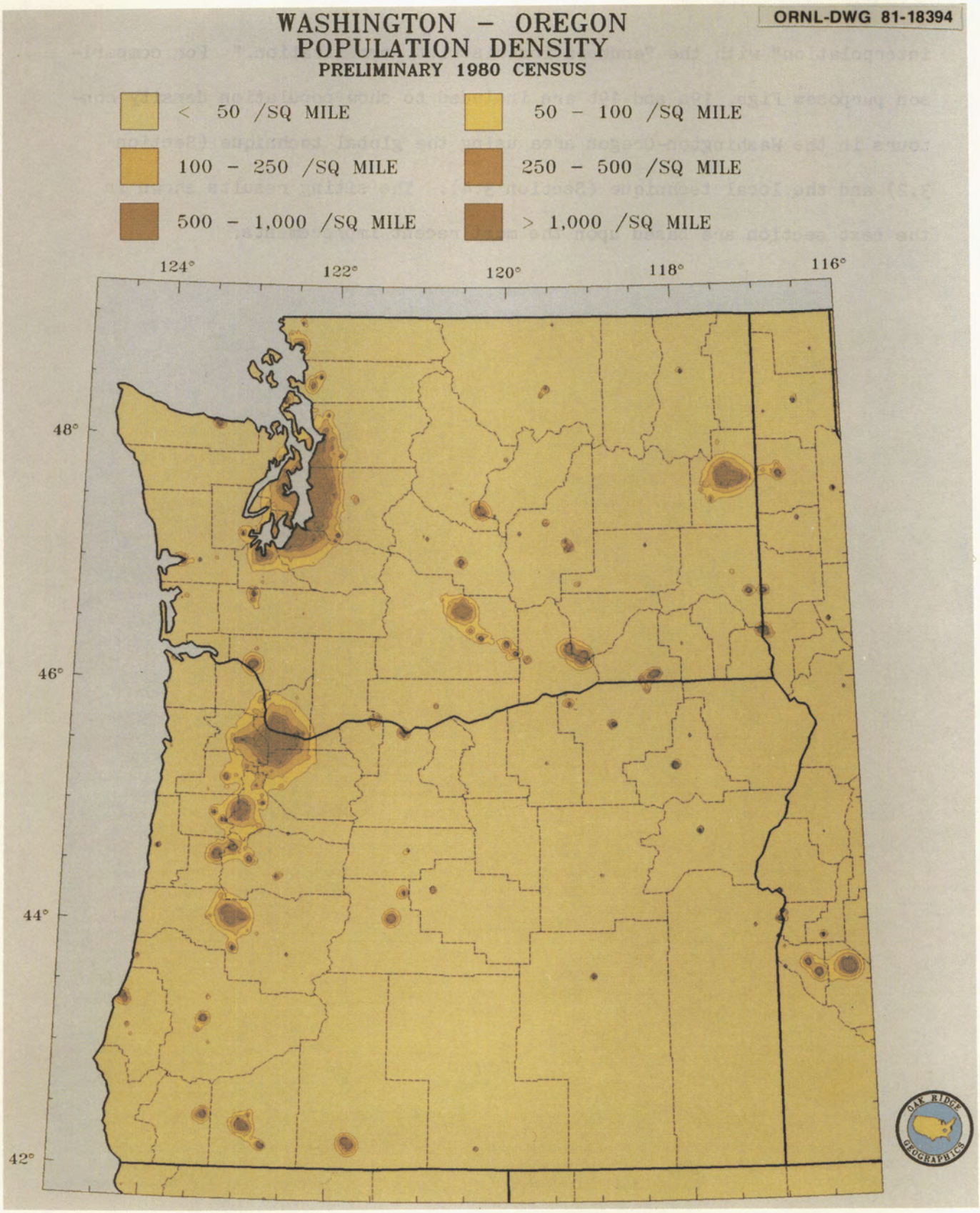

Fig. 19a. Population Density Contours in Washington-Oregon Region Using Global Interpolation.

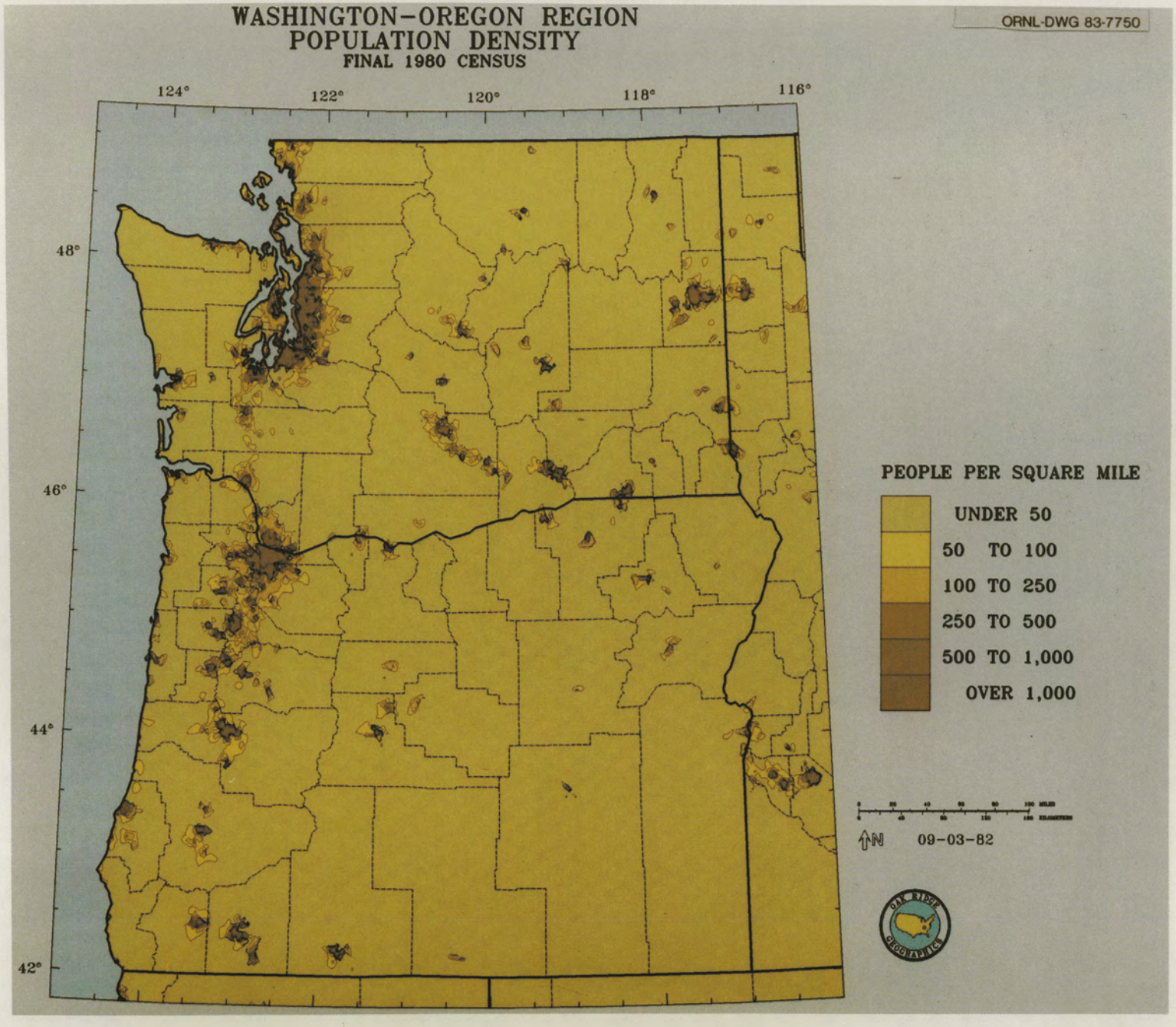

Fig. 19b. Population Density Contours in Washington-Oregon Region Using Local Thiessen-Network Interpolation.

4. EVALUATION OF SITING CRITERIA

4.1. Description of NRC Radial and Sector Criteria

In the Introduction section a brief description was given of the radial and sector criteria used for evaluating the desirability of areas for nuclear power plants as far as residential population is concerned. Displays were also presented showing the calculated population density, zones where population threshold levels were exceeded, and reactor sites in the PJM area. The population criteria were based upon the density levels (or correspondingly, number of people) residing in each of the radial and sector zones shown in Fig. 1. The radial zone boundaries were at 2 miles, 5 miles, 10 miles, 15 miles,...out to a maximum of 30 miles. The angular zones consisted of 16 sectors of 22-1/2° each, beginning with the first sector centered on the north direction. The maximum number of people given as a threshold level for each zone was given in Table 1 for Alternative Case 4. This particular alternative was used in determining the red PJM zones in Fig. 3. NRC requested that a total of six different alternatives be tested, referred to as Alternative Cases 1, 2,...6. The initial analyses were performed for three different geographic regions in the U.S. using Case 4 criteria. These results are described in Section 4.2. Results from testing the other alternatives are described in Section 4.3. Section 4.4 discusses the analysis of individual sites across the U.S. The purpose of this section (4.1) is to explain in detail how the population criteria are specified.

It should be noted that the alternatives being evaluated here are part of an effort to specify demographic criteria that are independent of design differences among plants. Failure of existing sites under these

alternatives has no implications about the acceptability of the plants at these sites which were designed and are operated to accommodate site deficiencies such as higher population densities. These demographic criteria are also being analyzed with the knowledge that population growth around sites is in many cases inevitable and to some extent predictable. The criteria will therefore be meant to apply at a certain point in time such as time of application and in many cases may be violated before a plant reaches the end of its useful life.

The criteria within each of the radial-sector zones can be expressed as limits on either population density or population counts. Although the original criteria were specified in terms of population density, they are easily converted into specific numbers of people by multiplying by the appropriate area. The population criteria associated with the seven radial zones are each cumulative beginning at the origin of the site (i.e., 0-2 miles, 0-5 miles, 0-10 miles, etc.). The two columns in Table 1 contain population threshold levels for each of the radial and sector zones. These counts are actually functions of specific density levels that have been converted to number of people. The criteria in Table 1 specify that potential sites are unacceptable if they exceed 250 people/mi^2 in the 0-2 mile zone or 750 people/mi^2 in the zones ranging from 2 miles to 30 miles. Since the outer zones are cumulative, this means that the 0-5 mile zone must use the 250 level out to 2 miles and the 750 level from 2-5 miles. Likewise the 0-10 mile zone uses a combination of the 250 and 750 density levels for 0-2 miles and 2-10 miles, respectively.

The sector criteria in Table 1 specifies that a site exceeds a threshold level if the population in any two adjacent sectors around the

site exceeds one-fourth of the maximum total population allowed within the radial zone. Before the comparison can actually be made, the individual population data in each grid cell must be aggregated to each of the 112 radial-sector zones. An aggregation of grid cells into a circular pattern does not exactly replicate the circle, and likewise, grid cell approximations of the 16 sectors do not exactly replicate the sector zones. Thus, a refinement was added to correct for this approximation by adjusting the grid cell aggregation on the basis of the actual area of the circles or annuli and the sector proportions. Figure 20a shows the numerical printout of incremental population counts for all of the zones around the Susquehanna site. The radial distance is given along the top and the angular sector down the side. Figure 20b shows the same data except that the counts have been accumulated out from the origin to each radial zone. These summed counts are the ones actually checked against the maximum allowed. A given cell is flagged if (1) any of the seven radial zones exceed the accumulative radial limit or (2) if any two adjacent sectors for any radial zone exceed the sector limit. For efficiency it was suggested that 45° sectors might be used (as done in the study[3,4] previously mentioned) to approximate two adjacent $22\text{-}1/2^{\circ}$ sectors. However, this would only allow for testing half of the $22\text{-}1/2^{\circ}$ sector combinations that are possible.

4.2. General Results for Major Regions in U.S.

In this section further regional results will be presented and discussed for the PJM area in the East, the Chicago-centered region in the Midwest, and the Washington-Oregon area in the far West. This will be followed by a more detailed discussion of the methodology for evaluating the

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SUSQUEHANNA 1980 RUN DATE: 11-12-82
LATITUDE= 41 DEG, 5 MIN, 30 SEC LONGITUDE= 76 DEG, 8 MIN, 55 SEC

INCREMENTAL POPULATION DATA

DISTANCE,MILES	0- 2	2- 5	5- 10	10- 15	15- 20	20- 25	25- 30
N	272	688	1207	1423	1283	855	622
NNE	0	306	3956	1392	8386	5276	3414
NE	91	167	3817	29885	116836	50199	32458
ENE	0	208	1138	5487	14505	1580	788
E	0	180	1317	4369	2710	365	696
ESE	92	88	1426	6740	2290	2123	1733
SE	0	169	3232	38901	4428	14072	17425
SSE	187	231	2901	4351	4695	14232	2845
S	0	142	1223	1135	14811	14237	31468
SSW	0	67	901	943	3758	20652	12131
SW	0	1107	1042	751	1121	10510	21163
WSW	276	5518	8987	3686	19919	6602	10638
W	0	3467	1933	1613	1601	2011	2314
WNW	0	641	1111	1286	1951	1420	1581
NW	281	534	883	1025	807	696	608
NNW	0	657	992	965	577	206	959
TOTAL	1199	14170	35666	103952	199678	145036	140843

Fig. 20a. Incremental Number of People in Each Radian-Sector Zone Around Susquehanna Site.

ORNL-DWG 83-8010

SUSQUEHANNA 1980 RUN DATE: 11-12-82
LATITUDE= 41 DEG, 5 MIN, 30 SEC LONGITUDE= 76 DEG, 8 MIN, 55 SEC

CUMULATIVE POPULATION DATA

DISTANCE,MILES	0- 2	0- 5	0- 10	0- 15	0- 20	0- 25	0- 30
N	272	960	2167	3590	4873	5728	6350
NNE	0	306	4262	5654	14040	19316	22730
NE	91	258	3675	33560	150396	200595	233053
ENE	0	208	1346	6833	21338	22918	23706
E	0	180	1497	5866	8576	8941	9637
ESE	92	180	1606	8346	10636	12759	14492
SE	0	169	3401	42302	46730	60802	78227
SSE	187	418	3319	7670	12365	26597	29442
S	0	142	1365	2500	17311	31548	63016
SSW	0	67	968	1911	5669	26321	38452
SW	0	1107	2149	2900	4021	14531	35694
WSW	276	5794	14781	18467	38386	44988	55626
W	0	3467	5400	7013	8614	10625	12939
WNW	0	641	1752	3038	4989	6409	7990
NW	281	815	1698	2723	3530	4226	4834
NNW	0	657	1649	2614	3191	3397	4356
TOTAL	1199	15369	51035	154987	354665	499701	640544

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Fig. 20b. Accumulative Number of People From Origin Out to Each Radial-Sector Zone for Susquehanna Site.

siting criteria. The reason for calculating site acceptabilities throughout large regions was to aid in understanding the overall restrictiveness of the population criteria in relation to various urban centers. It was felt that the three regions selected would represent a meaningful cross-section of the U.S., ranging from highly urban cities to rural communities. These regions also utilize various levels of nuclear power located at different distances from population centers. Figure 21 presents the same PJM siting calculation shown previously, but zones exceeding threshold levels are broken into three classes or colors depending on which criterion was the limiting factor. The red zones correspond to areas which exceeded both the radial criteria and the sector criteria. The orange zones exceeded only the sector criteria while the blue zones exceeded only the radial criteria. The light green area outside these zones corresponds to acceptable areas for reactor sites most of which occur in the rural areas.

The highly urban areas exceed both criteria and, thus, the center zones are red in most major cities. At greater distances from the inner cities, the overall population density drops below the radial criteria. But since the perimeter populations are not located homogeneously in circular patterns around potential sites, the sector criteria are still exceeded. This causes the orange zones around the outer edges of the red areas. Only in a few pockets do cells fail the radial test while not exceeding the sector criteria as indicated by the blue shading. Figure 22 shows the location of plant sites that have either been considered in the past or are currently being used in the PJM area. The status of these sites is indicated in the legend of the plot by the type and color of the

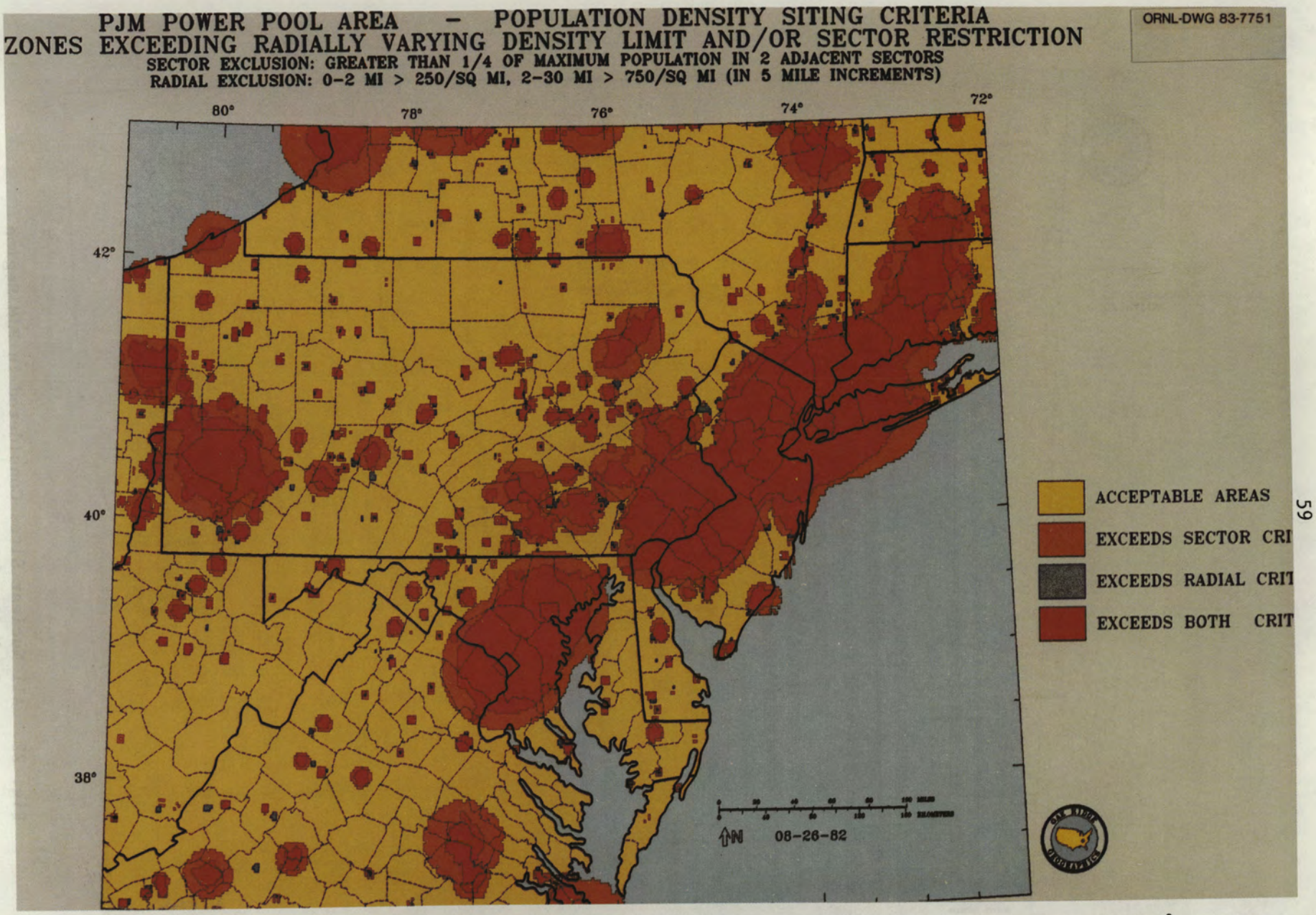

Fig. 21. Unfavorable Zones in PJM Region Based on Alternative Case 4 (Criteria = 250/mi^2 in 0-2 miles, 750/mi^2 in 2-30 miles, 1/4th population in 2 sectors).

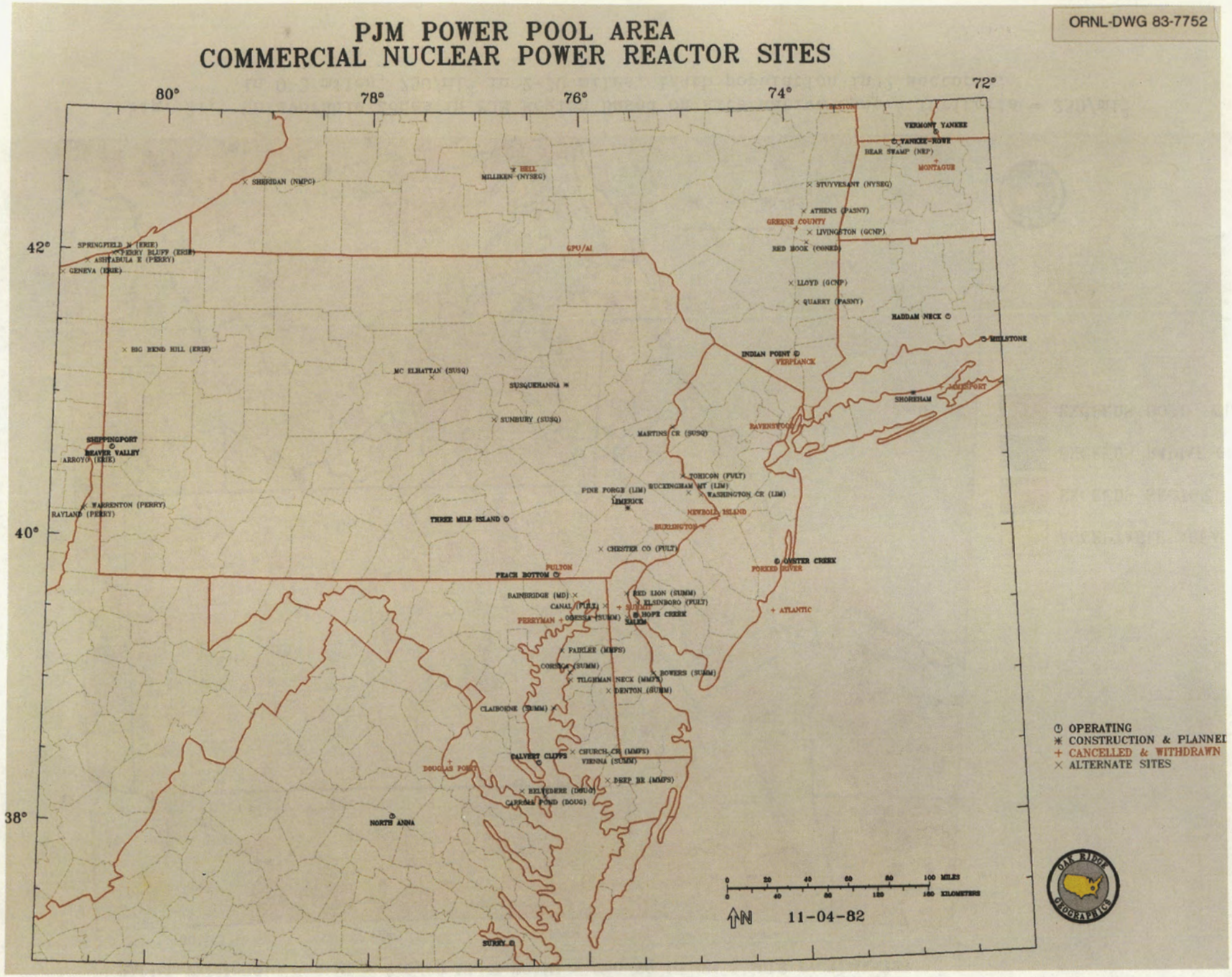

Fig. 22. All Nuclear Sites Considered in PJM Region Including Alternate Sites.

symbol plotted. These sites have been superimposed on the criteria map in Fig. 23. A number of existing sites fall in the red or orange zones indicating that they would exceed this particular criteria (Alternative Case 4) if they were being evaluated with the 1980 population estimates as calculated in this study. In order to assure correct zone calculations along the border of the map, a 30-mile buffer has been added around the outside of the PJM region for all calculations. This extra area is not plotted for any of the maps. If the buffer were not included, all sites or cells at the edge of the PJM region could not be evaluated out to the 30-mile radius. A similar buffer is used in the other two regions studied.

Close study of the siting patterns for the PJM area reveals that some small towns had areas around them which exceeded the threshold levels based usually on the sector criteria (orange zones). These patterns showed up as "doughnuts" on the map where the center portion of the town was considered acceptable, while a ring of cells around the town was not acceptable. This was because a potential site centered within a low-density town had the people distributed somewhat homogeneously in all sectors around the center grid cell, thus not exceeding the sector test. However, when the potential site moved off-center to the outer edge of the town, all the town's population fell within one or two sectors, so that the sector criteria were exceeded in moving around the town perimeter. This is somewhat of an artifact caused by the criteria stating that no more than one-fourth the maximum population may occur in two adjacent sectors.

A useful parameter to aid in evaluating zones exceeding the threshold levels is the total area (square miles) excluded within the study region. Table 4 gives the total square miles excluded in the PJM area and a

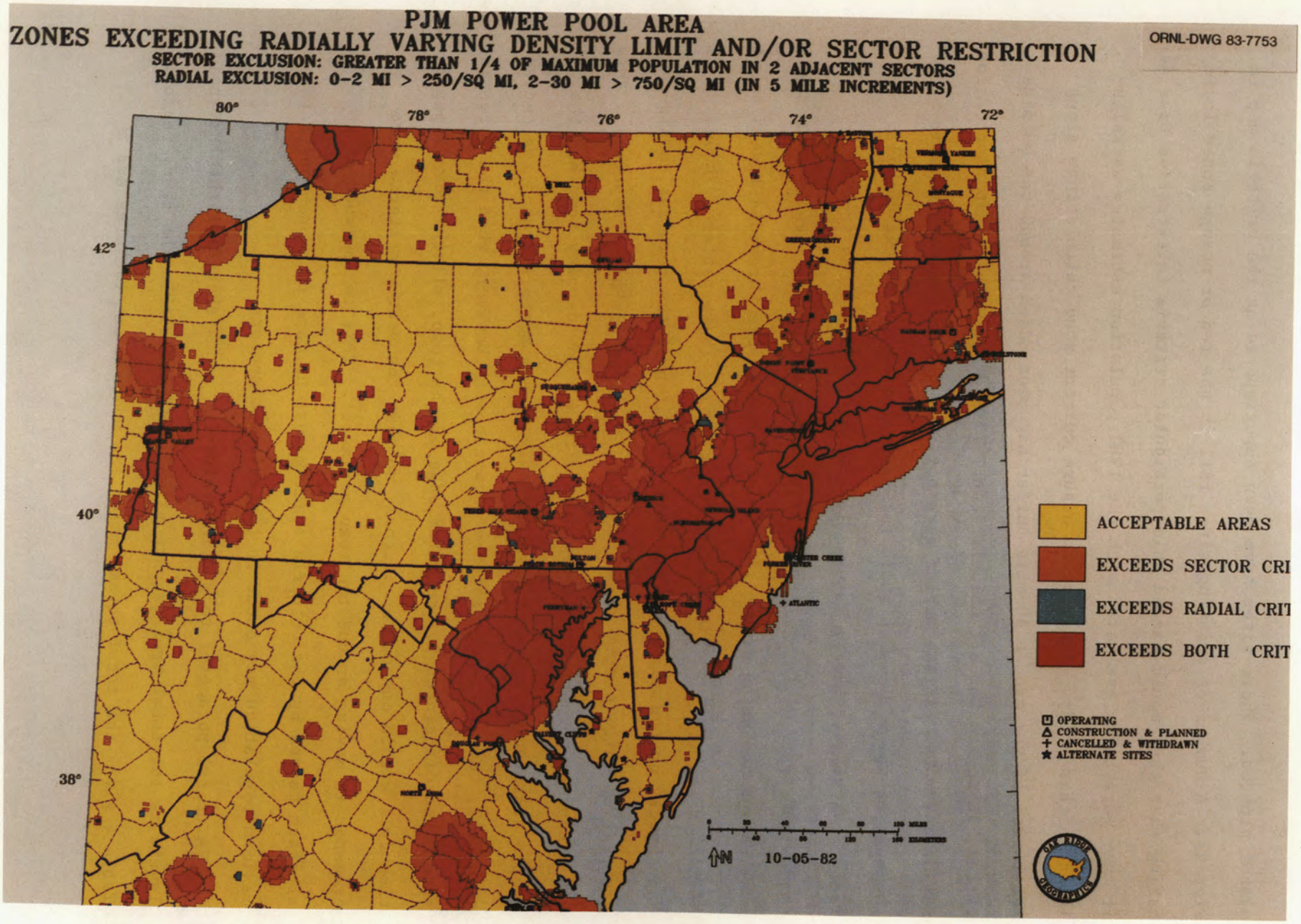

Fig. 23. All Nuclear Sites Superimposed on Unfavorable Zones In PJM Region (Alternative Case 4 Used).

Table 4. Area (mi^2) in PJM Region Unfavorable for Nuclear Power Plant Sites, Categorized by State Portion.

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AREA (SQ MI) IN PJM REGION UNACCEPTABLE FOR NUCLEAR POWER PLANT SITES, CATEGORIZED BY STATE PORTIONS

CASE: 4

STATE	PORTION OF STATE IN PJM (SQ MI)	AREA OF STATE PORTION EXCLUDED	PERCENT OF STATE PORTION EXCLUDED	AREA EXCLUDED BY SECTOR CRITERIA (ORANGE)	AREA EXCLUDED BY RADIAL CRITERIA (BLUE)	AREA EXCLUDED BY BOTH CRITERIA (RED)
CONNECTICUT	4422.30	3451.93	78.06	938.75	32.25	2480.93
DELAWARE	2014.75	508.62	25.24	153.90	17.56	337.15
DISTRICT OF COLUMBIA	67.04	67.04	100.00	0.0	0.0	67.04
MARYLAND	9917.59	4599.00	46.37	1335.50	46.17	3217.33
MASSACHUSETTS	3361.20	1422.96	42.33	729.81	28.69	664.46
NEW HAMPSHIRE	508.12	79.37	15.62	37.43	4.50	37.44
NEW JERSEY	7528.35	5637.61	74.89	657.46	65.40	4914.75
NEW YORK	26695.83	8350.82	31.28	3564.45	155.01	4631.36
OHIO	3256.73	1225.46	37.63	554.99	10.83	659.65
PENNSYLVANIA	44720.32	13572.26	30.35	5075.50	242.94	8253.82
VERMONT	710.36	44.97	6.33	1.50	8.99	34.47
VIRGINIA	25733.84	4442.80	17.26	2262.27	76.12	2104.41
WEST VIRGINIA	14717.08	920.86	6.26	338.59	35.00	547.27
TOTAL	143653.38	44323.66	30.85	15650.15	723.46	27950.06

breakdown as to how much area exceeded the radial criteria, the sector criteria, or both. The area excluded in each state is also given, although some states are not completely contained within the PJM region. Comparison of these area statistics for different siting criteria can aid in further evaluating the effect of different alternatives. Appendix A contains the area tables for all three regions of the country with all six alternatives calculated.

The same population criteria in Table 1 were applied to the more rural Washington-Oregon region as shown in Fig. 24. Nuclear sites are superimposed on the map. Again the red, orange, and blue zones are presented for unacceptable areas. The population density map was shown previously in Fig. 19b. It is quite obvious that much more area is available for siting nuclear plants as far as population restrictions are concerned. Table 5 presents the breakdown of areas (square miles) by state which exceed the threshold levels. Figure 25 is a plot of the population density contours for the Chicago-centered region. The major urban sprawl around Lake Michigan is obvious. Figure 26 presents the Case 4 siting criteria applied to the Chicago-centered region along with superimposed reactor sites. Table 6 contains the square mileage totals by state for all areas exceeding the threshold levels of Case 4. The influence of Chicago is similar to that of New York City. In addition to comparing different geographical regions for Case 4, other alternatives were tested using different population density levels for both the radial and sector criteria. Different numbers of adjacent sectors were also tested. These are discussed in the next section. One consideration in the analysis was whether different patterns resulted in the urban East as compared to the rural West.

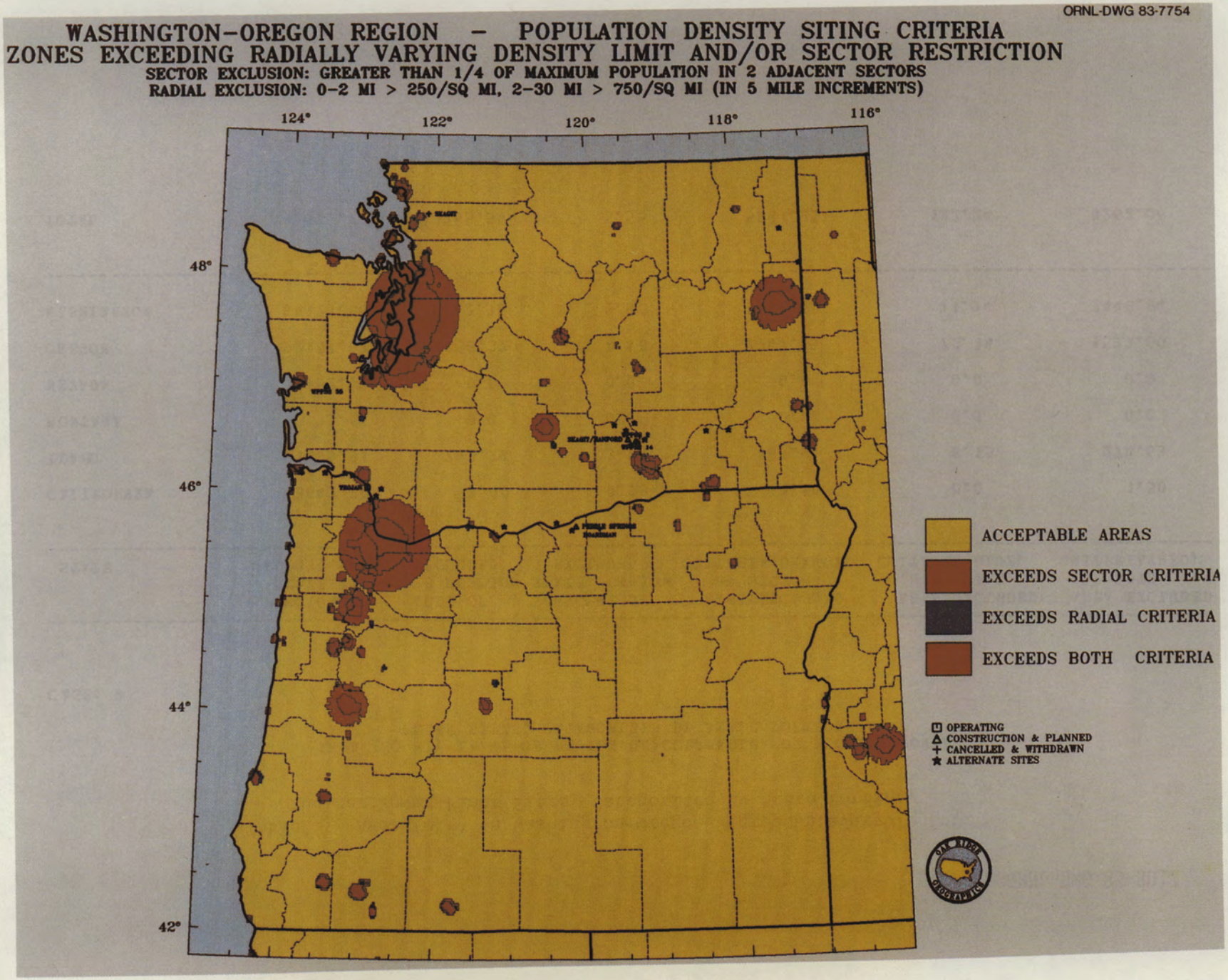

Fig. 24. Unfavorable Zones in Washington-Oregon Region with Nuclear Sites Superimposed (Alternative Case 4 used).

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Table 5. Area (mi^2) in Washington-Oregon Region Unfavorable for Nuclear Power Plant Sites, Categorized by State Portion.

AREA (SQ MI) IN WA-OR REGION UNACCEPTABLE FOR NUCLEAR POWER PLANT SITES, CATEGORIZED BY STATE PORTIONS

CASE: 4

STATE	PORTION OF STATE IN WAOR (SQ MI)	AREA OF STATE PORTION EXCLUDED	PERCENT OF STATE PORTION EXCLUDED	AREA EXCLUDED BY SECTOR CRITERIA (ORANGE)	AREA EXCLUDED BY RADIAL CRITERIA (BLUE)	AREA EXCLUDED BY BOTH CRITERIA (RED)
CALIFORNIA	3642.30	3.00	0.08	1.50	0.0	1.50
IDAHO	21608.91	743.79	3.44	461.01	8.15	274.63
MONTANA	92.61	0.0	0.0	0.0	0.0	0.0
NEVADA	3452.05	0.0	0.0	0.0	0.0	0.0
OREGON	92151.63	3856.37	4.18	2247.23	72.14	1537.00
WASHINGTON	64123.66	5662.38	8.83	3171.50	41.94	2448.94
TOTAL	185071.13	10265.54	5.55	5881.25	122.24	4262.06

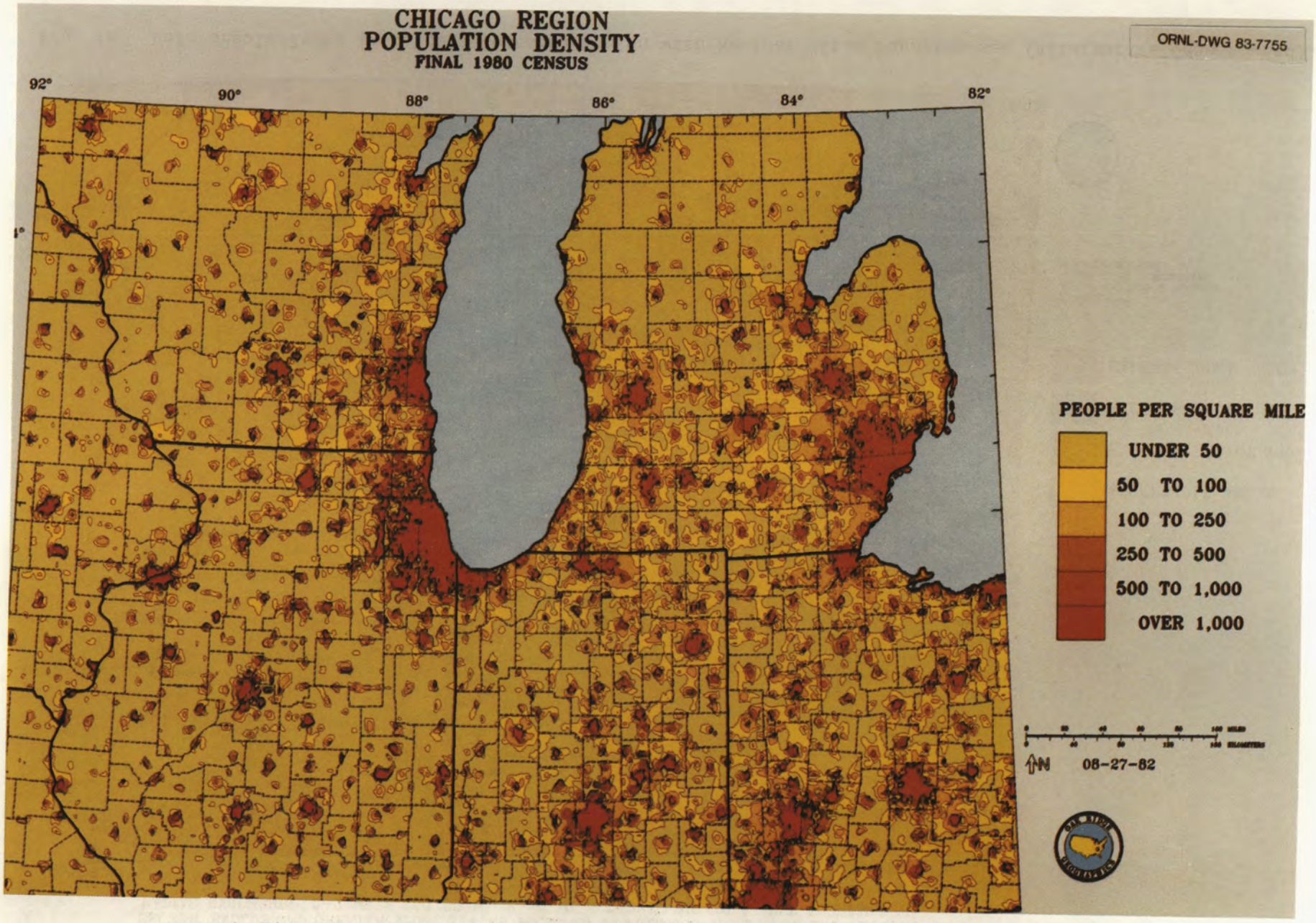

Fig. 25. Population Density Contours For Chicago-Centered Region.

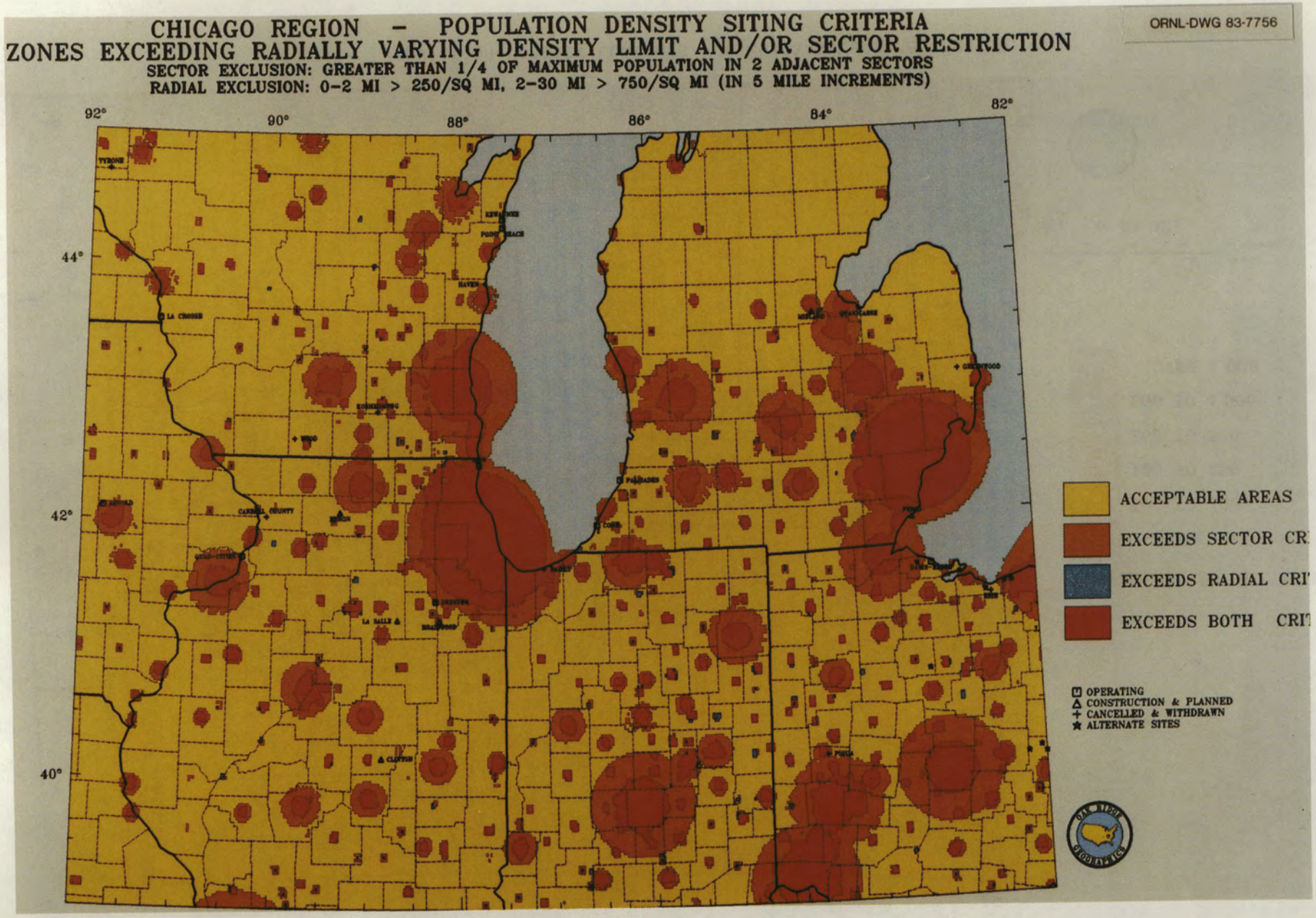

Fig. 26. Unfavorable Zones in Chicago-Centered Region with Nuclear Sites Superimposed (Alternative Case 4 used).

Table 6. Area (mi^2) in Chicago-Centered Region Unfavorable for Nuclear Power Plant Sites, Categorized by State Portion.

AREA (SQ MI) IN CHICAGO REGION UNACCEPTABLE FOR NUCLEAR POWER PLANT SITES, CATEGORIZED BY STATE PORTIONS

CASE: 4

STATE	PORTION OF STATE IN CHI (SQ MI)	AREA OF STATE PORTION EXCLUDED	PERCENT OF STATE PORTION EXCLUDED	AREA EXCLUDED BY SECTOR CRITERIA (ORANGE)	AREA EXCLUDED BY RADIAL CRITERIA (BLUE)	AREA EXCLUDED BY BOTH CRITERIA (RED)
ILLINOIS	41670.81	8794.63	21.10	4172.96	94.44	4527.23
INDIANA	26790.32	7688.49	28.70	4458.57	103.05	3126.87
IOWA	12528.54	1346.88	10.75	850.72	13.62	482.54
KENTUCKY	178.39	178.39	100.00	33.46	0.0	144.94
MICHIGAN	36716.54	9700.16	26.42	4765.38	65.87	4868.91
MINNESOTA	1524.28	117.74	7.72	60.37	0.0	57.38
MISSOURI	4478.59	91.63	2.05	52.05	0.0	39.58
OHIO	26200.54	9521.98	36.34	5227.70	62.32	4231.95
WEST VIRGINIA	3.19	3.19	100.00	0.0	0.0	3.19
WISCONSIN	31751.79	5080.51	16.00	2665.67	57.89	2356.95
TOTAL	181842.69	42523.58	23.38	22286.87	397.19	19839.52

4.3. Results From Different Siting Alernatives

Since all of the calculations and displays have been computerized, it is relatively easy to test different criteria alternatives once the gridded population densities have been calculated. As was mentioned previously, tests with six different population criteria were requested by NRC. These six alternatives can be expressed in terms of radial population density limits and maximum limits for two adjacent 22-1/2° sectors. Table 7 below presents these six cases.

Table 7. Six Alternative Cases for Population Criteria.

	Maximum Population Density Threshold Levels					
	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
0-2 Miles:	250/mi^2	250/mi^2	250/mi^2	250/mi^2	250/mi^2	250/mi^2
2-30 Miles:	500/mi^2	500/mi^2	500/mi^2	750/mi^2	750/mi^2	750/mi^2
Density In 2 Adjacent Sectors:	1000/mi^2 as 1/4th Max. Radial Pop.	1500/mi^2 as 3/8th Max. Radial Pop.	2000/mi^2 as 1/2 Max. Radial Pop.	1500/mi^2 as 1/4th Max. Radial Pop.	2250/mi^2 as 3/8th Max. Radial Pop.	3000/mi^2 as 1/2 Max. Radial Pop.

Results from Case 4 have already been discussed in Sections 1 and 4.2 for all three geographic regions with the appropriate population density maps, siting maps, and unfavorable area tables. Specific results are given in this section for Cases 1, 3, and 6 for the PJM region. Because of the bulk of the information, complete maps and tables for all six cases in all three regions are in Appendix A. The following Figs. 27a-27c present the maps of unfavorable zones for Cases 1, 3, and 6 in the PJM region. These are the same red, orange, and blue zones as described previously. Table 8 contains

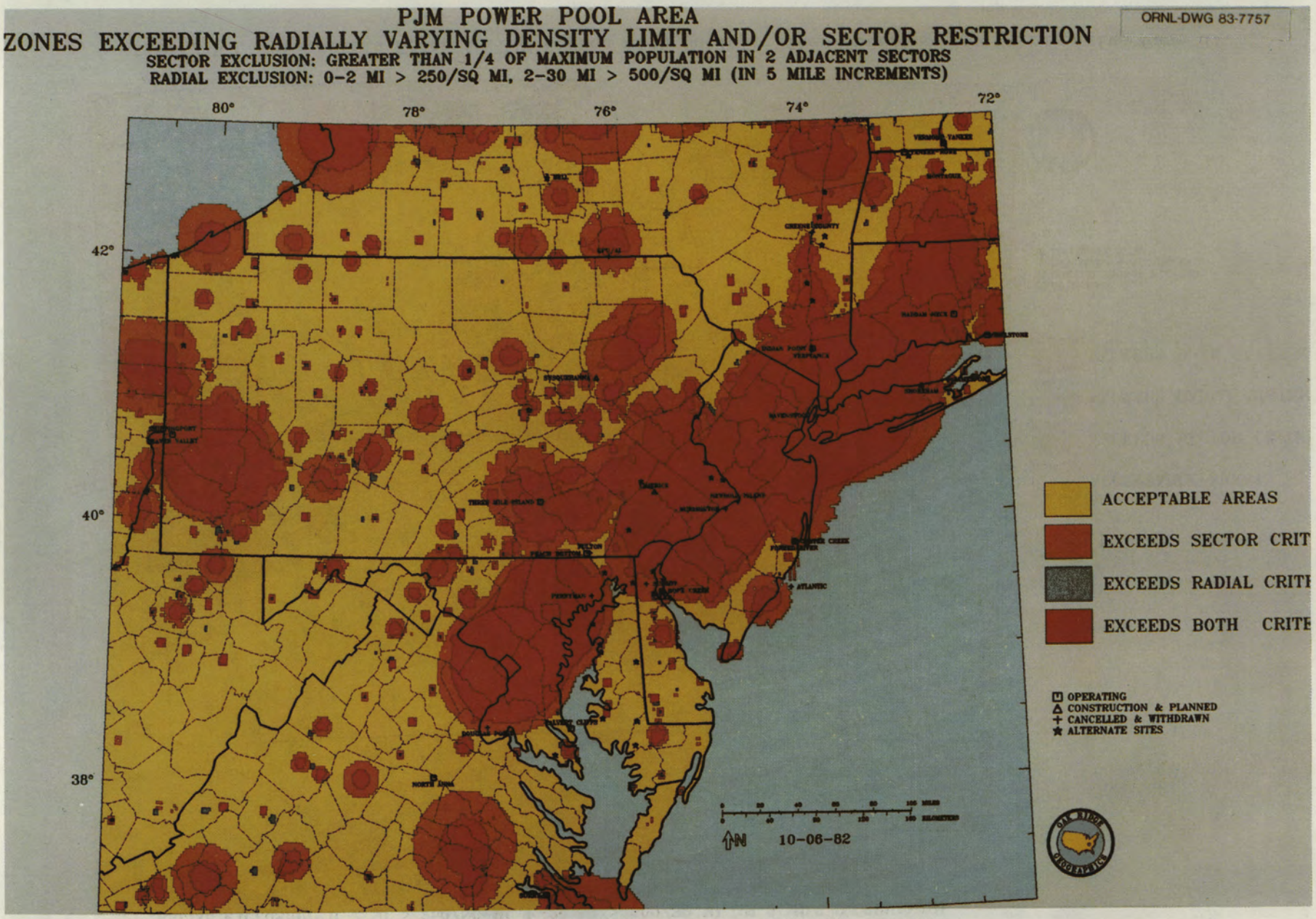

Fig. 27a. Unfavorable Zones in PJM Region with Nuclear Sites Superimposed (Alternative Case 1).

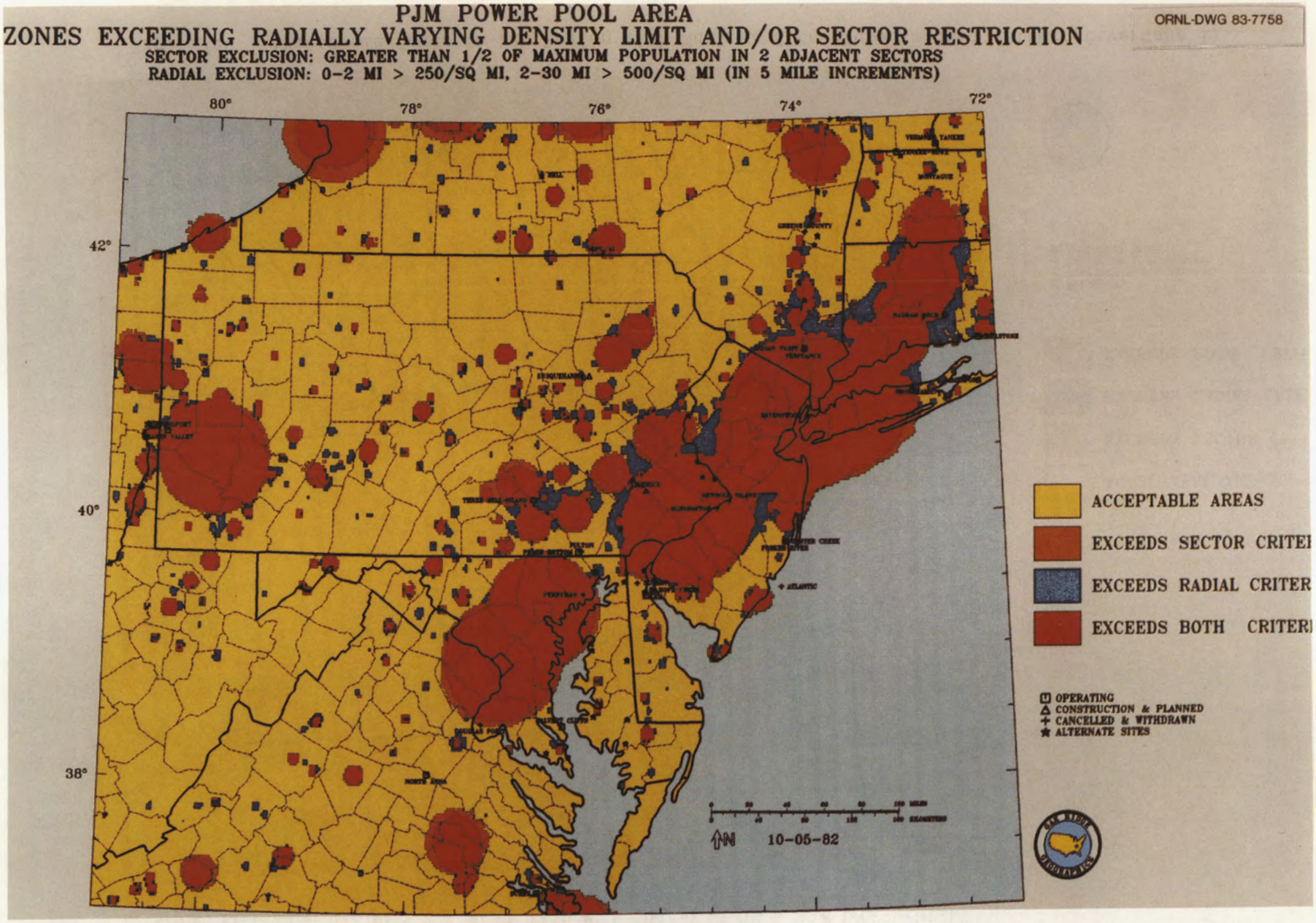

Fig. 27b. Unfavorable Zones in PJM Region with Nuclear Sites Superimposed (Alternative Case 3).

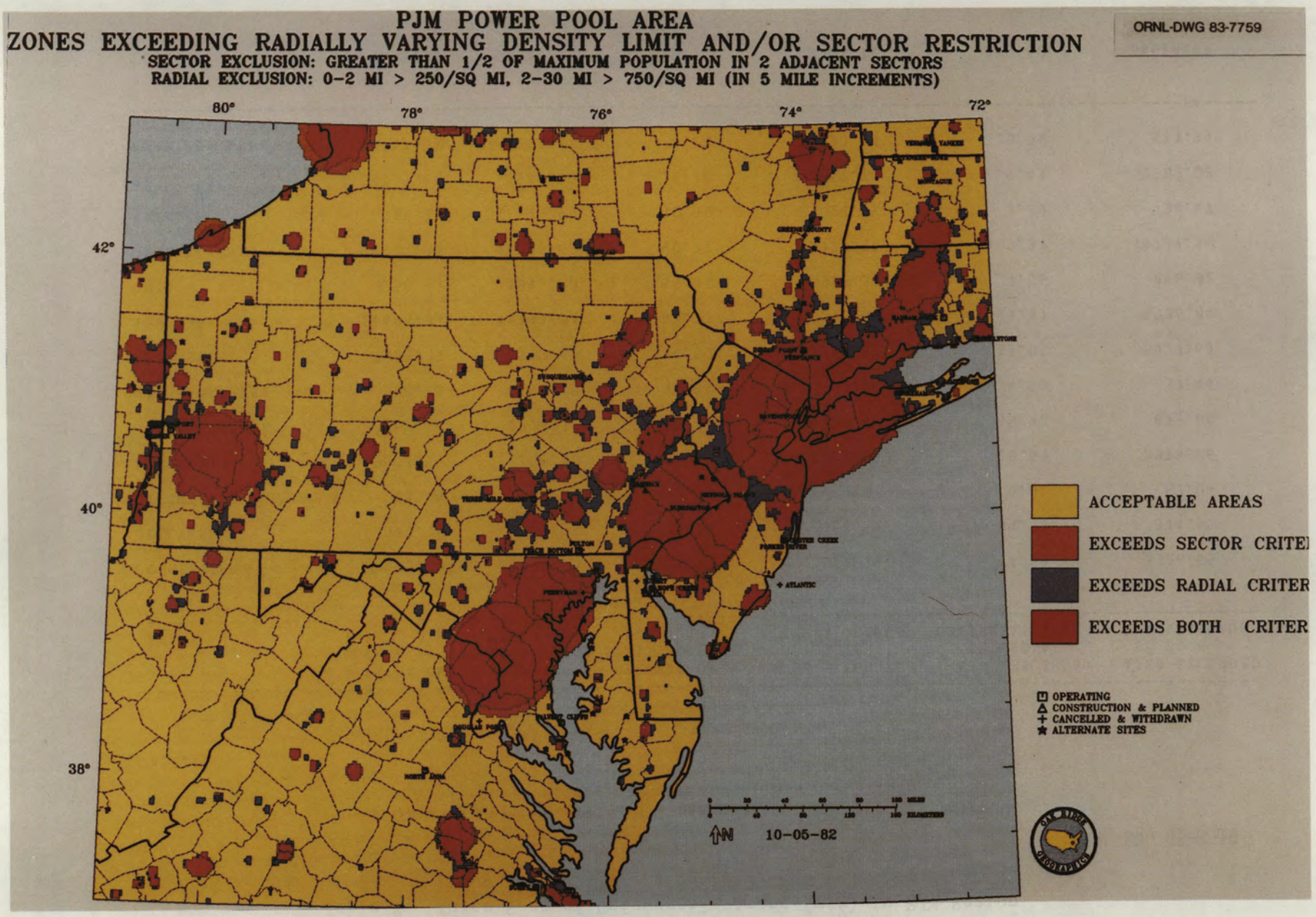

Fig. 27c. Unfavorable Zones in PJM Region with Nuclear Sites Superimposed (Alternative Case 6).

Table 8. Three Sets of Unfavorable Areas (mi^2) in PJM Region For Alternative Cases 1, 3, and 6.

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AREA (SQ MI) IN PJM REGION UNACCEPTABLE FOR NUCLEAR POWER PLANT SITES, CATEGORIZED BY STATE PORTIONS

CASE: 1

STATE	PORTION OF STATE IN PJM (SQ MI)	AREA OF STATE PORTION EXCLUDED	PERCENT OF STATE PORTION EXCLUDED	AREA EXCLUDED BY SECTOR CRITERIA (ORANGE)	AREA EXCLUDED BY RADIAL CRITERIA (BLUE)	AREA EXCLUDED BY BOTH CRITERIA (RED)
CONNECTICUT	4422.30	3885.68	87.87	557.59	1.53	3326.55
DELAWARE	2014.75	649.88	32.26	263.55	14.38	371.95
DISTRICT OF COLUMBIA	67.04	67.04	100.00	0.0	0.0	67.04
MARYLAND	9917.59	5209.70	52.53	1202.95	28.69	3978.06
MASSACHUSETTS	3361.20	2228.19	66.29	1339.49	15.10	873.60
NEW HAMPSHIRE	508.12	91.35	17.98	49.40	4.50	37.44
NEW JERSEY	7528.35	6362.65	84.52	917.97	17.05	5427.63
NEW YORK	26695.83	11141.31	41.73	5315.00	89.47	5736.84
OHIO	3256.73	1817.80	55.82	917.31	1.56	898.92
PENNSYLVANIA	44720.32	18008.62	40.27	7173.92	107.37	10727.34
VERMONT	710.36	71.99	10.13	28.53	8.99	34.47
VIRGINIA	25733.84	6510.39	25.30	3861.70	66.41	2582.28
WEST VIRGINIA	14717.08	1271.18	8.64	633.71	25.54	611.94
TOTAL	143653.38	57315.75	39.90	22261.11	380.60	34674.04

Table 8. (continued)

ORNL-DWG 83-8020

AREA (SQ MI) IN PJM REGION UNACCEPTABLE FOR NUCLEAR POWER PLANT SITES, CATEGORIZED BY STATE PORTIONS

CASE: 3

STATE	PORTION OF STATE IN PJM (SQ MI)	AREA OF STATE PORTION EXCLUDED	PERCENT OF STATE PORTION EXCLUDED	AREA EXCLUDED BY SECTOR CRITERIA (ORANGE)	AREA EXCLUDED BY RADIAL CRITERIA (BLUE)	AREA EXCLUDED BY BOTH CRITERIA (RED)
CONNECTICUT	4422.30	3344.90	75.64	16.80	699.69	2628.41
DELAWARE	2014.75	405.37	20.12	19.03	76.56	309.78
DISTRICT OF COLUMBIA	67.04	67.04	100.00	0.0	0.0	67.04
MARYLAND	9917.59	4264.93	43.00	258.17	176.70	3830.07
MASSACHUSETTS	3361.20	1055.29	31.40	166.58	139.01	749.69
NEW HAMPSHIRE	508.12	44.93	8.84	2.99	20.98	20.96
NEW JERSEY	7528.35	5525.16	73.39	80.06	548.59	4896.50
NEW YORK	26695.83	6850.09	25.66	1022.90	911.36	4915.84
OHIO	3256.73	974.40	29.92	73.91	134.64	765.85
PENNSYLVANIA	44720.32	11427.80	25.55	591.53	1787.55	9048.72
VERMONT	710.36	43.47	6.12	0.0	31.47	12.00
VIRGINIA	25733.84	3180.39	12.36	531.69	318.84	2329.86
WEST VIRGINIA	14717.08	689.69	4.69	52.20	199.58	437.91
TOTAL	143653.38	37873.45	26.36	2815.86	5044.97	30012.62

Table 8. (continued)

ORNL-DWG 83-8021

AREA (SQ MI) IN PJM REGION UNACCEPTABLE FOR NUCLEAR POWER PLANT SITES, CATEGORIZED BY STATE PORTIONS

CASE: 6

STATE	PORTION OF STATE IN PJM (SQ MI)	AREA OF STATE PORTION EXCLUDED	PERCENT OF STATE PORTION EXCLUDED	AREA EXCLUDED BY SECTOR CRITERIA (ORANGE)	AREA EXCLUDED BY RADIAL CRITERIA (BLUE)	AREA EXCLUDED BY BOTH CRITERIA (RED)
CONNECTICUT	4422.30	2537.70	57.38	24.50	628.27	1884.93
DELAWARE	2014.75	356.32	17.69	1.61	82.87	271.85
DISTRICT OF COLUMBIA	67.04	67.04	100.00	0.0	0.0	67.04
MARYLAND	9917.59	3783.58	38.15	520.07	214.80	3048.71
MASSACHUSETTS	3361.20	720.38	21.43	27.22	176.83	516.33
NEW HAMPSHIRE	508.12	44.93	8.84	2.99	20.98	20.96
NEW JERSEY	7528.35	5025.18	66.75	44.16	724.93	4256.09
NEW YORK	26695.83	5333.58	19.98	546.20	951.19	3836.19
OHIO	3256.73	712.07	21.86	41.58	164.04	506.44
PENNSYLVANIA	44720.32	9205.84	20.59	707.31	1966.68	6531.85
VERMONT	710.36	43.47	6.12	0.0	31.47	12.00
VIRGINIA	25733.84	2385.02	9.27	204.48	429.42	1751.12
WEST VIRGINIA	14717.08	613.90	4.17	31.63	237.38	344.90
TOTAL	143653.38	30829.00	21.46	2151.76	5628.84	23048.40

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the three sets of unfavorable area calculating (square miles) for these three runs (Cases 1, 3, and 6 in PJM). It is quite obvious that as the density levels are increased (less restrictive on sites), the unfavorable zones decrease in size. As the sector criteria are relaxed, the orange zones also decrease. By the time the sector limit reaches the "1/2 of maximum" point (Case 3 and 6), the restriction has changed from being a meaningful limit to one that has very little effect. Also the sector limit seems to have a higher relative impact where the urban centers are of intermediate size and density without a large urban-to-suburban sprawl. For example the extra large Washington D.C.-Baltimore area, New York City, and Pittsburgh center have smaller orange zones than do the somewhat smaller more compact cities in PJM. On a relative basis this would force sites to be located farther away from the intermediate size compact cities. In looking at the change from $750/mi^2$ to $500/mi^2$, the overall effect seems to be a fairly homogeneous expansion of exclusion zones.

For all three regions shown in Appendix A, a cell size of 1-1/4 minutes of latitude and longitude was used. Although the cells were expressed in terms of latitude/longitude, a conversion to a standard map projection was used so that actual ground distances in miles were computed and correct maps were plotted in all cases. The cells change size slightly depending on latitude, but are generally around one mile or so on a side. There were approximately 130,000 to 150,000 cells in these regions including the 30-mile buffer area around the outside. However, when individual sites were tested (as described in Section 4.4), the cell size was sometimes smaller so that results close to the sites would be slightly more accurate.

4.4. Application of Criteria to Individual Sites

In addition to applying the population criteria to large geographical regions, it is also useful to calculate the acceptability of individual sites throughout the U.S. to see generically how many exceed the threshold levels under the different alternatives. This requires looking at a 60 mile by 60 mile area for each site plus an appropriate buffer area (e.g., 10 to 15 miles more) to maintain continuity. Since many of these large search areas would overlap due to nearby sites (especially in the Northeast), the system can be set up on a geographic basis to more efficiently evaluate multiple sites that may lie within the same general area. The intent of this analysis is not to highlight specific plants as problem sites, but to provide an overview of enough sites that comparisons and trends can be seen among the six alternatives. It's also hoped that a more detailed understanding of the effect of various criteria will be gained. The results of these site evaluations are considered preliminary because the population distribution estimates are approximations, especially within a few miles of the sites, as explained previously.

A total of 248 individual sites was evaluated against all six alternative cases. These sites represented examples of active plants, as well as other types such as those under construction, planned reactors, canceled plants, and alternate sites. They were separated into a group of 91 primary sites and 157 secondary sites. Figure 28 shows the first page of the computer summary listing for the primary sites. The complete summary tables for both the primary and secondary sites are given in Appendix E. At each site the "pass-fail" status is given for all six cases. The

PASS/FAIL OF NUCLEAR SITES BASED ON SECTOR-RADIAL CRITERIA - PRIMARY SITES

'.' = PASSED BY MORE THAN 10%
'1' = PASSED, BUT WITHIN 10% OF FAIL
'*' = FAILED, BUT WITHIN 10% OF PASS
'X' = FAILED BY MORE THAN 10%

NUCLEAR SITE	LATITUDE	LONGITUDE	CASE1 SEC-RAD	CASE2 SEC-RAD	CASE3 SEC-RAD	CASE4 SEC-RAD	CASE5 SEC-RAD	CASE6 SEC-RAD
ALLENS CREEK	29.6786	96.1042	. .	. .	. .	. .	. .	. .
ARKANSAS	35.3100	93.2308	. .	. .	. .	. .	. .	. .
ARNOLD	42.1006	91.7772	X .	1 .	. .	1 .	. .	. .
BAILLY	41.6417	87.1250	X X	X X	X X	X *	X *	X *
BEAVER VALLEY	40.6219	80.4339	X X	X X	X X	X .	* .	. .
BELLEFONTE	34.7089	85.9272	. .	. .	. .	. .	. .	. .
BIG ROCK POINT	45.3592	85.1947	. .	. .	. .	. .	. .	. .
BLACK FOX	36.1169	95.5483	X .	. .	. .	. .	. .	. .
BRAIDWOOD	41.2436	88.2289	X 1	X 1	X 1	X 1	X 1	X 1
BROWNS FERRY	34.7042	87.1186	. .	. .	. .	. .	. .	. .
BRUNSWICK	33.9583	78.0105	* .	. .	. .	* .	. .	. .
BYRON	42.0750	89.2819	X .	. .	. .	. .	. .	. .
CALLAWAY	38.7611	91.7817	. .	. .	. .	. .	. .	. .
CALVERT CLIFFS	38.4347	76.4419	. .	. .	. .	. .	. .	. .
CATAWBA	35.0514	81.0694	X .	X .	. .	X .	. .	. .
CHEROKEE	35.0367	81.5119	. .	. .	. .	. .	. .	. .
CLINTON	40.1719	88.8342	. .	. .	. .	. .	. .	. .
COMANCHE PEAK	32.2978	97.7850	. .	. .	. .	. .	. .	. .
COOK	41.9761	86.5664	1 .	. .	. .	. .	. .	. .
COOPER	40.3619	95.6411	. .	. .	. .	. .	. .	. .
CRYSTAL RIVER	28.9572	82.6989	1 .	. .	. .	1 .	. .	. .
DAVIS-BESSE	41.5972	83.0864	X .	. .	. .	. .	. .	. .
DIABLO CANYON	35.2117	120.8544	. .	. .	. .	. .	. .	. .
DRESDEN	41.3897	88.2711	X .	X .	. .	X .	. .	. .
FARLEY	31.2228	85.1125	. .	. .	. .	. .	. .	. .
FERMI	41.9633	83.2586	X X	X X	X X	X 1	X 1	X 1
FITZPATRICK	43.5239	76.3983	. .	. .	. .	. .	. .	. .
FORKED RIVER	39.8100	74.2100	X X	X X	. X	X X	X X	. X
FORT CALHOUN	41.5208	96.0767	X .	X .	1 .	X .	. .	. .
FORT ST VRAIN	40.2447	104.8744	. .	. .	. .	. .	. .	. .
GINNA	43.2778	77.3089	X 1	X 1	X 1	X .	X .	* .
GRAND GULF	32.0075	91.0480	. .	. .	. .	. .	. .	. .
HALLAM NECK	41.4819	72.4992	X X	X X	* X	X .	1 .	. .
HARRIS	35.6333	78.9561	. .	. .	. .	. .	. .	. .
HARTSVILLE	36.3542	86.0861	. .	. .	. .	. .	. .	. .
HATCH	31.9342	82.3444	. .	. .	. .	. .	. .	. .
HOPE CREEK	39.4678	75.5381	X .	* .	. .	* .	. .	. .
INDIAN POINT	41.2714	73.9525	X X	X X	X X	X X	X X	X X
KEWAUNEE	44.3430	87.5361	. .	. .	. .	. .	. .	. .
LA CROSSE	43.5583	91.2305	. .	. .	. .	. .	. .	. .
LA SALLE	41.2439	88.6708	. .	. .	. .	. .	. .	. .
LIMERICK	40.2200	75.5900	X X	X X	X X	X X	X X	X X
MAINE YANKEE	43.9505	69.6961	. .	. .	. .	. .	. .	. .
MARBLE HILL	38.6000	85.4480	* .	. .	. .	. .	. .	. .
MCGUIRE	35.4322	80.9483	X 1	X 1	. 1	X .	. .	. .
MIDLAND	43.5861	84.2231	X X	X X	X X	X X	X X	X X
MILLSTONE	41.3086	72.1680	X X	X X	X X	X X	X X	X X
MONTICELLO	45.3333	93.8483	. .	. .	. .	. .	. .	. .
NINE MILE POINT	43.5222	76.4100	. .	. .	. .	. .	. .	. .
NORTH ANNA	38.0608	77.7905	. .	. .	. .	. .	. .	. .
OCONEE	34.7917	82.8986	. .	. .	. .	. .	. .	. .
OYSTER CREEK	39.8142	74.2064	X X	X X	. X	X X	X X	. X
PALISADES	42.3222	86.3153	. .	. .	. .	. .	. .	. .

Fig. 28. First Page of Summary Table Showing Pass or Fail Status For Nuclear Sites (Six Population Alternatives Used).

"pass-fail" status is actually shown separately for the sector and radial criteria. Four possible status symbols are used:

(1) . Meaning the site passed by more than 10% of the threshold level, even for the worst radius (or adjacent sectors).

(2) 1 Meaning the site passed, but the worst radius (or adjacent sectors) was within 10% of exceeding the threshold level.

(3) * Meaning the site failed (exceeded the threshold), but the worst radius (or adjacent sectors) only failed by 10% or less.

(4) x Meaning the site failed (exceeded the threshold) and the worst radius (or adjacent sectors) failed by more than 10% of the threshold level.

These symbols are listed in a somewhat descending order with respect to site failure. The reason for having four breakdowns was to indicate which sites exceeded the criteria by such a large margin that there was no question about their evaluation under that alternative, whereas other sites that were within 10% of the criteria limits might deserve more detailed analysis. Of course, if either the radial or sector limit was exceeded, then the site itself exceeded that respective alternative. It should be noted that when actually evaluating a proposed site, actual population information is necessary, especially within five miles. The coarse nature of the census data in rural areas makes the prediction of pass/fail given here sufficient for general trend comparisons but inapplicable for individual site analyses.

One aid to a more detailed analysis of individual sites is the graphic presentation shown in Fig. 29 for the Midland site in Michigan. The density contours are shown on the right and population counts on the left with

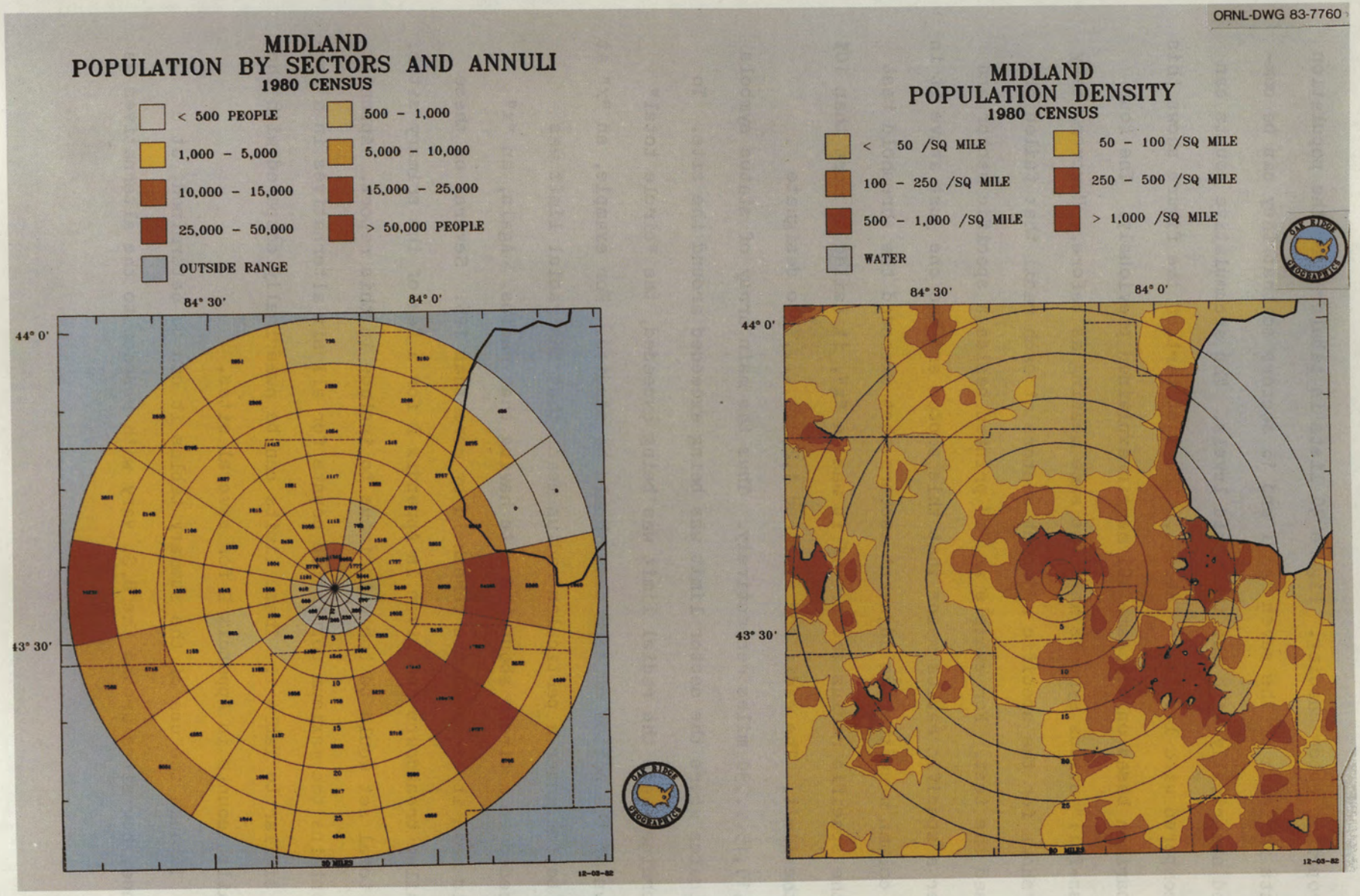

Fig. 29. Population Density Contours (Right) and Radial-Sector Population Map (Left) for Midland Site.

appropriate color shading. Figure 30 lists in tabular form the population counts for each of the seven radii and 16 sectors so that they can be compared numerically with the threshold levels. The accumulative counts can be compared with levels in Table 1. The last part of the figure shows this comparison based on the same 10% margin explained previously. The four "pass-fail" status symbols have the same meaning as before. However, they are shown for the specific adjacent sectors at each radii that failed or passed the test. For example an "x" printed beside a specific sector and under a specific radius means that this sector and the one just above it in the column were the two adjacent sectors that exceeded the threshold test at the specific radius shown. If it was an "x", it failed by more than 10% of the limit. The radii are numbered 1,2,3,4,...,7 to designate 2,5,10,15...,30 miles respectively. Thus the main array of status symbols indicates where the sector limit was being exceeded around the site. To determine where the radial limit was being exceeded, the "circle total" shown at the bottom of each case should be studied. For example, an "x" at the bottom under a particular radius means that the radial limit was exceeded in a circle about the site having that radius. Again, an "x" would mean it exceeded the threshold by more than 10%. Several of these detailed breakdowns are given in Appendix D for a few of the primary sites. The total set would be too voluminous to include in this report. Appendix C contains the maximum population counts for all six alternatives in a format similar to Table 1. These limits can be numerically compared with the detailed counts in Appendix D for several sites.

Through the use of the summary tables it can be determined, at a glance, how sites around the U.S. vary with respect to the alternatives as

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MIDLAND 1980 RUN DATE: 01-04-83
LATITUDE= 43 DEG,35 MIN, 10 SEC LONGITUDE= 84 DEG,13 MIN, 23 SEC

INCREMENTAL POPULATION DATA

DISTANCE,MILES	0- 2	2- 5	5- 10	10- 15	15- 20	20- 25	25- 30
N	1282	11303	1113	1117	1054	1289	735
NNE	905	9963	793	1383	1318	2266	3180
NE	627	1777	1518	2757	3757	2275	435
ENE	422	3444	1737	2853	9818	0	0
E	155	949	2469	8939	64365	5368	1640
ESE	30	270	1602	2436	17823	3522	4599
SE	25	280	2353	17443	109478	19727	8705
SSE	61	230	1934	5272	3716	3590	4859
S	88	265	1849	1758	2202	2917	4348
SSW	129	365	1180	1656	1137	1096	1644
SW	141	486	969	1183	2648	4283	8031
WSW	159	669	1039	925	1153	5718	7588
W	174	918	1558	1543	1333	4490	30232
WNW	199	1191	1604	1533	1106	2148	3821
NW	238	2779	2433	1815	1837	2795	2808
NNW	1118	6157	2088	1281	1413	2305	2951
TOTAL	5753	41046	26239	53894	224158	63789	85576

CUMULATIVE POPULATION DATA

DISTANCE,MILES	0- 2	0- 5	0- 10	0- 15	0- 20	0- 25	0- 30
N	1282	12585	13698	14815	15869	17158	17893
NNE	905	10868	11661	13044	14362	16628	19808
NE	627	2404	3922	6679	10436	12711	13146
ENE	422	3866	5603	8456	18274	18274	18274
E	155	1104	3573	12512	76877	82245	83885
ESE	30	300	1902	4338	22161	25683	30282
SE	25	305	2658	20101	129579	149306	158011
SSE	61	291	2225	7497	11213	14803	19662
S	88	353	2202	3960	6162	9079	13427
SSW	129	494	1674	3330	4467	5563	7207
SW	141	627	1596	2779	5427	9710	17741
WSW	159	828	1867	2792	3945	9663	17251
W	174	1092	2650	4193	5526	10016	40248
WNW	199	1390	2994	4527	5633	7781	11602
NW	238	3017	5450	7265	9102	11897	14705
NNW	1118	7275	9363	10644	12057	14362	17313
TOTAL	5753	46799	73038	126932	351090	414879	500455

IHC002I STOP 0

Fig. 30. Detailed Population Counts and Pass-Fail Status By Sector and Radius for Midland Site.

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FAIL OR NEAR-FAIL AT LEAST ONE TEST -- '1' = PASSED, BUT WITHIN 10% OF FAIL
'*' = FAILED, BUT WITHIN 10% OF PASS
'X' = FAILED BY MORE THAN 10%

	CASE1							CASE2							CASE3							CASE4							CASE5							CASE6						
SEC/RAD	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7
N	X	X	.	.	.	.	.	X	X	.	.	.	.	.	X	*	.	.	.	.	.	X	X	.	.	.	.	.	X	1	.	.	.	.	.	X	.	.	.	.	.	.
NNE	X	X	.	.	.	.	.	X	X	.	.	.	.	.	X	X	.	.	.	.	.	X	X	.	.	.	.	.	X	X	.	.	.	.	.	X	.	.	.	.	.	.
NE	X	X	.	.	.	.	.	X	1	.	.	.	.	.	1	.	.	.	.	.	.	X	*	.	.	.	.	.	X	.	.	.	.	.	.	1	.	.	.	.	.	.
ENE	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
E	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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SSW	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SW	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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WNW	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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NNW	X	X	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.
CIRCLE	X	X	.	.	.	.	.	X	X	.	.	.	.	.	X	X	.	.	.	.	.	X	.	.	.	.	.	.	X	.	.	.	.	.	.	X	.	.	.	.	.	.

Fig. 30. (continued)

far as population characteristics are concerned. The summary also gives a relative idea of how restrictive each of the six alternatives are. The detailed breakdown allows the determination of what part of an area around a site is causing a problem and how significant the problem is. If the only restrictions are in the 0-2 mile zone, further site study may be needed on a detailed basis (e.g., field visits, aerial photography, base maps, etc.) to verify or improve the resolution of the population data. In some cases specific sites failed only a few of the sector criteria within 0-2 miles for particular alternatives. In this case the margin of error may be such that the "pass-fail" status of such sites may be on the borderline or may be incorrect. For this reason the results are considered preliminary.

5. RELATED POPULATION DISTRIBUTION WORK

5.1. Future Improvements to Population Distribution and Analysis

Several other computer development activities have been under way that involve population distribution calculations over geographical areas. This section discusses some of these activities and indicates areas where future work may be done. Some of these projects are not necessarily involved with nuclear power plant siting but the results would be directly applicable. The improvements discussed in this section involve the use of new geographic data bases to refine the spatial distribution of people, especially in urban and coastal areas. Section 5.2 will discuss the use of remotely sensed data (e.g., LANDSAT imagery, aerial photography, etc.) for improving population distributions. The last section, 5.3, will present some preliminary results of combining population data in the vicinity of a nuclear site with other geographic characteristics of the site. The intent is to briefly demonstrate how such integration used in conjunction with geographic analysis systems can aid not only in assessing nuclear sites but also in emergency planning and management and in risk assessment. As these different improvements are implemented, some of the siting criteria alternatives can be reevaluated. This would be especially beneficial along coastlines of the Northeast and the Southwest. Many of the graphics capabilities and spatial analysis tools used to carry out these population-related tasks have been developed over several years as part of the general geographic information systems work. Additional development has gone into modifying or adding to these routines to make them directly applicable to the population work described here.

The best way to improve the spatial distribution of census data would be through the use of subcounty geographical information. As mentioned previously, the 1970 census units (such as enumeration districts) changed for 1980 so that there was no subcounty locational information readily available in digital form when the siting calculations were done. One data base that has been digitized since then consists of the boundaries of census tracts (one level above enumeration districts). With these boundaries accurate areas can be calculated at the census track level to refine the population density values (currently the enumeration district areas are approximated from the Thiessen polygons). The census tract densities or counts can then be prorated down to the 1970 enumeration districts within them and population counts can also be normalized at the tract level. This will improve the enumeration district estimates significantly, thereby refining the interpolation to grid cell densities. The current district values are estimated from county-level data as described earlier. Although the census tract data will provide for better control at a subcounty level, the tracts are only defined for urban areas. Thus, rural calculations would only be improved in the aggregate sense where the total rural population in a county was corrected. The 1980 census tract data and civil division information are currently used for improving site population estimates using a combination of manual and semi-automated techniques.

A second improvement may be made along the U.S. coastlines using more accurate latitude-longitude coordinates for the border. Detailed study of the current population densities in urban areas along the coastline revealed that density levels were sometimes too high. The problem was caused by inaccurate coastline definitions which were sometimes one or two

miles inland from where they should be. In addition, various islands or peninsulas were not even contained in the cartographic data base. This was because the standard "county and coastline data base" (used by geographic groups around the country) had originally been digitized a number of years ago from a U.S. map without the high resolution needed for these types of studies. The original digitization was intended for use and mapping at the national level. Since any area outside the U.S. border (e.g., oceans) are excluded from the calculations using Thiessen polygons (representing enumeration districts), the calculated district areas (square miles) were too small when the coastline was too far inland. Thus, dividing the district population by too small an area resulted in densities that were too high. In marginal situations this might have caused some coastal sites to fail the siting criteria when they should pass. The problem will be corrected when more accurate coastlines are incorporated. This has been done on a test basis out to 50 miles from a few coastal sites using cartographic data digitized by the U.S. Geological Survey from the 1:2,000,000 National Atlas maps. Editing of the coastline data base is being finished to correct some problem spots and join outlines at map sheet borders.

Another anomaly occurred when detailed studies were made of certain reactor areas around the U.S. The anomaly was caused by specific land areas that were restricted from residential population. For example, the Hanford reservation in Washington state is owned by the Federal government and no permanent residents normally live on the reservation. However, the interpolation procedure spreads a few people onto the reservation from the residential areas immediately adjacent to it. The same is true for the large DOE reservation in Oak Ridge, Tennessee, and for other types of

government reservations that are located next to urban areas (e.g., national parks, state forests, etc.). The problem is usually not very severe because the interpolation technique is "local" in nature and few people are erroneously located on the reservation. Also, the reactors themselves are not located near the boundary, but are usually within the interior of the area. The mechanism now being implemented for handling this problem is to digitize the boundary of the reservation and use it as an exclusion area so that no people are assigned within the boundary. This is very similar to the "water body" problem of not locating people off the coastline. Figure 31 presents some initial results from another project for the DOE reservation and surrounding area in Oak Ridge, Tennessee. Notice the exclusion area corresponding to the reservation in the center of the map. The plot is centered on the Oak Ridge National Laboratory.

In order to obtain more spatial resolution than is available from the previously discussed techniques, some information would need to be digitized for the enumeration districts. At a minimum, the centroids would be needed for the 1980 census just as they were digitized for the 1970 census. As mentioned previously, the Census Bureau may only be able to do this as a low priority project because of budget problems. It might be possible to digitize these 1980 centroids for the immediate area around the nuclear plants (e.g., out to 5 to 10 miles), but still represents a large effort if done for all sites in the U. S. Even then, the results could still be inaccurate for rural areas where enumeration districts are very large and the people are clustered in small towns. Since many nuclear plants are located in less populated areas, further refinements are being investigated. One method utilizing 7-1/2' quadrangle maps is presented in the

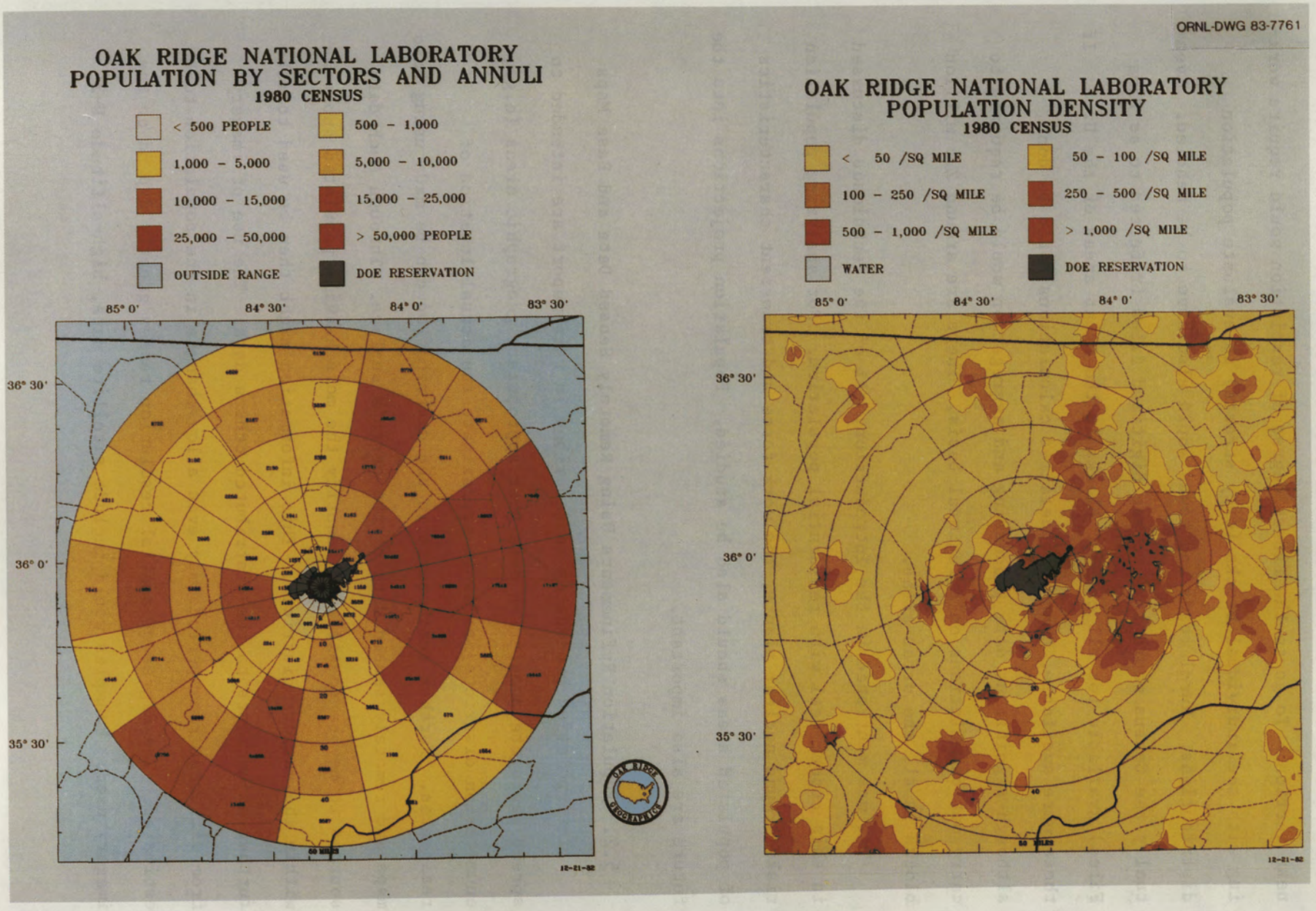

Fig. 31. Population Density Contours and Radial-Sector Map with DOE Reservation Excluded for Oak Ridge National Lab.

next section. To go to the finest degree of resolution would require working with the individual blocks (city streets) to evaluate population distributions. Rural roads and towns would also have to be handled. Eventually the Census would like to see digitized files (referred to as Dime Files) available for all current blocks in the urban areas of the U. S. If these were available, then very detailed calculations could be done, although significant data processing and aggregation would be required to carry out calculations on a regional basis. There are around 2.5 million blocks in all the urban areas.

As was mentioned in the Introduction, all of the techniques discussed in this report deal with residential population. For analyzing population risks around nuclear plants, the work force and transient characteristics of populated areas should also be studied. Population projections into the future are also important.

5.2. Population Refinements Using Remotely Sensed Data and Base Maps

Interpolation procedures as described in this report are intended to spread aggregate population data over appropriate geographic areas (e.g., enumeration districts) so as to approximate the actual location of residences. Further refinements in the distribution can be made using base maps and remotely sensed data of the earth's surface. Through such data sources it may be possible to identify the more heavily populated subareas within the various districts. This information might then be used to make further adjustments to the distributed census data. The use of imagery from different time periods may even allow changes in the population to be estimated. The degree of spatial resolution ranges greatly depend on the imagery used. Examples would include satellite data, high-altitude U-2

photography, and low-altitude aerial photography. Another important factor is the availability or transformation of data into computer form, especially for regional studies over large areas. Manual techniques may be prohibitive in this case. Base maps also provide accurate spatial reference and certain landcover features that can aid in adjusting distributions and combining different data sources. Imagery in its original form is geometrically distorted, and base maps are used to correct the image data before combination with census data in a latitude-longitude form.

Improvements are being made to the current distribution techniques to accept low-population zones digitized as polygonal boundaries within 10 miles of a site. Examples of such zones would be swamps, forested areas with no roads, government-owned land with no residential population, water bodies, very rural barren or agricultural land, etc. Detailed hydrology, islands, and coastlines are also computerized. These zones and boundaries are currently digitized from 7-1/2′ quadrangle maps with aerial photography used to enhance the delineation based on more recent overflights if available. The computer algorithms then exclude any distribution to these zones. A typical example is shown in Fig. 32 for a 10-mile radius around the Millstone, Connecticut, site. The plot on the left half shows the distribution without using any new digitized data, while the right half shows significant improvements utilizing accurate hydrology and the digitized zones. The next level of improvement would be to digitize high-population urban zones and perhaps medium-level zones (or use the remainder as medium zones) so that a spatial weighting function could be computed and used to influence the distributions of the people. This would be similar to using landcover/landuse for improvements as discussed in the following

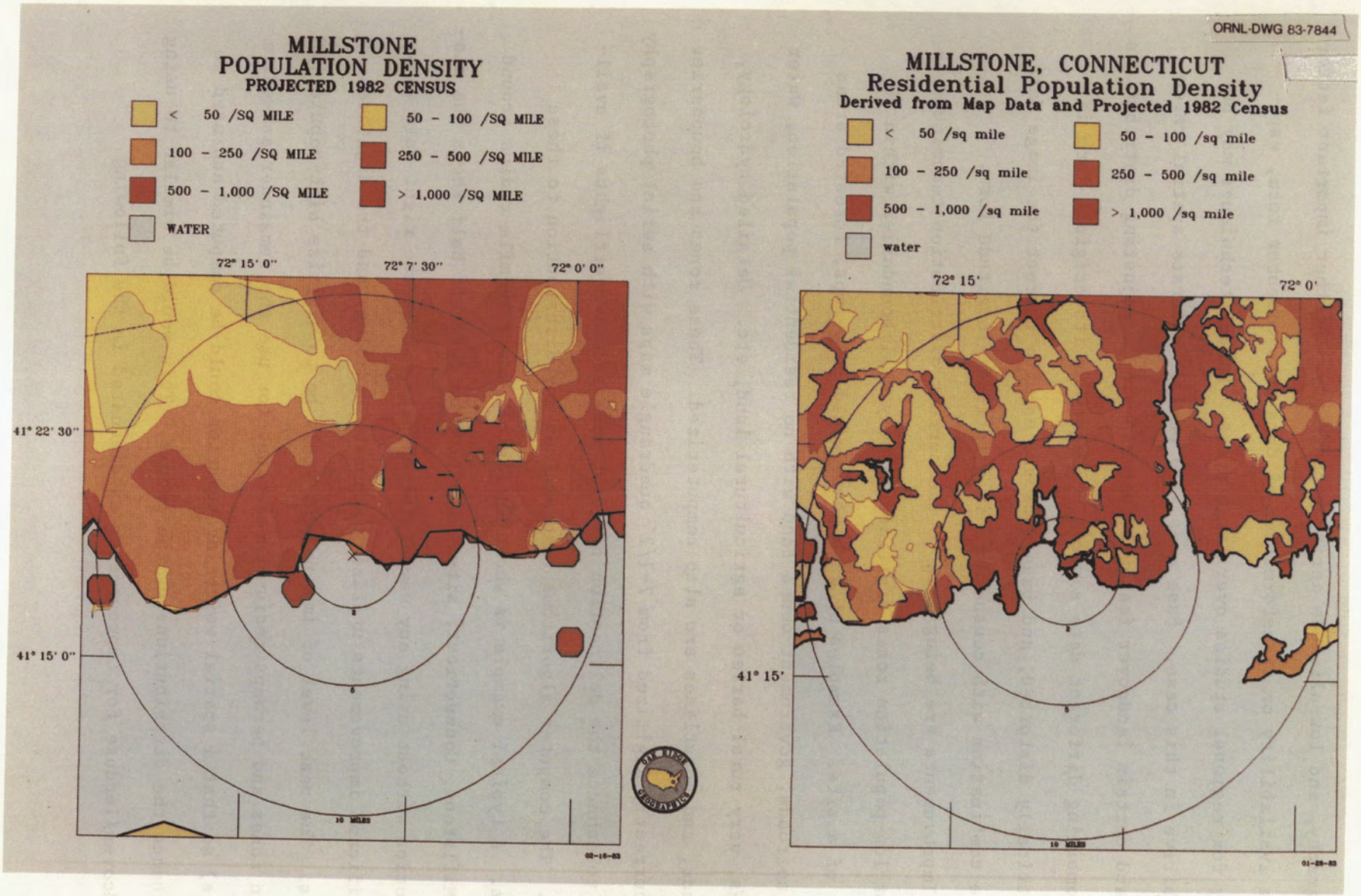

Fig. 32. Population Density Contours for 10-Mile Millstone, Connecticut, Site with and without Digitized Data Enhancement.

paragraphs. For areas such as the rural Midwest where people are clustered in towns, a technique of digitizing the urban boundaries is being implemented. The distribution is then carried out in the urban and rural areas separately with the results merged before presenting them to the user. Exclusion zones are still used in distributions.

These types of techniques would be most beneficial in refining the population and siting evaluations near nuclear sites (e.g., 0-5 miles). Even having exact 1980 enumeration district boundaries and counts without further digitized data would probably not be sufficient for nuclear sites in rural areas where the districts are large and populations clustered. Population results from an area around the Sequoyah nuclear plant were presented in earlier sections. Further demonstration work from this area is presented here to give a brief idea of how remote sensing data might aid in population refinements. Figure 33 represents the raw LANDSAT satellite data around the Sequoyah site. The plant site is located in the center of the image as a bright area on the shores of the Chickamauga reservoir. The dam is located in the lower left corner. Most of the nearby residents live southwest of the plant with Chattanooga located south of the dam. The population contours can be superimposed on this imagery after rectification to aid in evaluating the distribution. One obvious enhancement would be to remove the people spread into water bodies and redistribute them correctly on the land area. Figure 34 exemplifies the first step of removing people from the water, although the redistribution has not yet been done. The highways, roads, railroads, and 7-1/2 minute map borders have also been superimposed on the LANDSAT imagery to aid in identifying where population centers might be located. A further enhancement would be to classify the

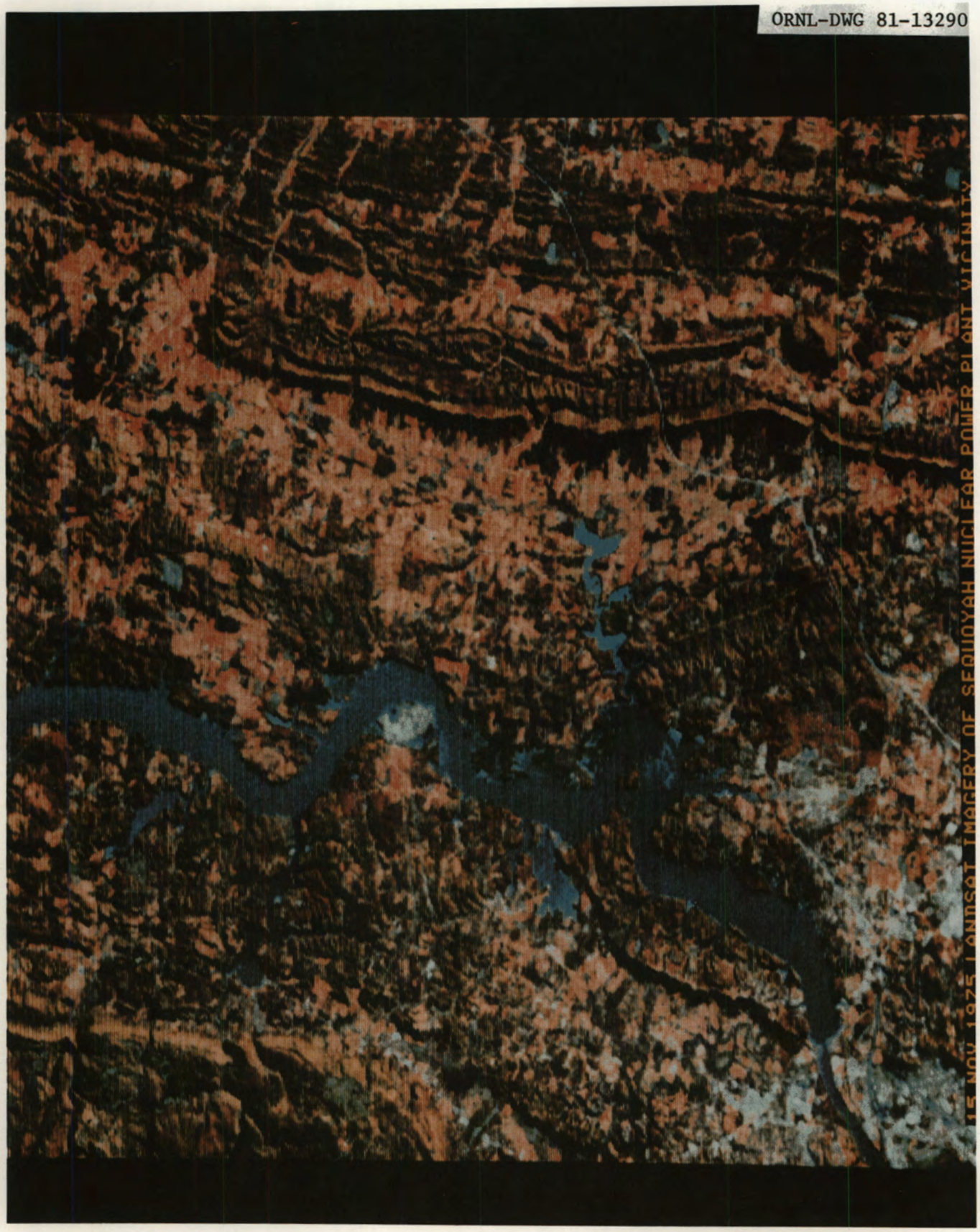

Fig. 33. Computerized LANDSAT Display for Sequoyah Nuclear Plant Vicinity.

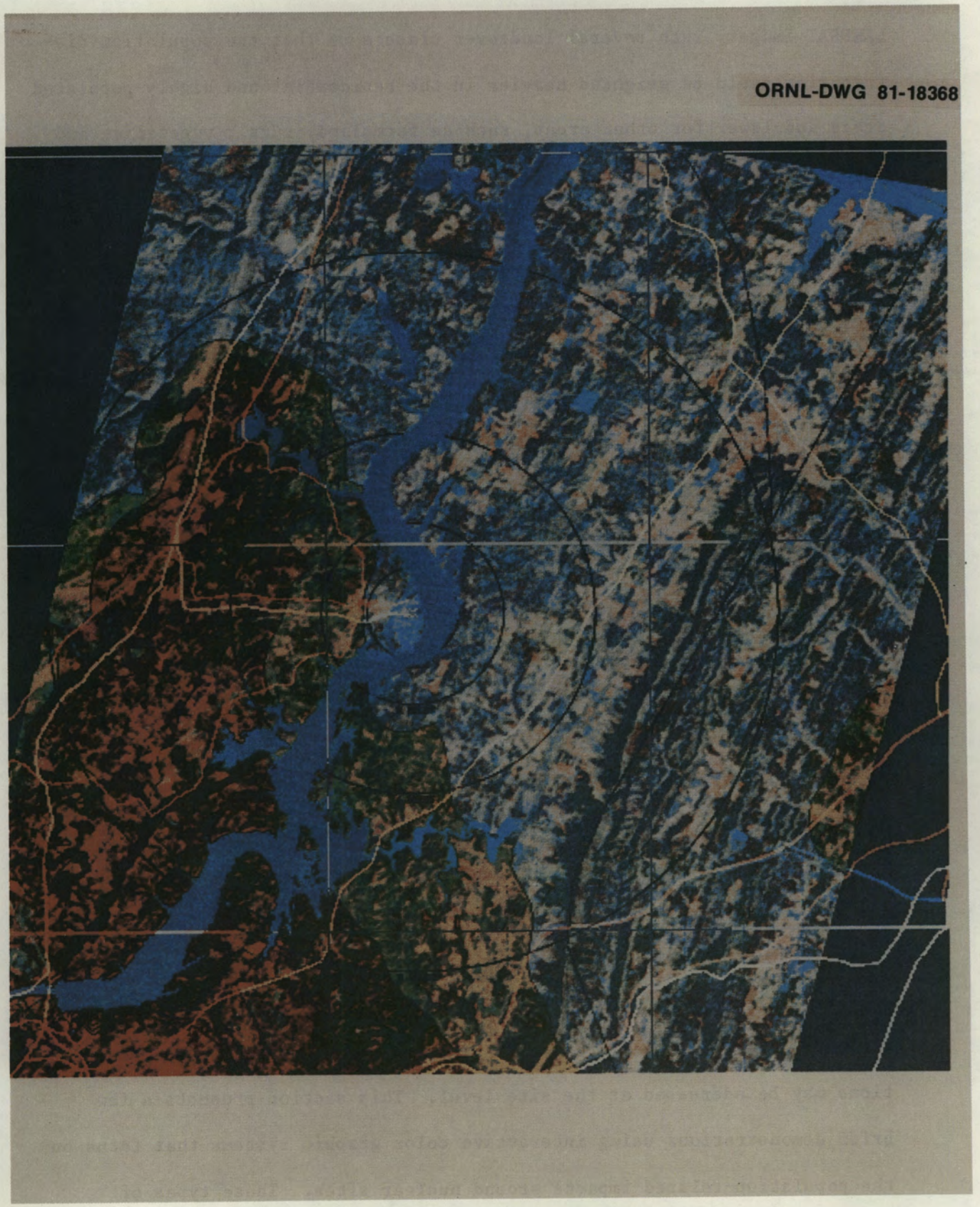

Fig. 34. Computerized Display of Population Contours Superimposed with LANDSAT Data and Highways and Railroads for Sequoyah Plant Vicinity.

LANDSAT imagery into several landcover classes so that the population distribution could be weighted heavier in the residential and highly populated areas and lower for other areas, such as farm land, rural, vegetative and forest land, etc. Special features, such as airports and golf courses, could even be incorporated. LANDSAT data is not of sufficient resolution for detailed delineations, thus aerial photography would be more advantageous. U-2 aerial photography shown in Fig. 35 can be video digitized or scanned so that similiar types of calculations might be done at a higher resolution in the immediate area around the plant. The Sequoyah site is the very bright area in the center of the image. Again, this data would have to be geometrically rectified before performing any analyses.

5.3. Integration of Population Data with Nuclear Site Characteristics

As computer systems have been developed to analyze population data in conjunction with nuclear power plant siting, an obvious extension involves the consideration of other geographic characteristics of nuclear sites. Examples might include terrain, landcover, highways, surface water, wind rose, seismicity, etc. The integration of these types of data using computer graphic systems allows for a variety of nuclear site assessments. On a regional basis, combining population restrictions with other exclusion zones (such as areas with insufficient cooling water, unacceptable seismic risks, restricted wilderness areas, etc.) allows the analyst to determine whether the remaining acceptable areas are sufficient to meet future needs for nuclear sites in different regions of the U.S. Other integration questions may be addressed at the site level. This section presents a few brief demonstrations using interactive color graphic systems that focus on the population-related impacts around nuclear sites. These types of

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Fig. 35. U-2 Aerial Photography for Sequoyah Nuclear Plant Vicinity (Original imagery courtesty of TVA, Chattanooga).

dynamic capabilities may be useful in assessing risks and aiding decision makers in emergency planning and management. The reason for presenting results in graphic form, is to greatly enhance the analysis and interpretation of spatial relationships among different variables and criteria. For example, the assessment of different sector criteria on a regional basis would have been very difficult without computer maps. A variety of map presentations have been used in this report including polygonal boundary maps, shaded contour maps, centroid point maps, 3-D perspective displays, shaded grid cell maps, county maps, etc. However, the real usefulness of the systems is in performing the myriad of spatial calculations repeatedly for different data bases and parameters.

The Sequoyah nuclear plant has again been used as a demonstration site. The terrain of the area is shown in Fig. 36 with two spikes in the center of the scene representing the two cooling towers. Various types of problems could occur that would effect the surrounding population. For example, if a contaminant were released to the atmosphere and blown over urban areas, the decision maker would like to use whatever tools could aid him in determining the number of people affected. In Fig. 37, a display of the radial-sector population data is shown superimposed on the LANDSAT imagery in the vicinity of the Sequoyah site. This image is presented on a color CRT with a user-controlled cursor on the screen so that he can trace out possible paths that a contaminant might be transported over. In demonstration mode the computer can display the incremental and cumulative population affected, as shown at the bottom of the display. If evacuation procedures were being evaluated, the highways and roads could also be incorporated (previously shown in Fig. 34) along with transportation

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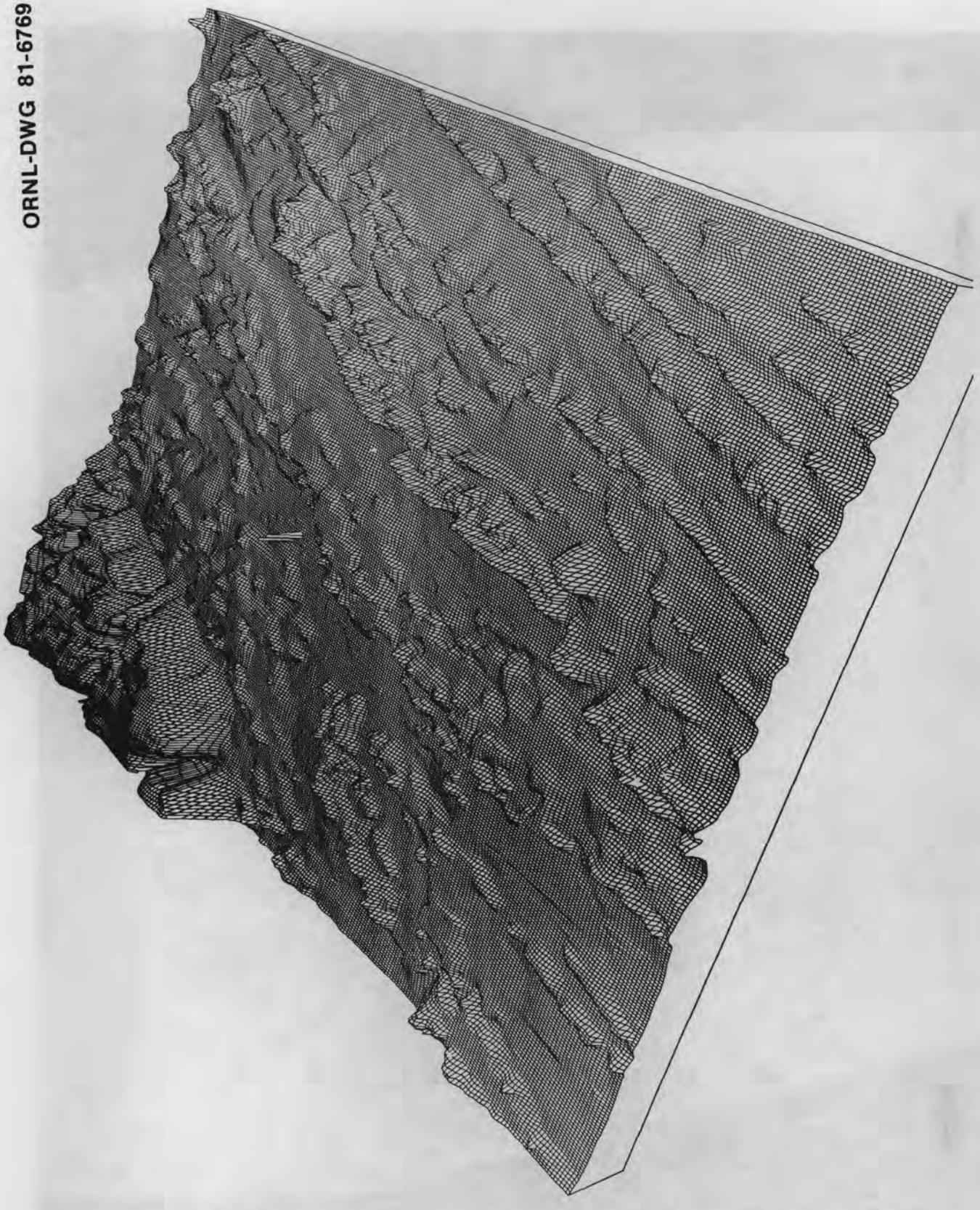

Fig. 36. 3-D Perspective Display of Terrain Around Sequoyah Nuclear Site. Two Spikes in Center Represent Cooling Towers (Vertical axis is exaggerated).

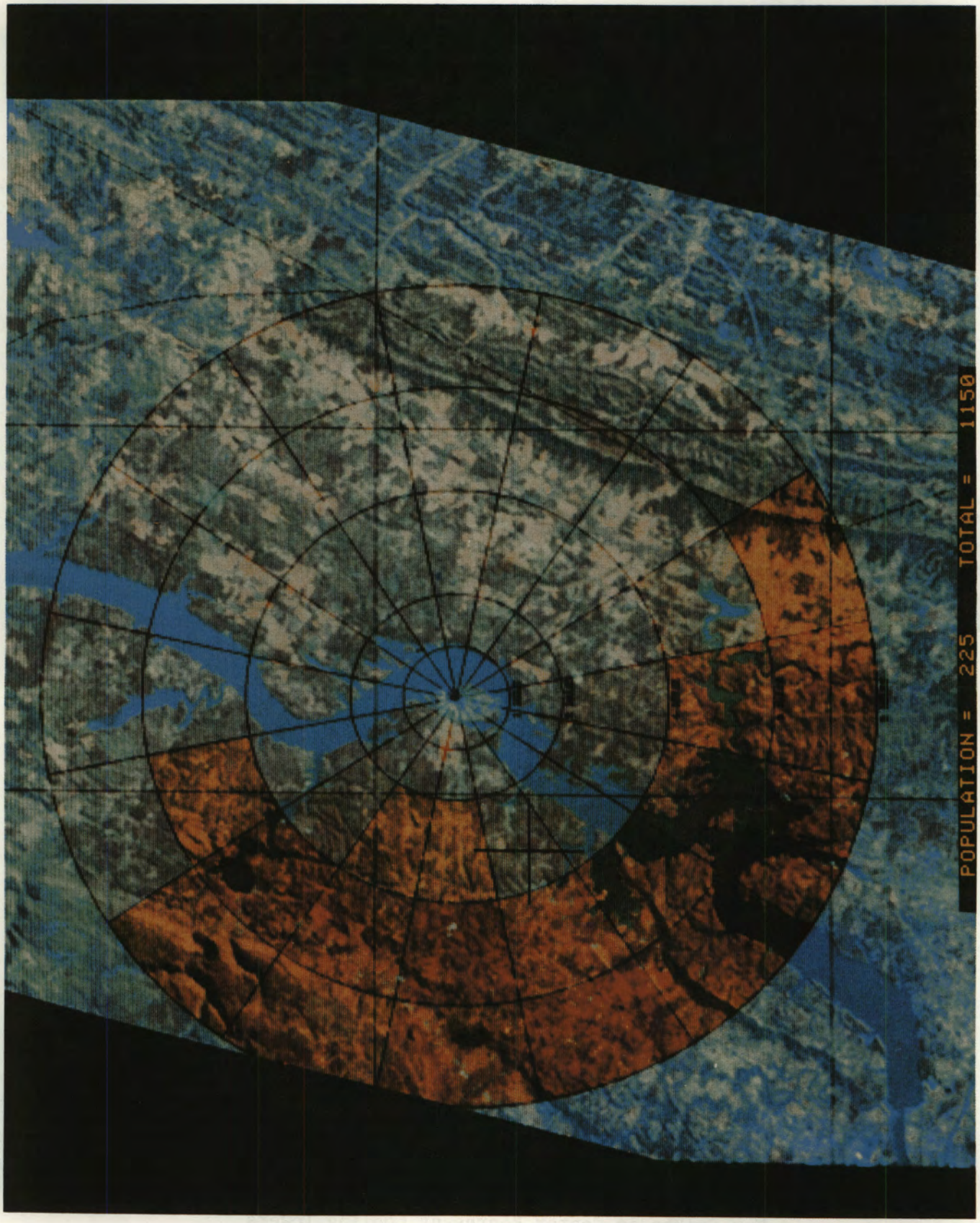

Fig. 37. LANDSAT Data Superimposed with Radial-Sector Population Data Around Sequoyah Nuclear Plant.

models. By incorporating air transport models, wind rose patterns (Fig. 38), topography (Fig. 39), monitoring station data, contour mapping, etc., the decision maker can be aided in determining effected populations and planning or evaluating emergency measures. Contaminant spills into the water system that might affect populated areas downstream is another type of problem requiring spatial analyses.

This report has focused on the methodology and results of evaluating population criteria for siting nuclear power plants. However, the techniques and data bases are applicable to a wide range of spatial problems dealing with the analysis of functions distributed over a geographical surface. Other components of the geographic systems are useful in additional siting questions (such as the calculation and display of water flow to determine areas that would have sufficient cooling water for power plants). By integrating these types of geographic techniques, data bases, and computer systems, decision makers are aided in carrying out the detailed analysis and planning functions required to make rational and consistent decisions.

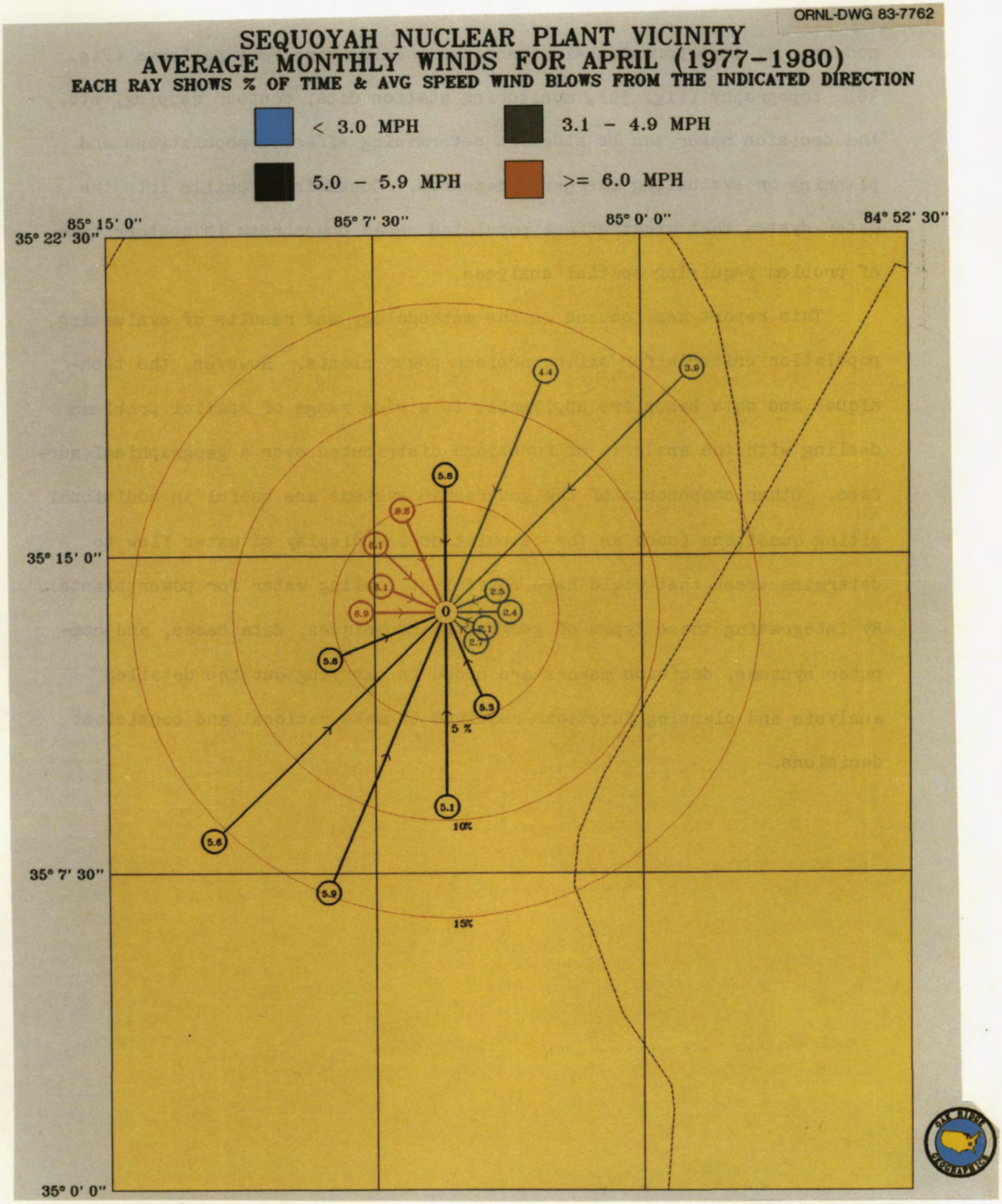

Fig. 38. Wind Rose Display for Sequoyah Nuclear Plant Showing Direction, Speed, and Percent Time.

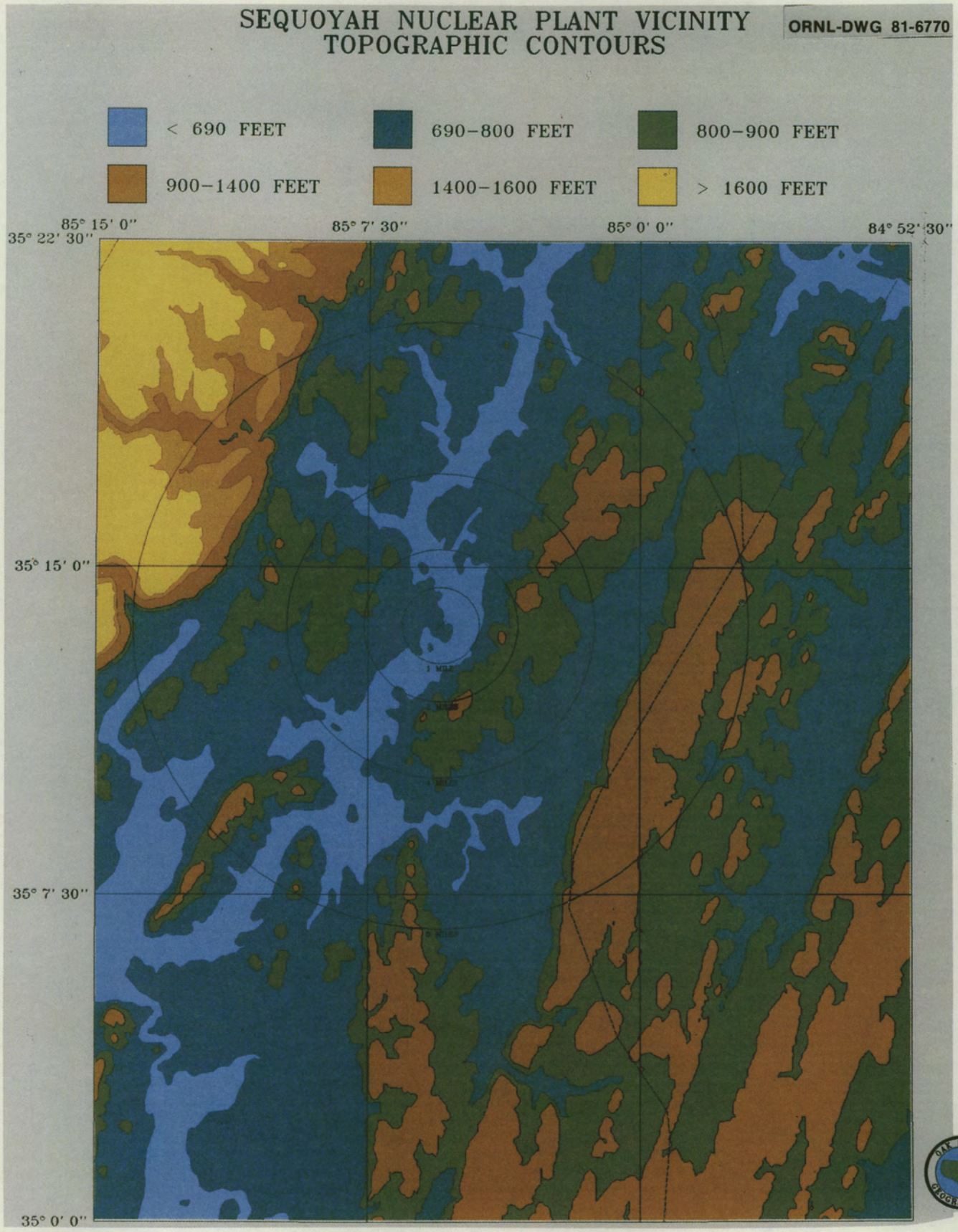

Fig. 39. Topographic Contours Depicting Terrain for Sequoyah Nuclear Plant Vicinity.

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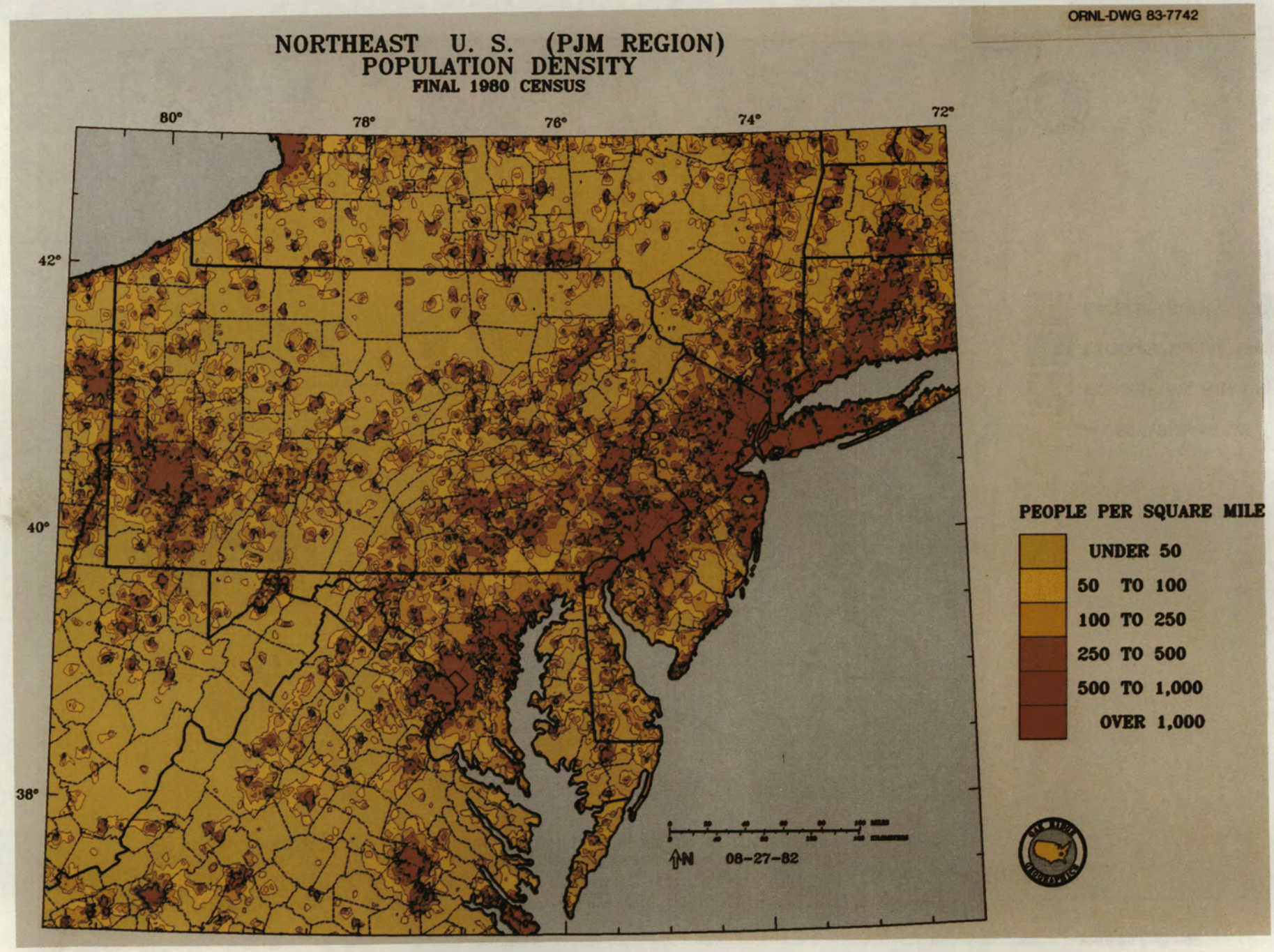
APPENDIX A

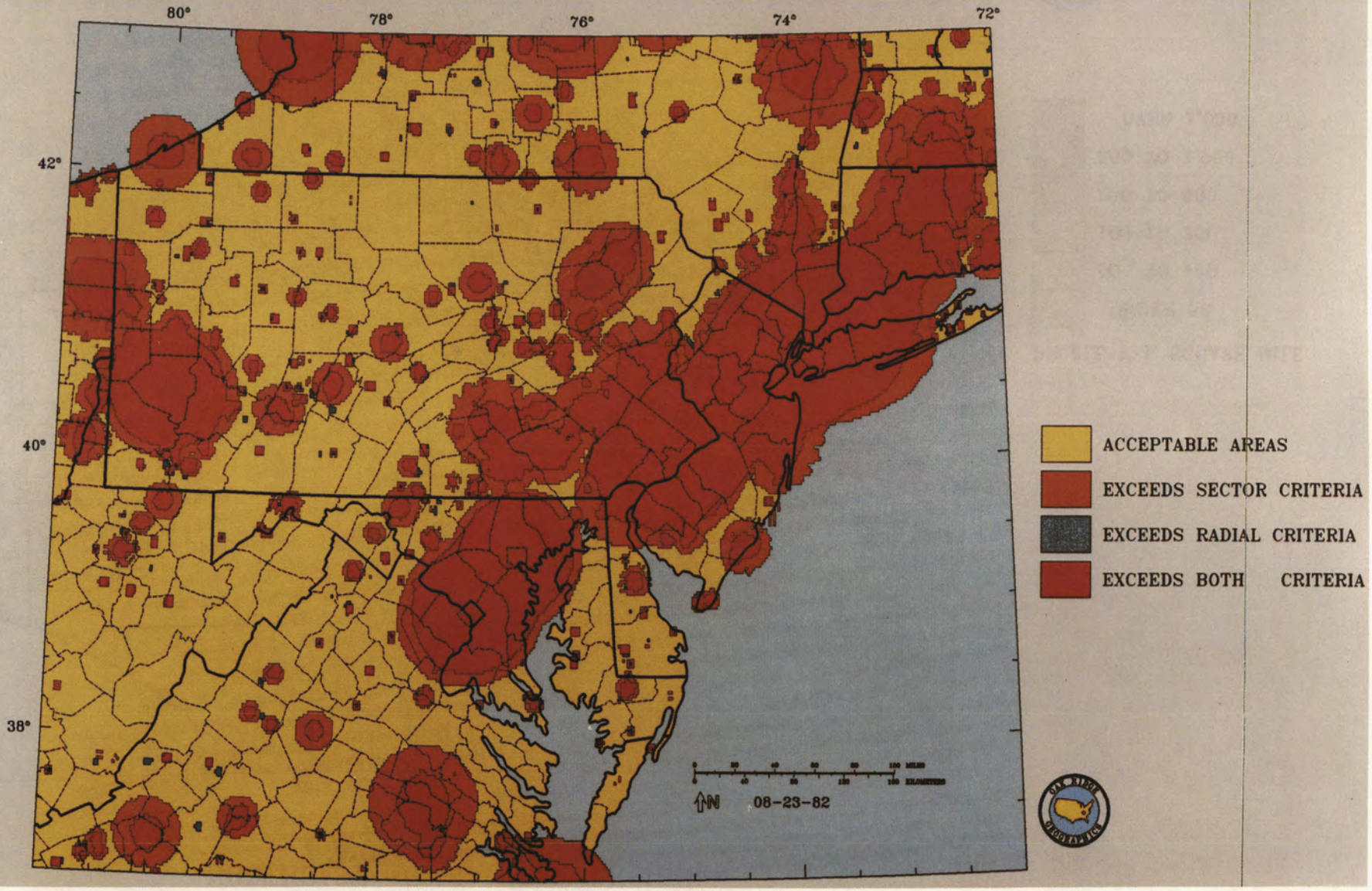
POPULATION DENSITY MAPS, SITING MAPS, AND UNFAVORABLE AREA TABLES FOR THREE MAJOR REGIONS IN U.S. (SIX ALTERNATIVES USED)


ORNL-DWG 83-7742
NORTHEAST U. S. (PJM REGION)
POPULATION DENSITY
FINAL 1980 CENSUS
80°
78°
76°
74°
72°
42°
40°
38°
N
08-27-82
PEOPLE PER SQUARE MILE
UNDER 50
50 TO 100
100 TO 250
250 TO 500
500 TO 1,000
OVER 1,000

ORNL-DWG 83-7763

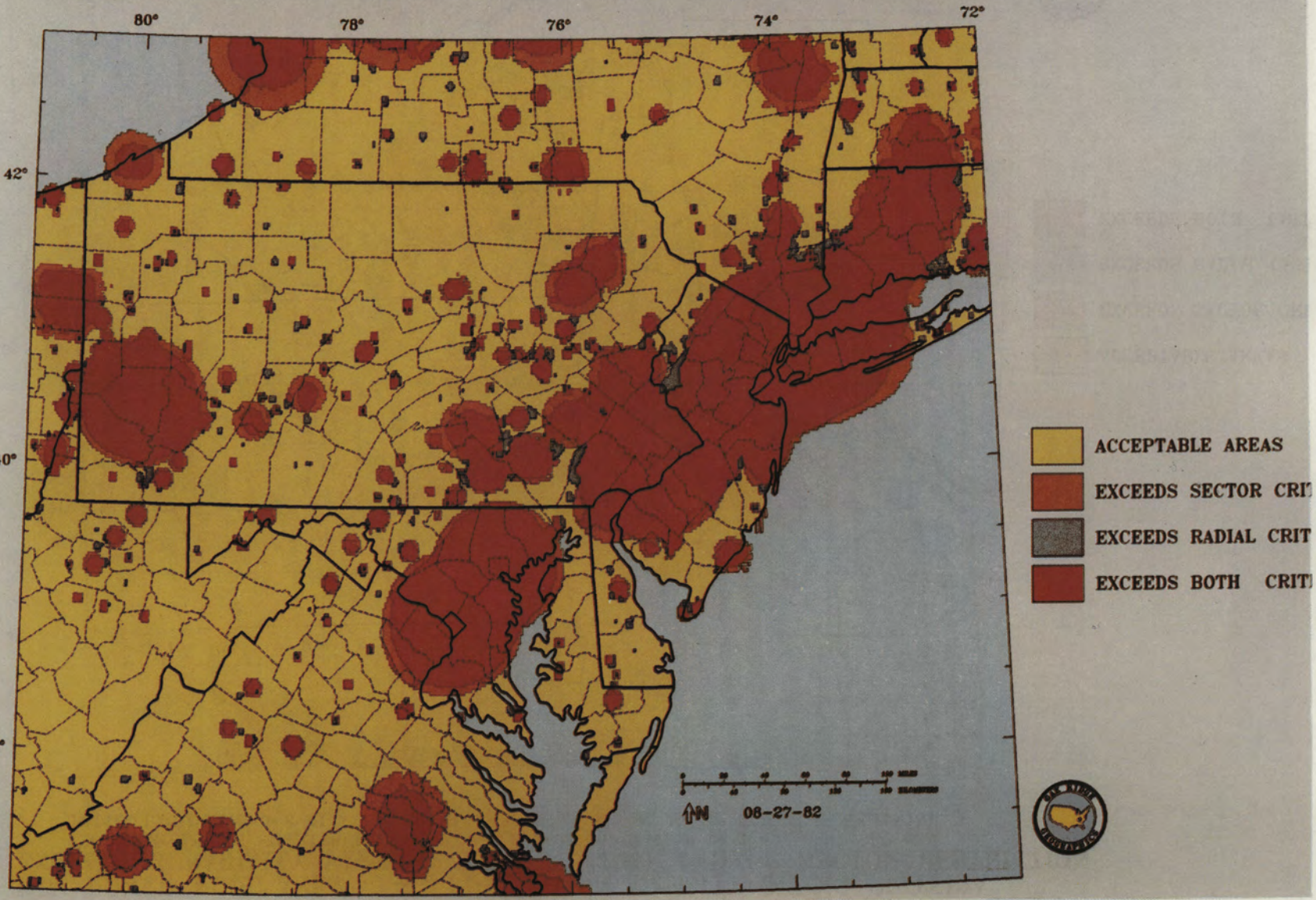
PJM POWER POOL AREA – POPULATION DENSITY SITING CRITERIA
ZONES EXCEEDING RADIALLY VARYING DENSITY LIMIT AND/OR SECTOR RESTRICTION

SECTOR EXCLUSION: GREATER THAN 1/4 OF MAXIMUM POPULATION IN 2 ADJACENT SECTORS
RADIAL EXCLUSION: 0–2 MI > 250/SQ MI, 2–30 MI > 500/SQ MI (IN 5 MILE INCREMENTS)



PJM POWER POOL AREA - POPULATION DENSITY SITING CRITERIA
ZONES EXCEEDING RADIALLY VARYING DENSITY LIMIT AND/OR SECTOR RESTRICTION

SECTOR EXCLUSION: GREATER THAN 3/8 OF MAXIMUM POPULATION IN 2 ADJACENT SECTORS
RADIAL EXCLUSION: 0-2 MI > 250/SQ MI, 2-30 MI > 500/SQ MI (IN 5 MILE INCREMENTS)



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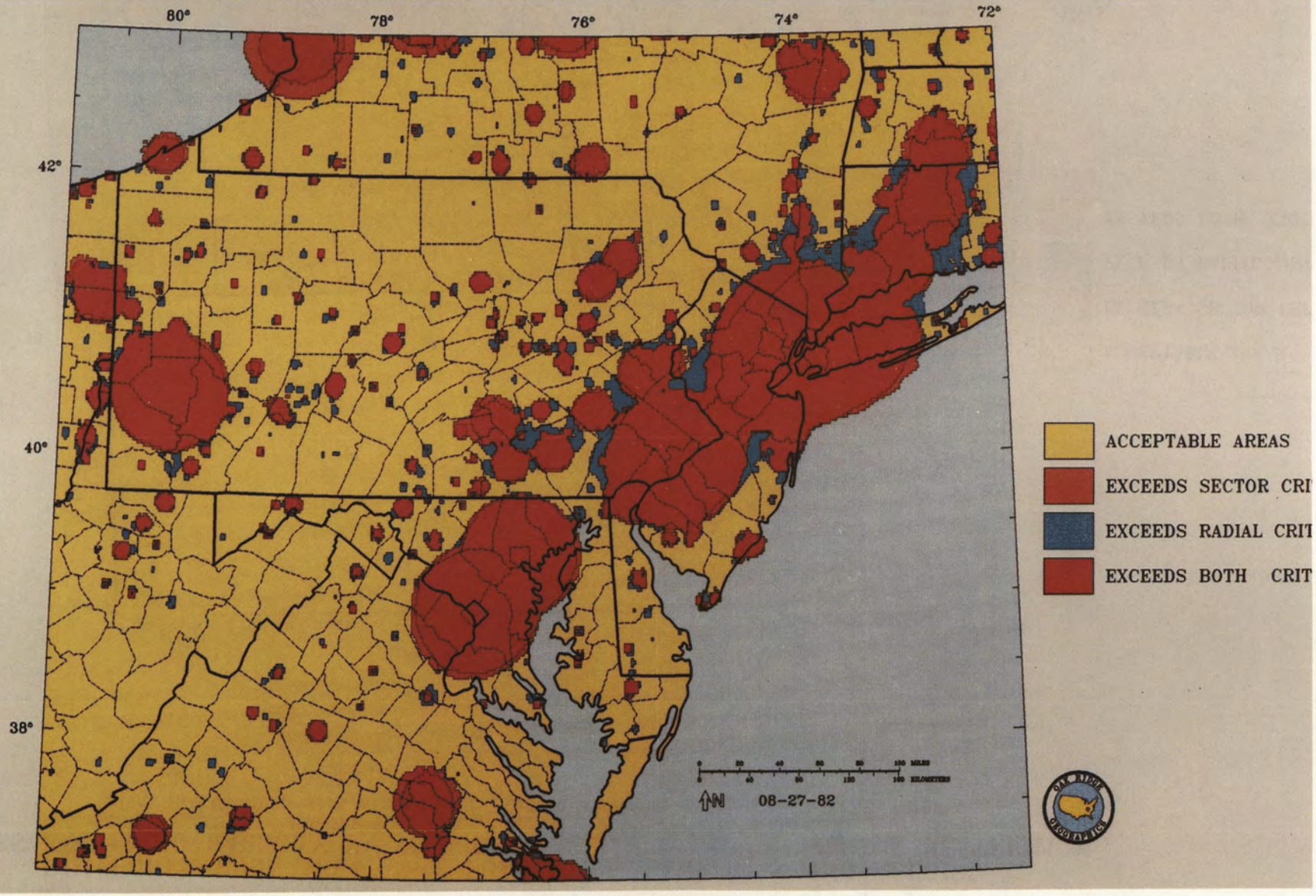
PJM POWER POOL AREA – POPULATION DENSITY SITING CRITERIA
ZONES EXCEEDING RADIALLY VARYING DENSITY LIMIT AND/OR SECTOR RESTRICTION

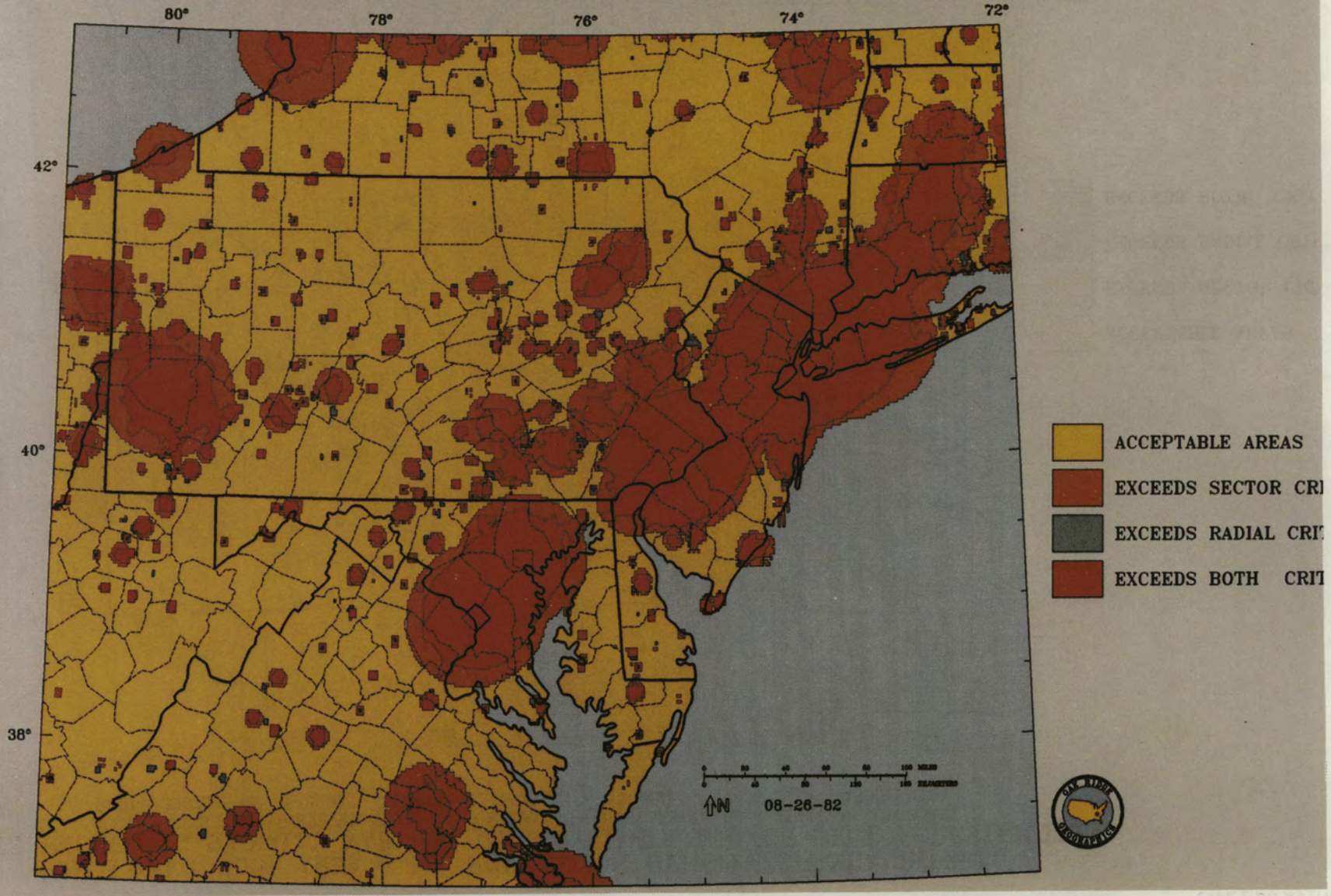
SECTOR EXCLUSION: GREATER THAN 1/2 OF MAXIMUM POPULATION IN 2 ADJACENT SECTORS
RADIAL EXCLUSION: 0–2 MI > 250/SQ MI, 2–30 MI > 500/SQ MI (IN 5 MILE INCREMENTS)



ORNL-DWG 83-7751

PJM POWER POOL AREA – POPULATION DENSITY SITING CRITERIA
ZONES EXCEEDING RADIALLY VARYING DENSITY LIMIT AND/OR SECTOR RESTRICTION

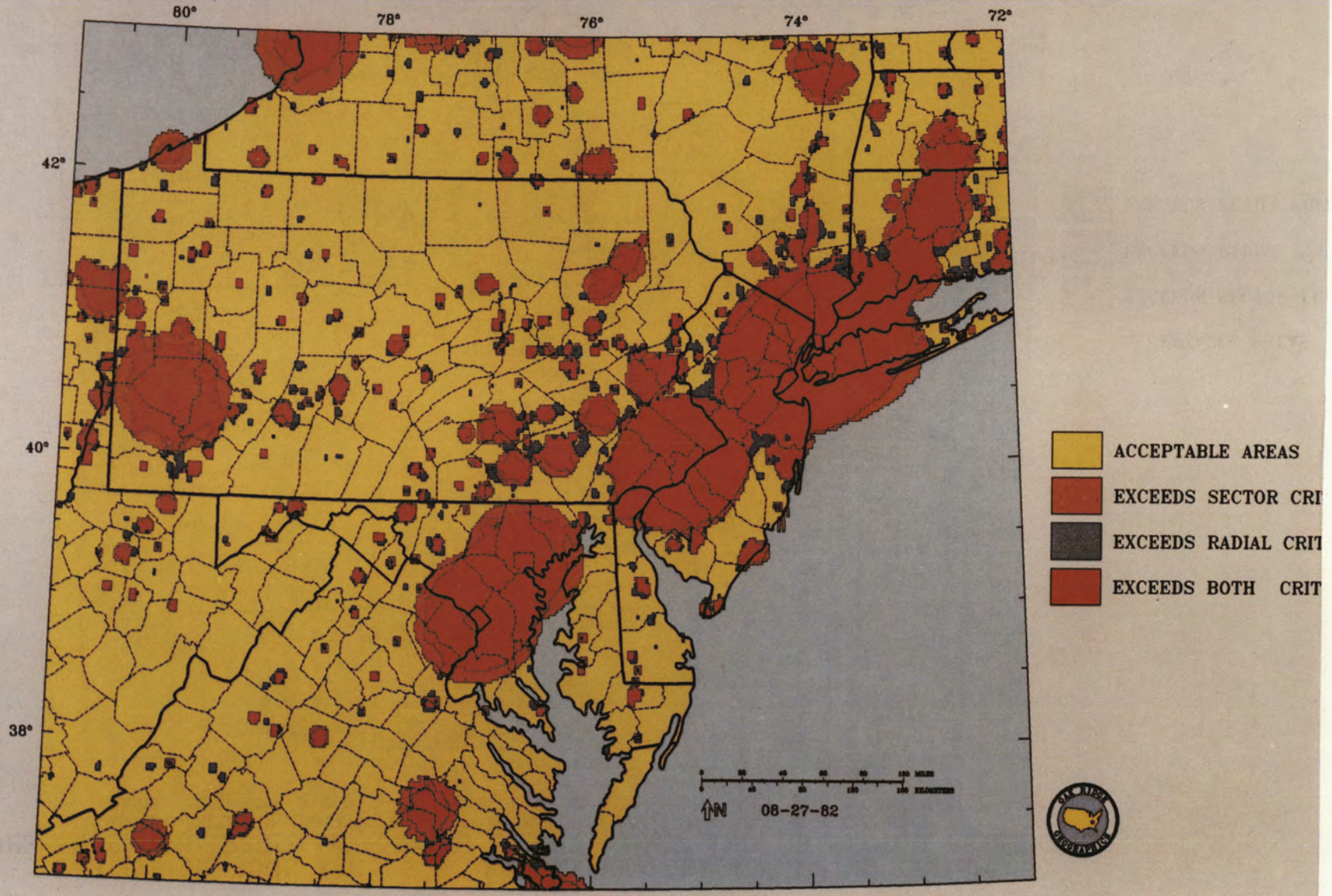
SECTOR EXCLUSION: GREATER THAN 1/4 OF MAXIMUM POPULATION IN 2 ADJACENT SECTORS
RADIAL EXCLUSION: 0–2 MI > 250/SQ MI, 2–30 MI > 750/SQ MI (IN 5 MILE INCREMENTS)



ORNL-DWG 83-7766

PJM POWER POOL AREA – POPULATION DENSITY SITING CRITERIA
ZONES EXCEEDING RADIALLY VARYING DENSITY LIMIT AND/OR SECTOR RESTRICTION

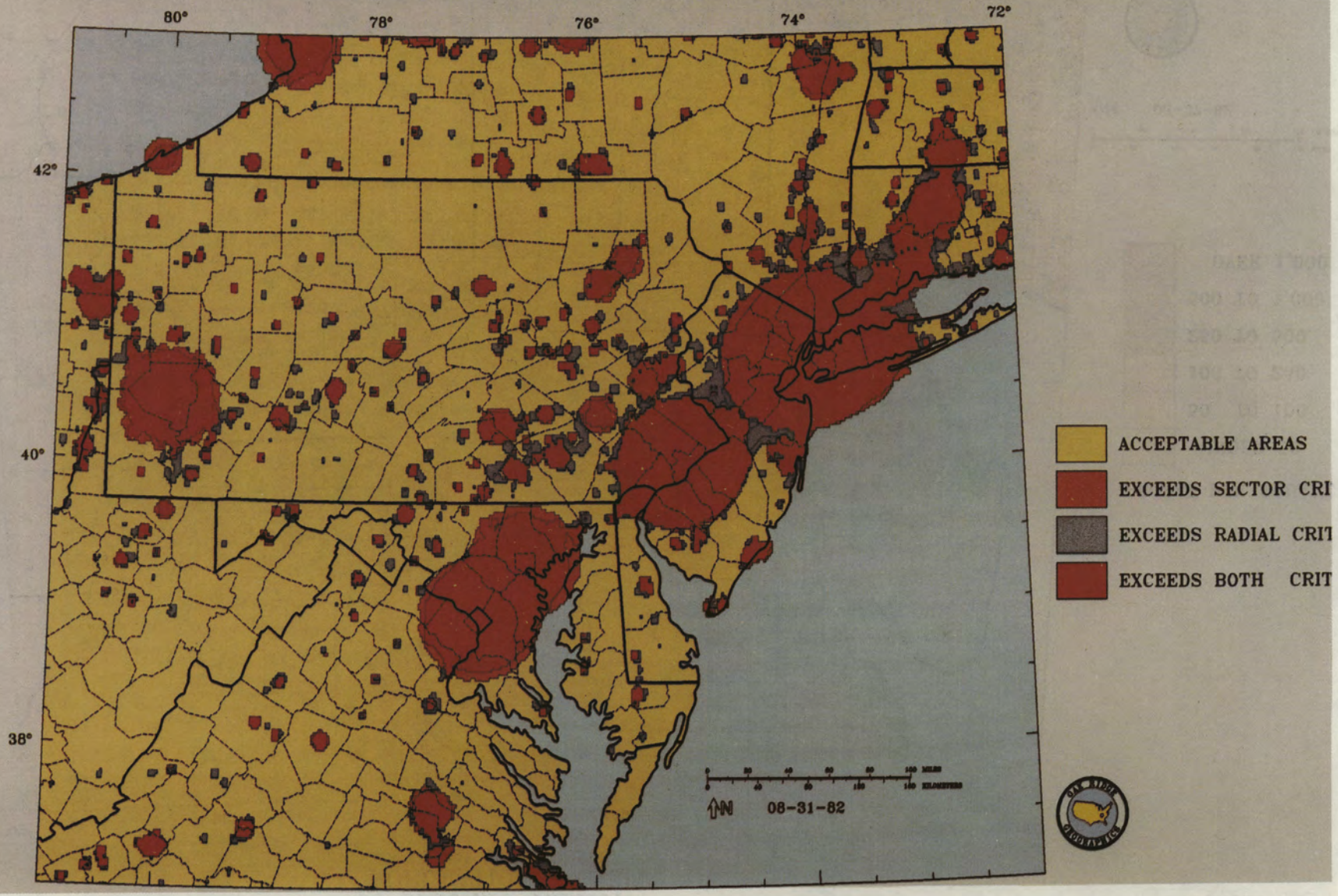
SECTOR EXCLUSION: GREATER THAN 3/8 OF MAXIMUM POPULATION IN 2 ADJACENT SECTORS
RADIAL EXCLUSION: 0-2 MI > 250/SQ MI, 2-30 MI > 750/SQ MI (IN 5 MILE INCREMENTS)

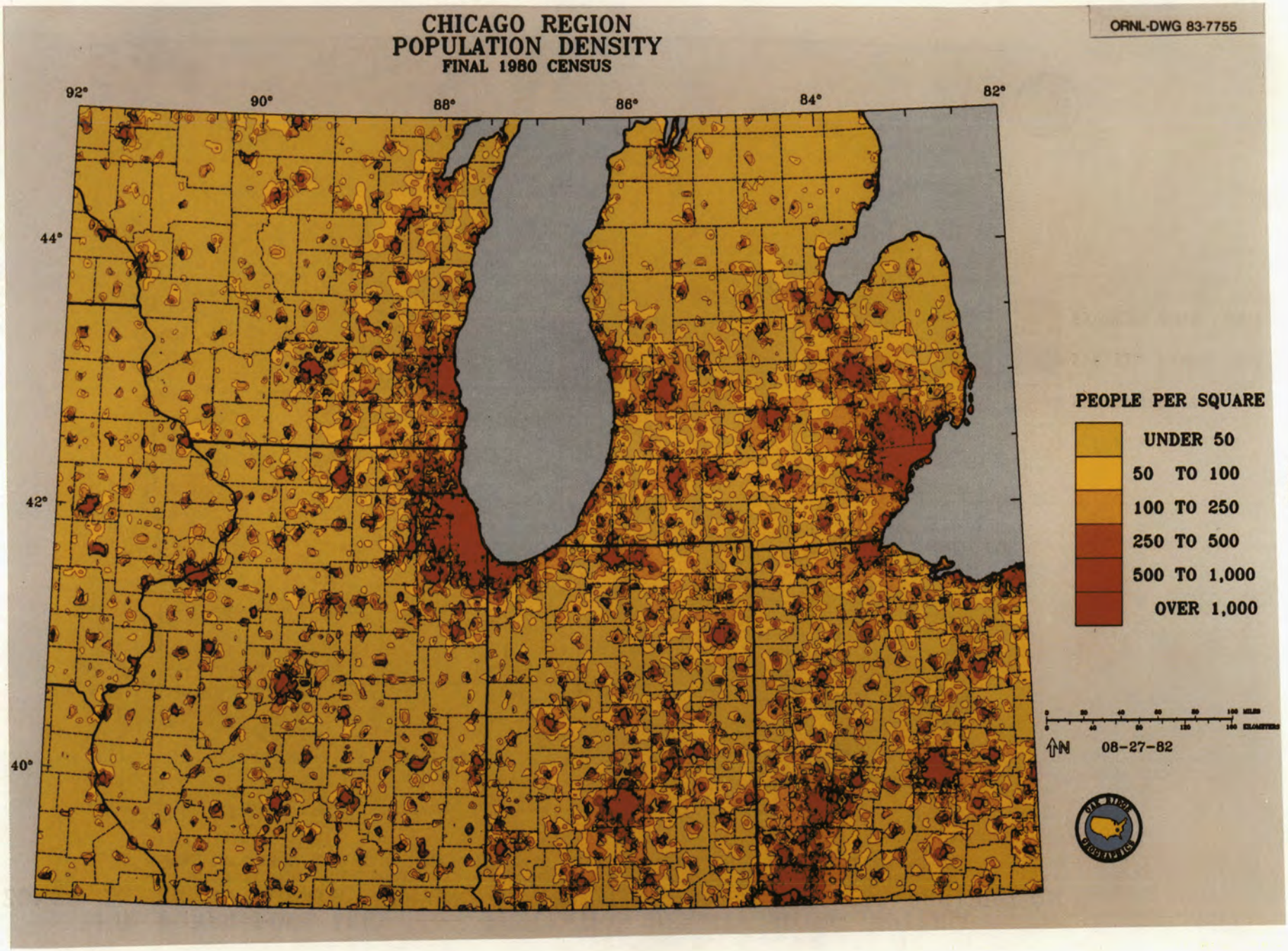


ORNL-DWG 83-7767

PJM POWER POOL AREA – POPULATION DENSITY SITING CRITERIA
ZONES EXCEEDING RADIALLY VARYING DENSITY LIMIT AND/OR SECTOR RESTRICTION

SECTOR EXCLUSION: GREATER THAN 1/2 OF MAXIMUM POPULATION IN 2 ADJACENT SECTORS
RADIAL EXCLUSION: 0–2 MI > 250/SQ MI, 2–30 MI > 750/SQ MI (IN 5 MILE INCREMENTS)

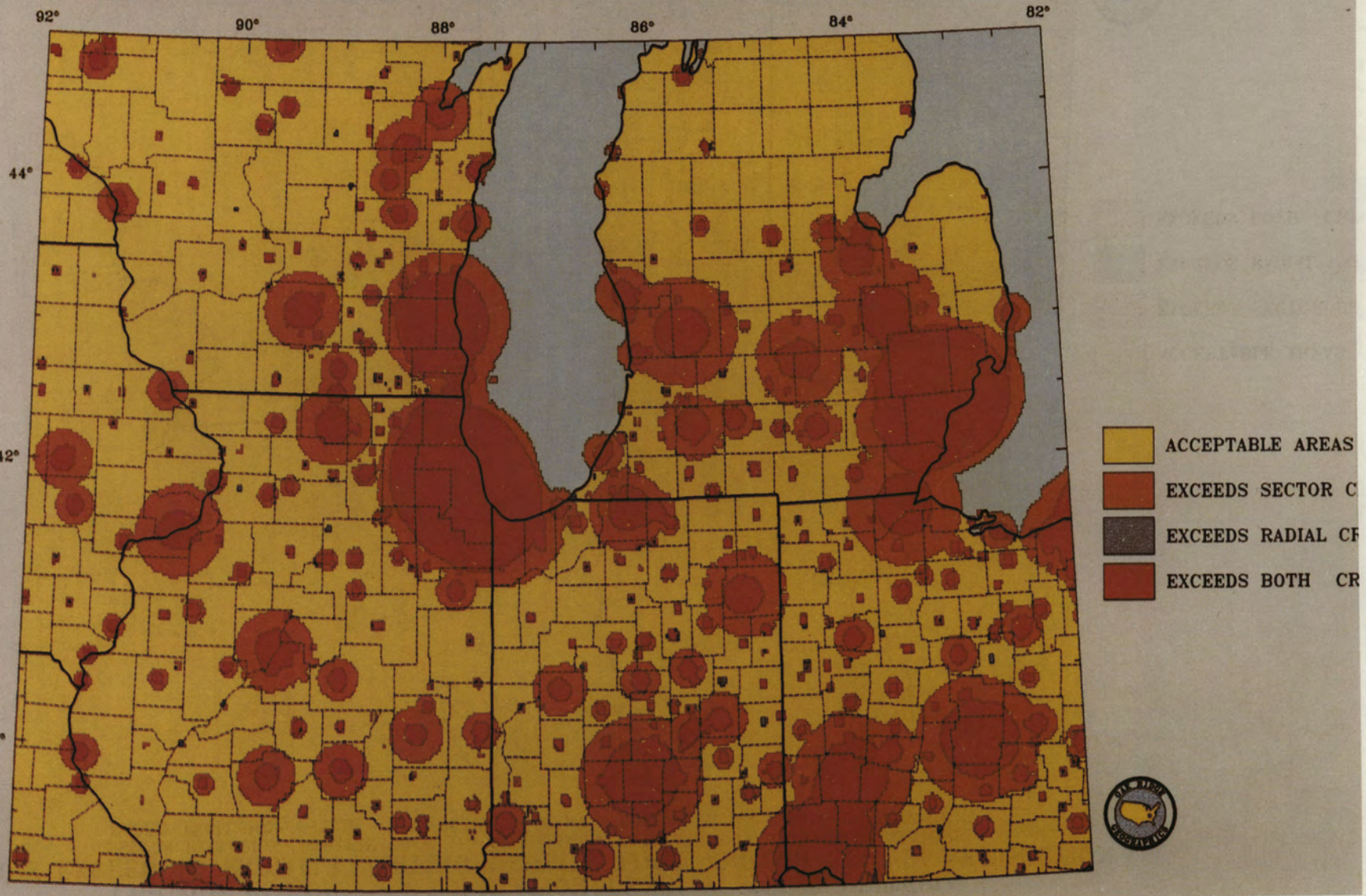



CHICAGO REGION
POPULATION DENSITY
FINAL 1980 CENSUS
ORNL-DWG 83-7755
92°
90°
88°
86°
84°
82°
44°
42°
40°
PEOPLE PER SQUARE
UNDER 50
50 TO 100
100 TO 250
250 TO 500
500 TO 1,000
OVER 1,000
N
08-27-82

ORNL-DWG 83-7768

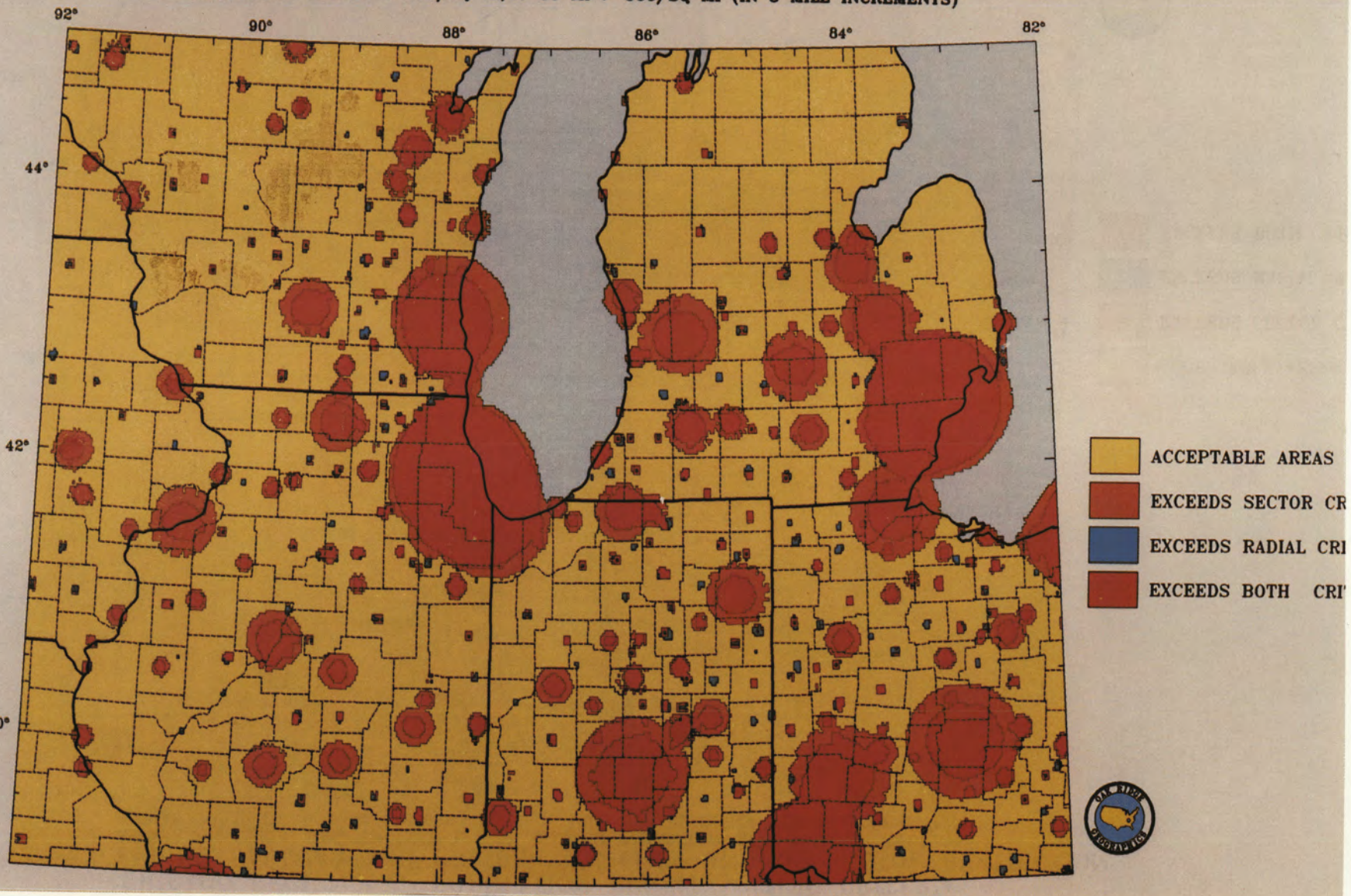
CHICAGO REGION – POPULATION DENSITY SITING CRITERIA
ZONES EXCEEDING RADIALLY VARYING DENSITY LIMIT AND/OR SECTOR RESTRICTION

SECTOR EXCLUSION: GREATER THAN 1/4 OF MAXIMUM POPULATION IN 2 ADJACENT SECTORS
RADIAL EXCLUSION: 0–2 MI > 250/SQ MI, 2–30 MI > 500/SQ MI (IN 5 MILE INCREMENTS)



ORNL-DWG 83-7769

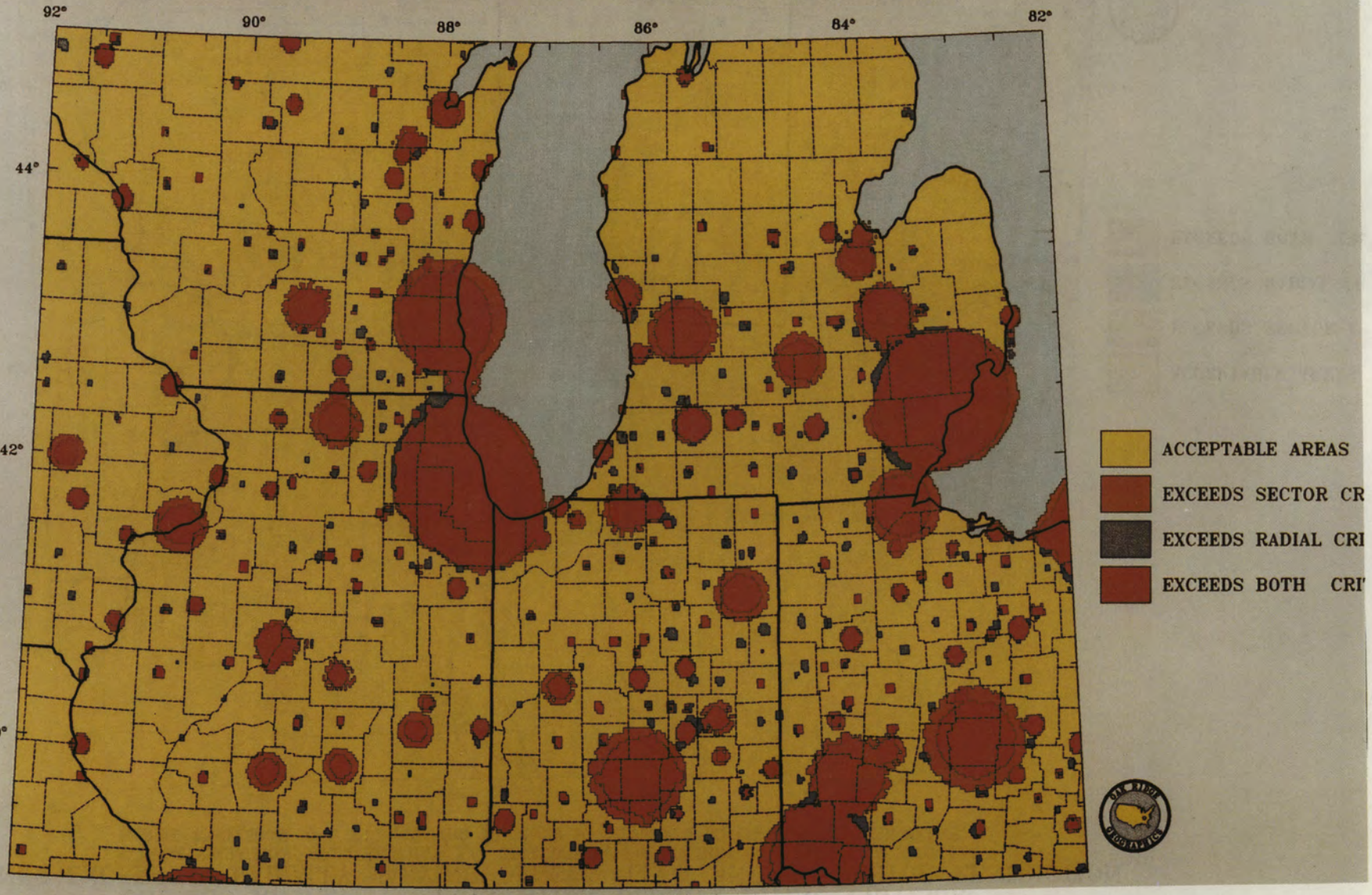
CHICAGO REGION – POPULATION DENSITY SITING CRITERIA
ZONES EXCEEDING RADIALLY VARYING DENSITY LIMIT AND/OR SECTOR RESTRICTION
SECTOR EXCLUSION: GREATER THAN 3/8 OF MAXIMUM POPULATION IN 2 ADJACENT SECTORS
RADIAL EXCLUSION: 0–2 MI > 250/SQ MI, 2–30 MI > 500/SQ MI (IN 5 MILE INCREMENTS)



ORNL-DWG 83-7770

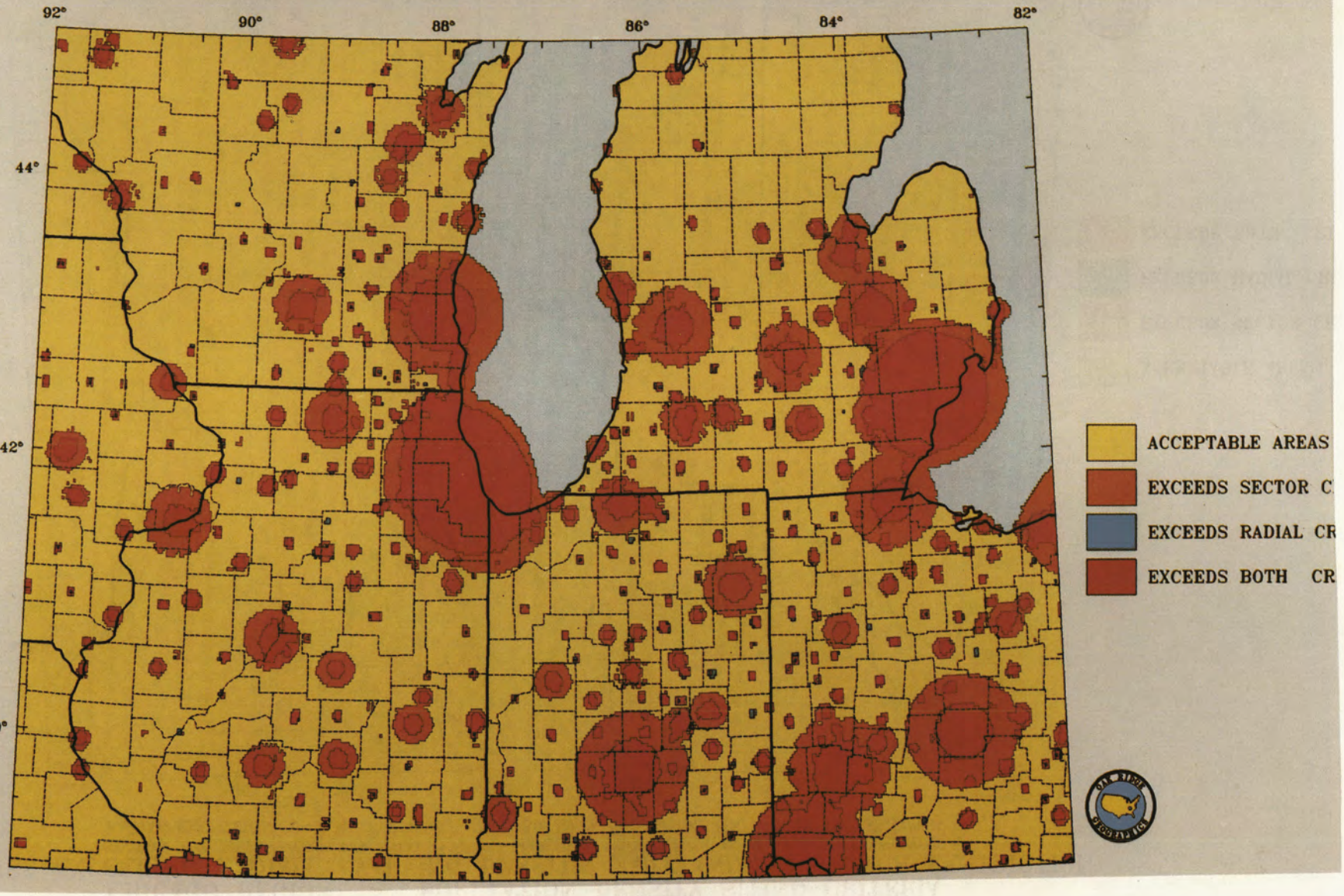
CHICAGO REGION – POPULATION DENSITY SITING CRITERIA
ZONES EXCEEDING RADIALLY VARYING DENSITY LIMIT AND/OR SECTOR RESTRICTION

SECTOR EXCLUSION: GREATER THAN 1/2 OF MAXIMUM POPULATION IN 2 ADJACENT SECTORS
RADIAL EXCLUSION: 0–2 MI > 250/SQ MI, 2–30 MI > 500/SQ MI (IN 5 MILE INCREMENTS)



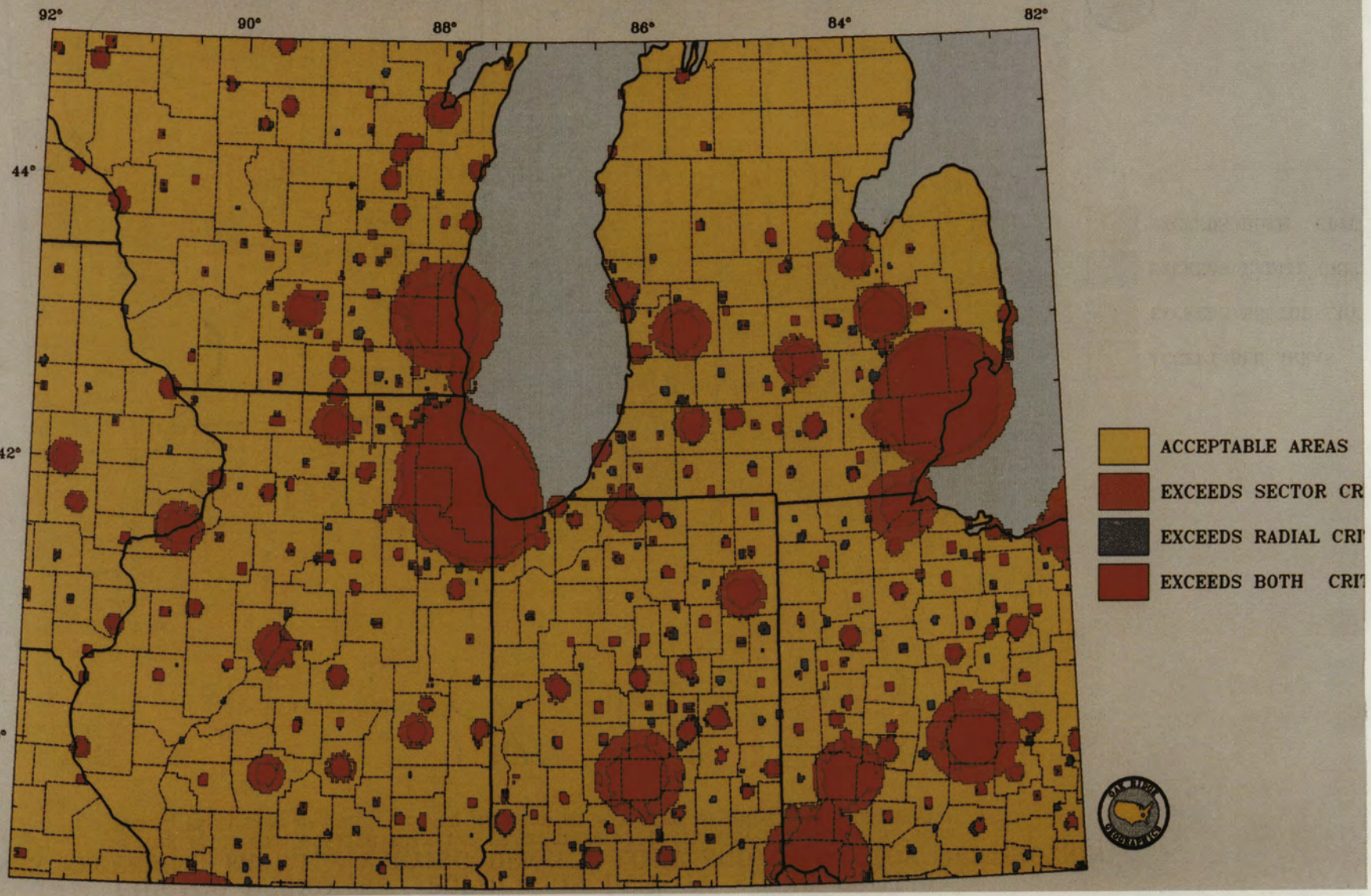
ORNL-DWG 83-7771

CHICAGO REGION – POPULATION DENSITY SITING CRITERIA
ZONES EXCEEDING RADIALLY VARYING DENSITY LIMIT AND/OR SECTOR RESTRICTION
SECTOR EXCLUSION: GREATER THAN 1/4 OF MAXIMUM POPULATION IN 2 ADJACENT SECTORS
RADIAL EXCLUSION: 0–2 MI > 250/SQ MI, 2–30 MI > 750/SQ MI (IN 5 MILE INCREMENTS)



ORNL-DWG 83-7772

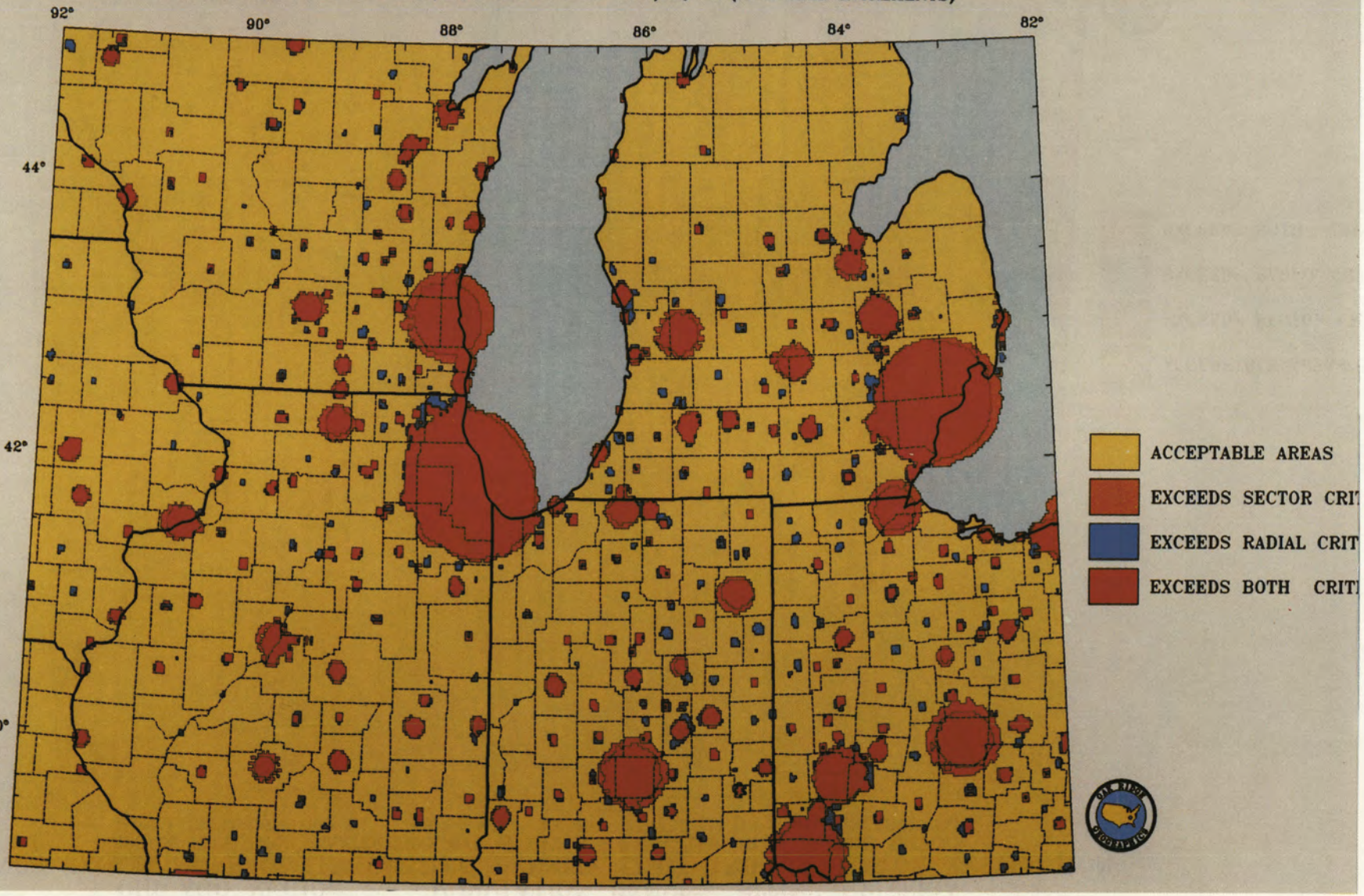
CHICAGO REGION – POPULATION DENSITY SITING CRITERIA
ZONES EXCEEDING RADIALLY VARYING DENSITY LIMIT AND/OR SECTOR RESTRICTION
SECTOR EXCLUSION: GREATER THAN 3/8 OF MAXIMUM POPULATION IN 2 ADJACENT SECTORS
RADIAL EXCLUSION: 0–2 MI > 250/SQ MI, 2–30 MI > 750/SQ MI (IN 5 MILE INCREMENTS)

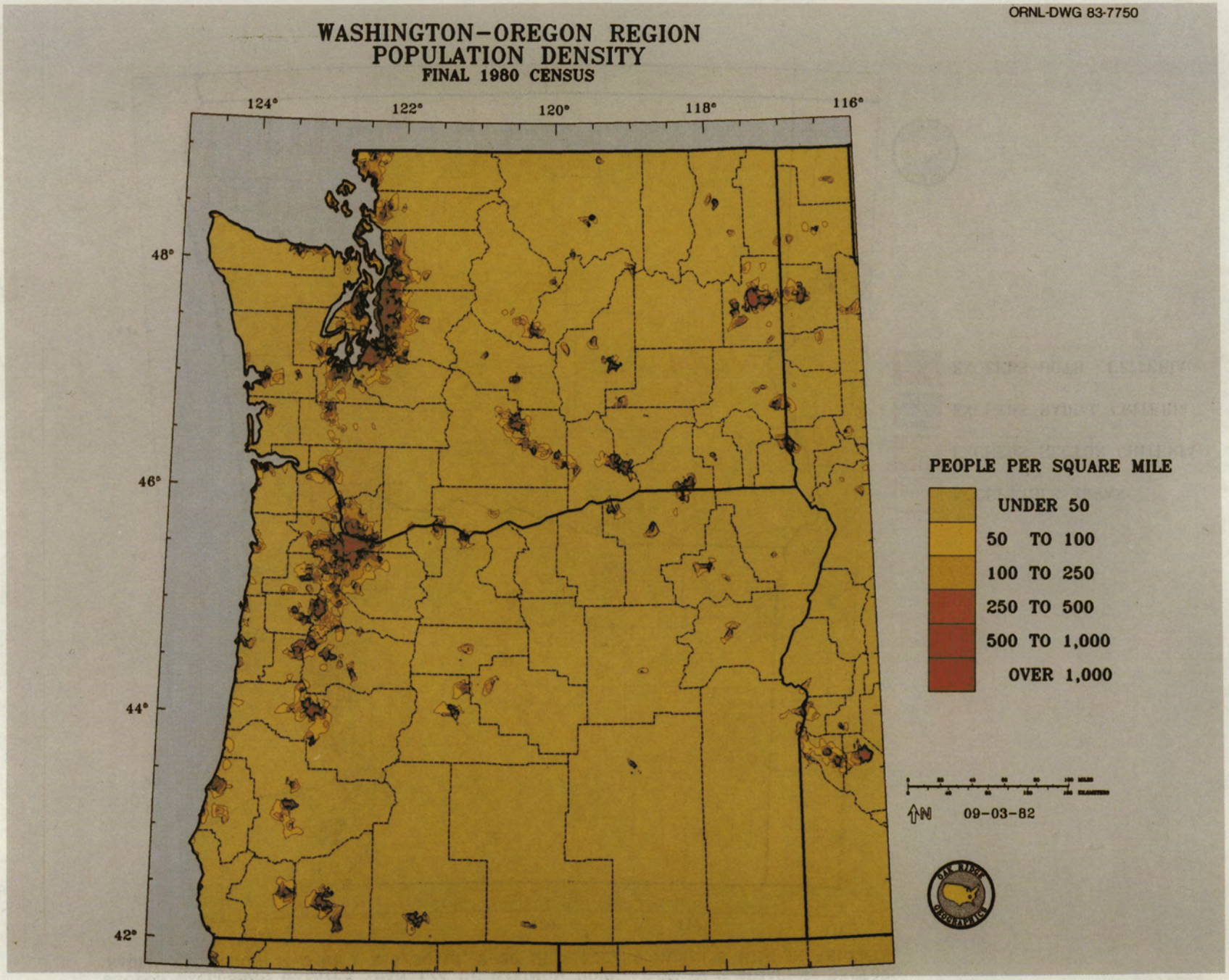


ORNL-DWG 83-7773

CHICAGO REGION - POPULATION DENSITY SITING CRITERIA
ZONES EXCEEDING RADIALLY VARYING DENSITY LIMIT AND/OR SECTOR RESTRICTION

SECTOR EXCLUSION: GREATER THAN 1/2 OF MAXIMUM POPULATION IN 2 ADJACENT SECTORS
RADIAL EXCLUSION: 0-2 MI > 250/SQ MI, 2-30 MI > 750/SQ MI (IN 5 MILE INCREMENTS)

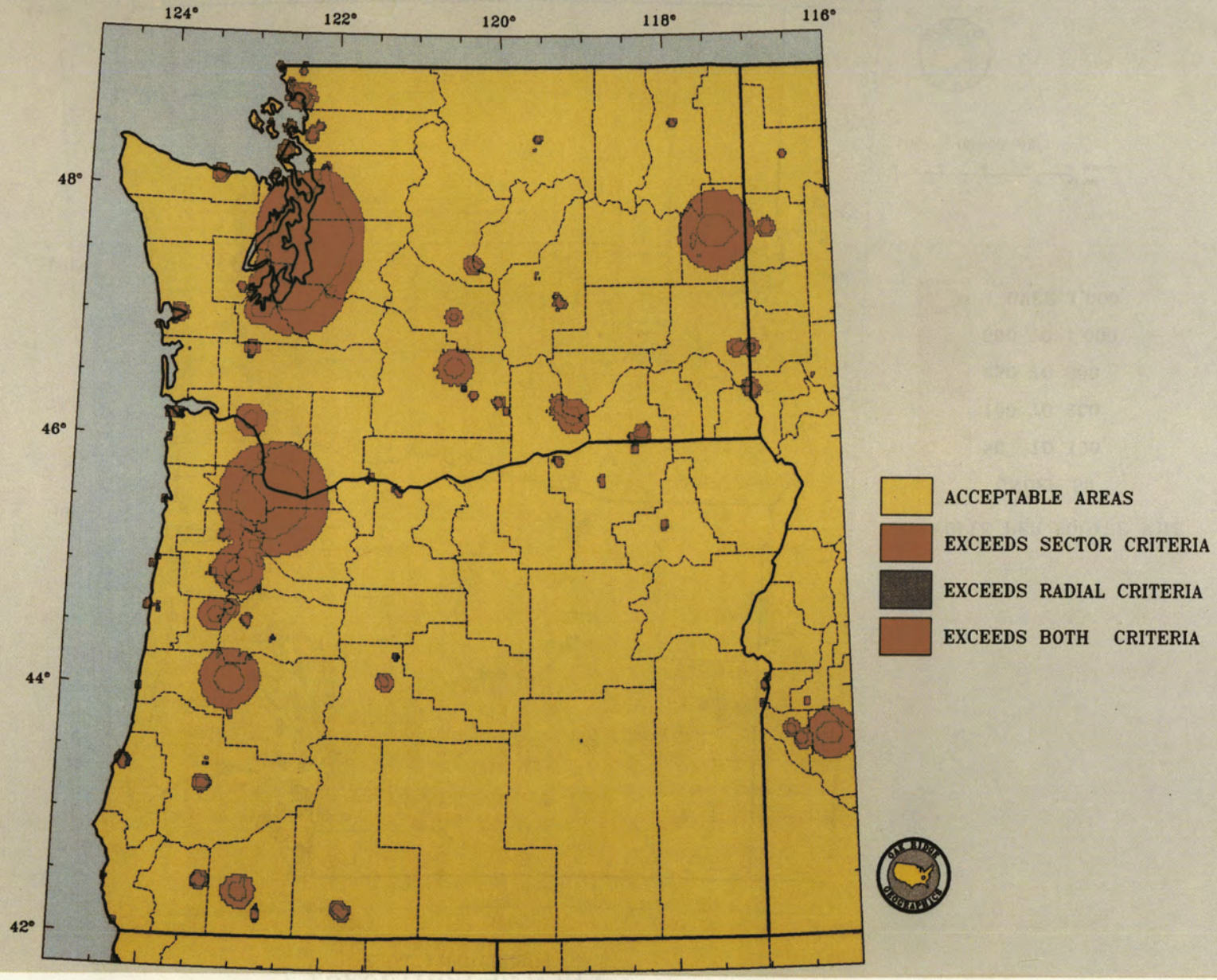



ORNL-DWG 83-7750
WASHINGTON–OREGON REGION
POPULATION DENSITY
FINAL 1980 CENSUS
124°
122°
120°
118°
116°
48°
46°
44°
42°
PEOPLE PER SQUARE MILE
UNDER 50
50 TO 100
100 TO 250
250 TO 500
500 TO 1,000
OVER 1,000
N
09-03-82

ORNL-DWG 83-7774

WASHINGTON–OREGON REGION – POPULATION DENSITY SITING CRITERIA
ZONES EXCEEDING RADIALLY VARYING DENSITY LIMIT AND/OR SECTOR RESTRICTION

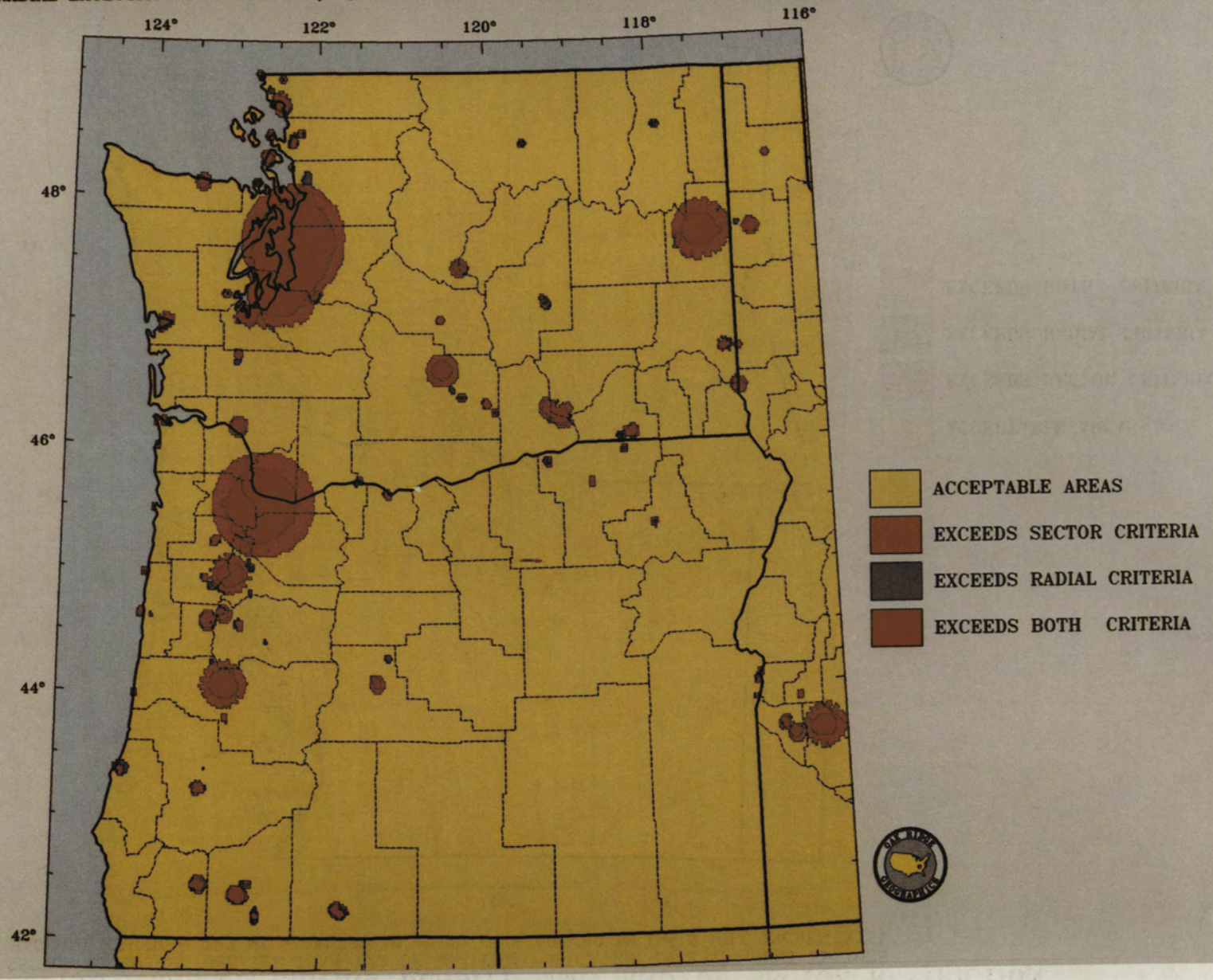
SECTOR EXCLUSION: GREATER THAN 1/4 OF MAXIMUM POPULATION IN 2 ADJACENT SECTORS
RADIAL EXCLUSION: 0–2 MI > 250/SQ MI, 2–30 MI > 500/SQ MI (IN 5 MILE INCREMENTS)



ORNL-DWG 83-7775

WASHINGTON–OREGON REGION – POPULATION DENSITY SITING CRITERIA
ZONES EXCEEDING RADIALLY VARYING DENSITY LIMIT AND/OR SECTOR RESTRICTION

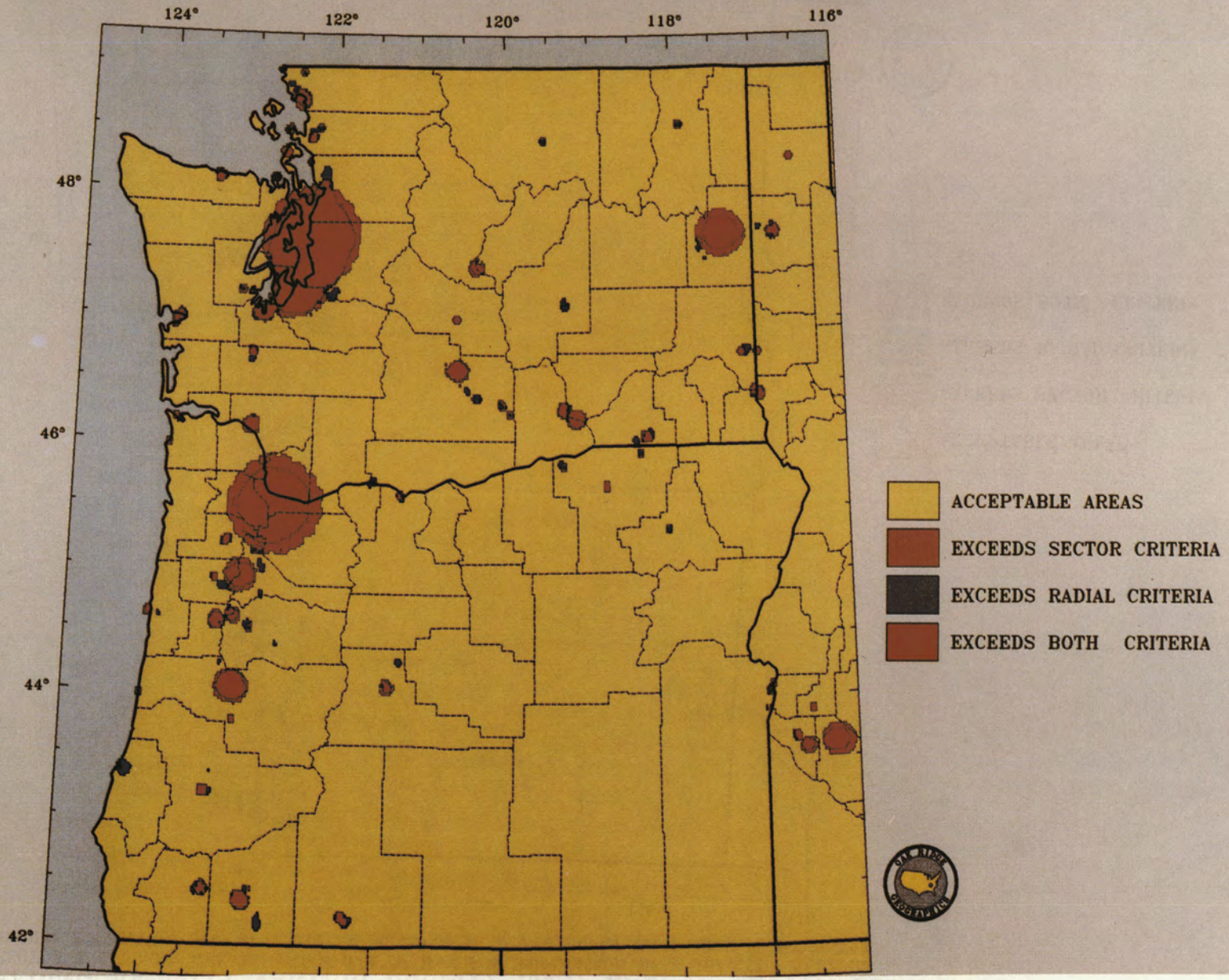
SECTOR EXCLUSION: GREATER THAN 3/8 OF MAXIMUM POPULATION IN 2 ADJACENT SECTORS
RADIAL EXCLUSION: 0–2 MI > 250/SQ MI, 2–30 MI > 500/SQ MI (IN 5 MILE INCREMENTS)



ORNL-DWG 83-7776

WASHINGTON–OREGON REGION – POPULATION DENSITY SITING CRITERIA
ZONES EXCEEDING RADIALLY VARYING DENSITY LIMIT AND/OR SECTOR RESTRICTION

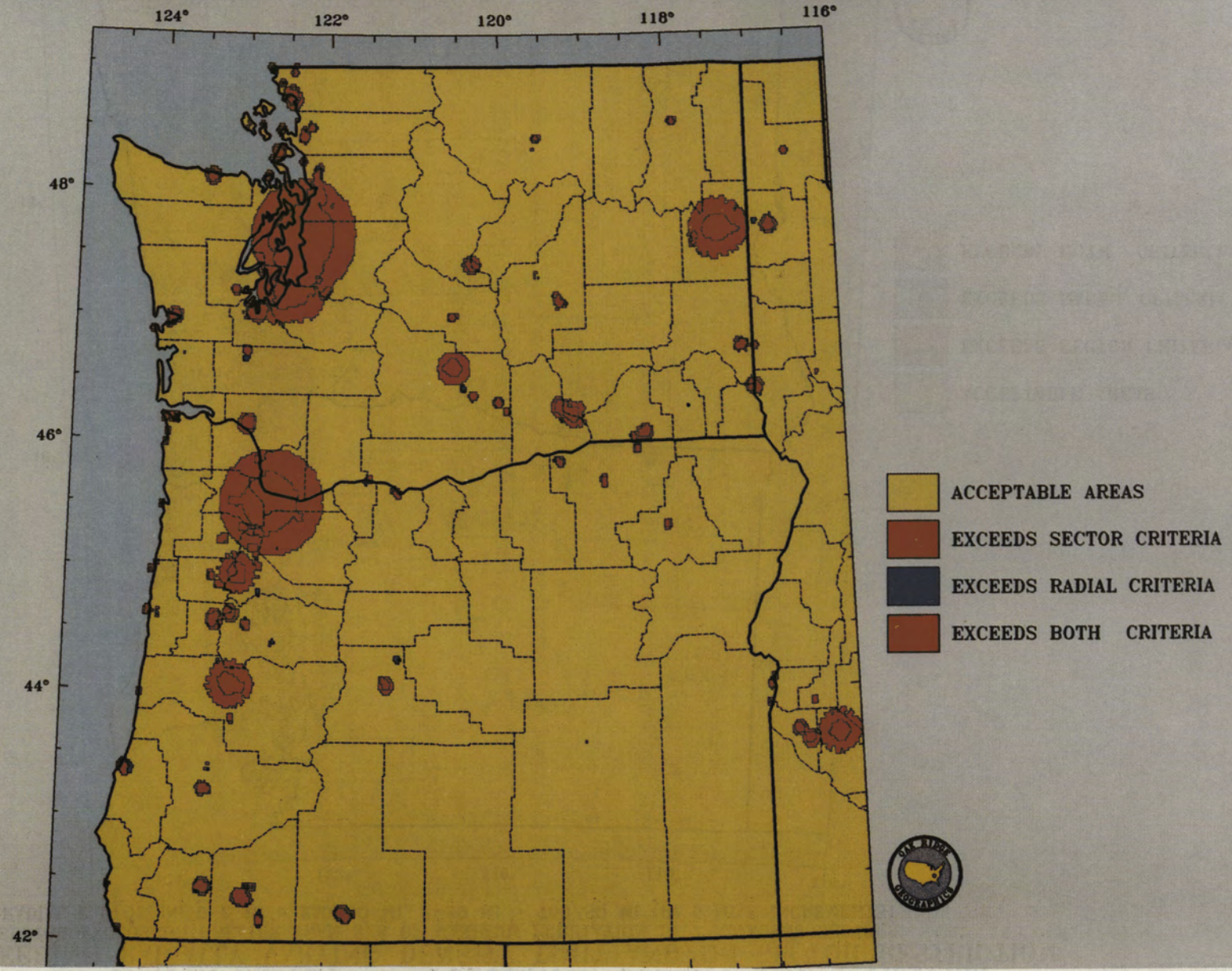
SECTOR EXCLUSION: GREATER THAN 1/2 OF MAXIMUM POPULATION IN 2 ADJACENT SECTORS
RADIAL EXCLUSION: 0–2 MI > 250/SQ MI, 2–30 MI > 500/SQ MI (IN 5 MILE INCREMENTS)



ORNL-DWG 83-7777

WASHINGTON–OREGON REGION – POPULATION DENSITY SITING CRITERIA
ZONES EXCEEDING RADIALLY VARYING DENSITY LIMIT AND/OR SECTOR RESTRICTION

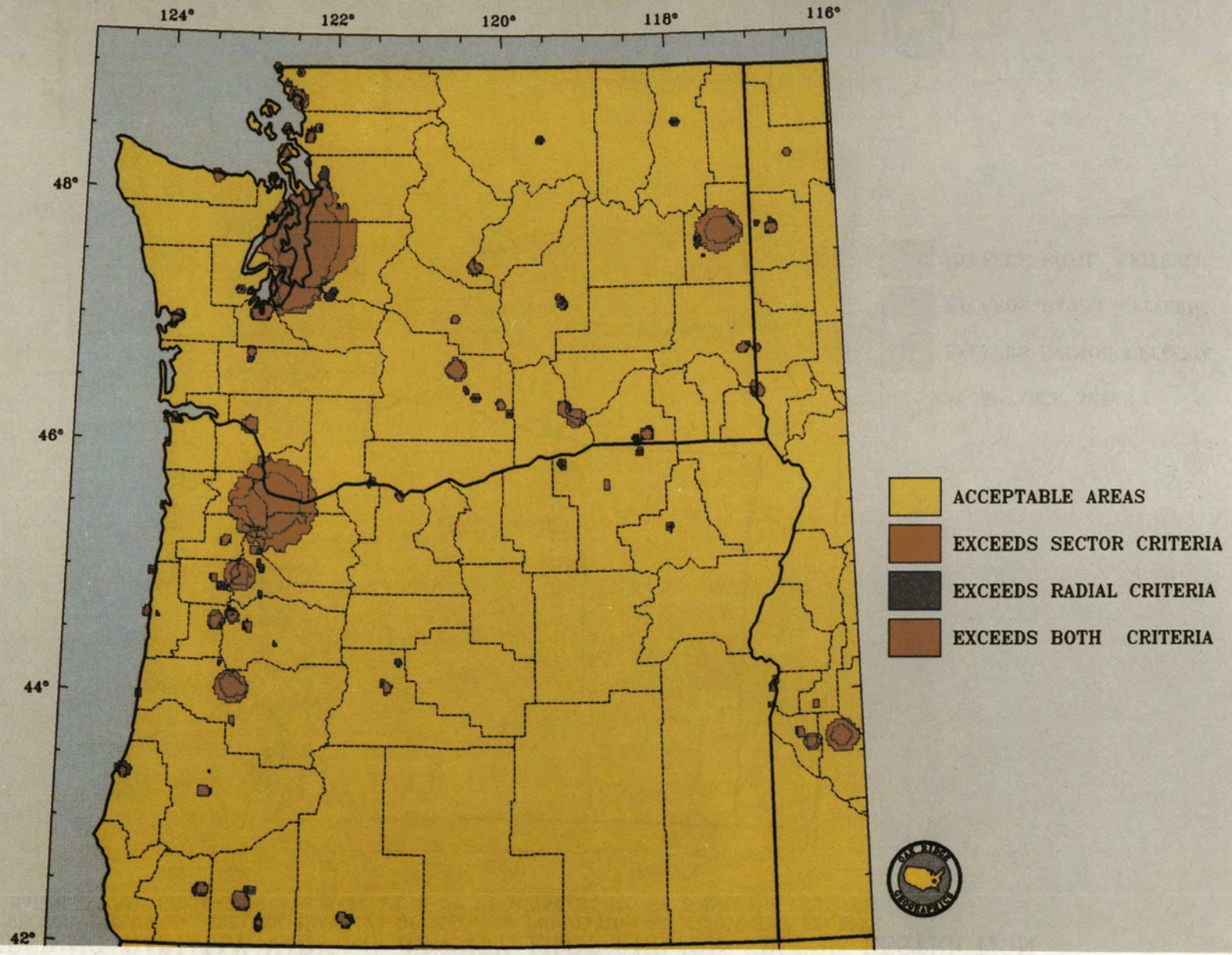
SECTOR EXCLUSION: GREATER THAN 1/4 OF MAXIMUM POPULATION IN 2 ADJACENT SECTORS
RADIAL EXCLUSION: 0–2 MI > 250/SQ MI, 2–30 MI > 750/SQ MI (IN 5 MILE INCREMENTS)



ORNL-DWG 83-7778

WASHINGTON–OREGON REGION – POPULATION DENSITY SITING CRITERIA
ZONES EXCEEDING RADIALLY VARYING DENSITY LIMIT AND/OR SECTOR RESTRICTION

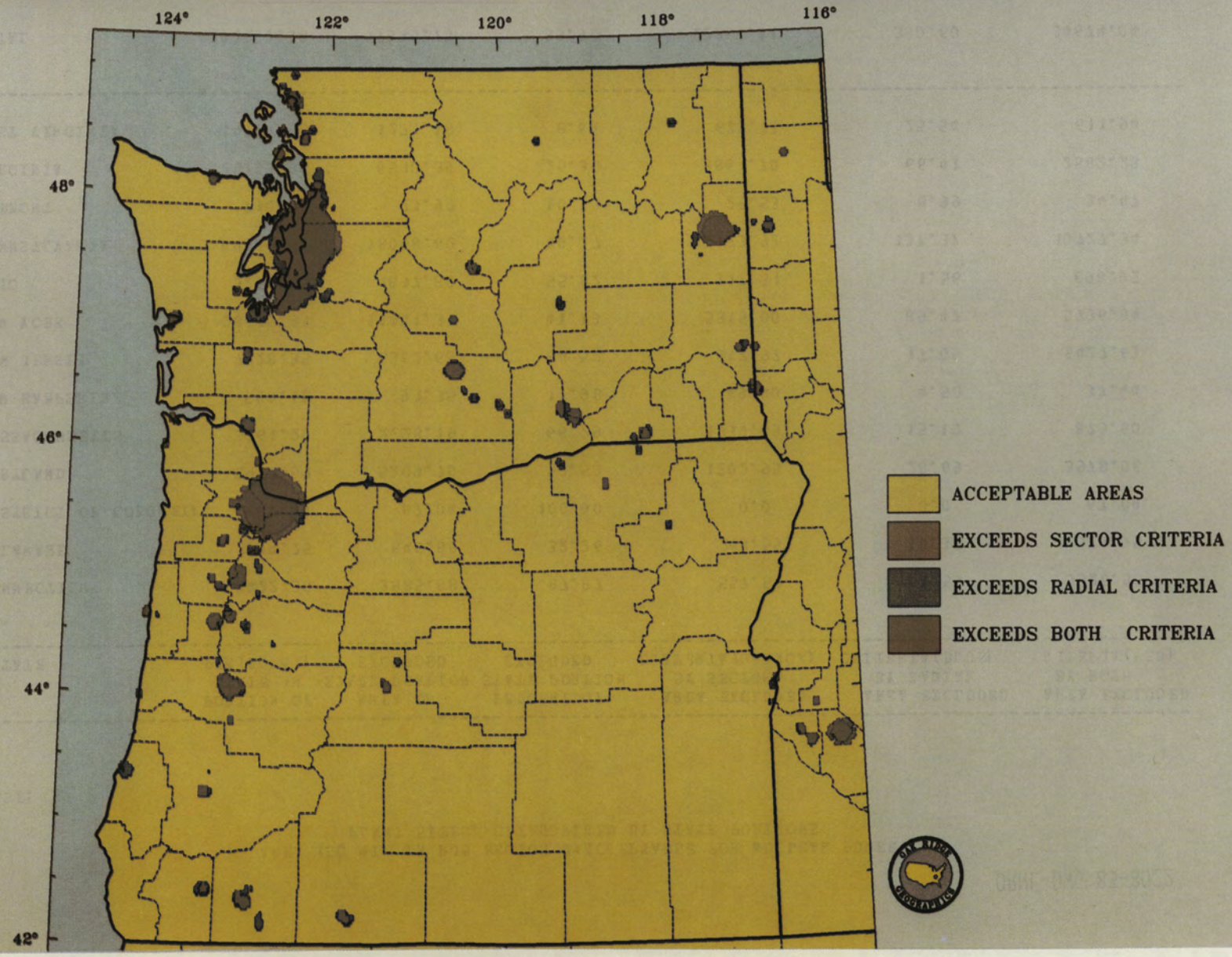
SECTOR EXCLUSION: GREATER THAN 3/8 OF MAXIMUM POPULATION IN 2 ADJACENT SECTORS
RADIAL EXCLUSION: 0–2 MI > 250/SQ MI, 2–30 MI > 750/SQ MI (IN 5 MILE INCREMENTS)



ORNL-DWG 83-7779

WASHINGTON-OREGON REGION - POPULATION DENSITY SITING CRITERIA
ZONES EXCEEDING RADIALLY VARYING DENSITY LIMIT AND/OR SECTOR RESTRICTION

SECTOR EXCLUSION: GREATER THAN 1/2 OF MAXIMUM POPULATION IN 2 ADJACENT SECTORS
RADIAL EXCLUSION: 0-2 MI > 250/SQ MI, 2-30 MI > 750/SQ MI (IN 5 MILE INCREMENTS)



ORNL-DWG 83-8022

AREA (SQ MI) IN PJM REGION UNACCEPTABLE FOR NUCLEAR POWER PLANT SITES, CATEGORIZED BY STATE PORTIONS

CASE: 1

STATE	PORTION OF STATE IN PJM (SQ MI)	AREA OF STATE PORTION EXCLUDED	PERCENT OF STATE PORTION EXCLUDED	AREA EXCLUDED BY SECTOR CRITERIA (ORANGE)	AREA EXCLUDED BY RADIAL CRITERIA (BLUE)	AREA EXCLUDED BY BOTH CRITERIA (RED)
CONNECTICUT	4422.30	3885.68	87.87	557.59	1.53	3326.55
DELAWARE	2014.75	649.88	32.26	263.55	14.38	371.95
DISTRICT OF COLUMBIA	67.04	67.04	100.00	0.0	0.0	67.04
MARYLAND	9917.59	5209.70	52.53	1202.95	28.69	3978.06
MASSACHUSETTS	3361.20	2228.19	66.29	1339.49	15.10	873.60
NEW HAMPSHIRE	508.12	91.35	17.98	49.40	4.50	37.44
NEW JERSEY	7528.35	6362.65	84.52	917.97	17.05	5427.63
NEW YORK	26695.83	11141.31	41.73	5315.00	89.47	5736.84
OHIO	3256.73	1817.80	55.82	917.31	1.56	898.92
PENNSYLVANIA	44720.32	18008.62	40.27	7173.92	107.37	10727.34
VERMONT	710.36	71.99	10.13	28.53	8.99	34.47
VIRGINIA	25733.84	6510.39	25.30	3861.70	66.41	2582.28
WEST VIRGINIA	14717.08	1271.18	8.64	633.71	25.54	611.94
TOTAL	143653.38	57315.75	39.90	22261.11	380.60	34674.04

ORNL-DWG 83-8023

AREA (SQ MI) IN PJM REGION UNACCEPTABLE FOR NUCLEAR POWER PLANT SITES, CATEGORIZED BY STATE PORTIONS

CASE: 2

STATE	PORTION OF STATE IN PJM (SQ MI)	AREA OF STATE PORTION EXCLUDED	PERCENT OF STATE PORTION EXCLUDED	AREA EXCLUDED BY SECTOR CRITERIA (ORANGE)	AREA EXCLUDED BY RADIAL CRITERIA (BLUE)	AREA EXCLUDED BY BOTH CRITERIA (RED)
CONNECTICUT	4422.30	3491.64	78.96	163.55	156.37	3171.72
DELAWARE	2014.75	481.47	23.90	95.13	54.26	332.07
DISTRICT OF COLUMBIA	67.04	67.04	100.00	0.0	0.0	67.04
MARYLAND	9917.59	4551.18	45.89	544.42	84.43	3922.33
MASSACHUSETTS	3361.20	1400.33	41.66	511.63	60.34	828.36
NEW HAMPSHIRE	508.12	79.37	15.62	37.43	12.00	29.94
NEW JERSEY	7528.35	5718.21	75.96	273.37	204.26	5240.58
NEW YORK	26695.83	8214.07	30.77	2387.35	392.84	5433.89
OHIO	3256.73	1201.86	36.90	301.37	43.30	857.19
PENNSYLVANIA	44720.32	13318.72	29.78	2483.49	751.52	10083.71
VERMONT	710.36	43.47	6.12	0.0	22.48	20.99
VIRGINIA	25733.84	4347.16	16.89	1698.48	153.98	2494.71
WEST VIRGINIA	14717.08	840.95	5.71	203.47	87.30	550.18
TOTAL	143653.38	43755.45	30.46	8699.67	2023.08	33032.70

ORNL-DWG 83-8024

AREA (SQ MI) IN PJM REGION UNACCEPTABLE FOR NUCLEAR POWER PLANT SITES, CATEGORIZED BY STATE PORTIONS

CASE: 3

STATE	PORTION OF STATE IN PJM (SQ MI)	AREA OF STATE PORTION EXCLUDED	PERCENT OF STATE PORTION EXCLUDED	AREA EXCLUDED BY SECTOR CRITERIA (ORANGE)	AREA EXCLUDED BY RADIAL CRITERIA (BLUE)	AREA EXCLUDED BY BOTH CRITERIA (RED)
CONNECTICUT	4422.30	3344.90	75.64	16.80	699.69	2628.41
DELAWARE	2014.75	405.37	20.12	19.03	76.56	309.78
DISTRICT OF COLUMBIA	67.04	67.04	100.00	0.0	0.0	67.04
MARYLAND	9917.59	4264.93	43.00	258.17	176.70	3830.07
MASSACHUSETTS	3361.20	1055.29	31.40	166.58	139.01	749.69
NEW HAMPSHIRE	508.12	44.93	8.84	2.99	20.98	20.96
NEW JERSEY	7528.35	5525.16	73.39	80.06	548.59	4896.50
NEW YORK	26695.83	6850.09	25.66	1022.90	911.36	4915.84
OHIO	3256.73	974.40	29.92	73.91	134.64	765.85
PENNSYLVANIA	44720.32	11427.80	25.55	591.53	1787.55	9048.72
VERMONT	710.36	43.47	6.12	0.0	31.47	12.00
VIRGINIA	25733.84	3180.39	12.36	531.69	318.84	2329.86
WEST VIRGINIA	14717.08	689.69	4.69	52.20	199.58	437.91
TOTAL	143653.38	37873.45	26.36	2815.86	5044.97	30012.62

ORNL-DWG 83-8025

AREA (SQ MI) IN PJM REGION UNACCEPTABLE FOR NUCLEAR POWER PLANT SITES, CATEGORIZED BY STATE PORTIONS

CASE: 4

STATE	PORTION OF STATE IN PJM (SQ MI)	AREA OF STATE PORTION EXCLUDED	PERCENT OF STATE PORTION EXCLUDED	AREA EXCLUDED BY SECTOR CRITERIA (ORANGE)	AREA EXCLUDED BY RADIAL CRITERIA (BLUE)	AREA EXCLUDED BY BOTH CRITERIA (RED)
CONNECTICUT	4422.30	3451.93	78.06	938.75	32.25	2480.93
DELAWARE	2014.75	508.62	25.24	153.90	17.56	337.15
DISTRICT OF COLUMBIA	67.04	67.04	100.00	0.0	0.0	67.04
MARYLAND	9917.59	4599.00	46.37	1335.50	46.17	3217.33
MASSACHUSETTS	3361.20	1422.96	42.33	729.81	28.69	664.46
NEW HAMPSHIRE	508.12	79.37	15.62	37.43	4.50	37.44
NEW JERSEY	7528.35	5637.61	74.89	657.46	65.40	4914.75
NEW YORK	26695.83	8350.82	31.28	3564.45	155.01	4631.36
OHIO	3256.73	1225.46	37.63	554.99	10.83	659.65
PENNSYLVANIA	44720.32	13572.26	30.35	5075.50	242.94	8253.82
VERMONT	710.36	44.97	6.33	1.50	8.99	34.47
VIRGINIA	25733.84	4442.80	17.26	2262.27	76.12	2104.41
WEST VIRGINIA	14717.08	920.86	6.26	338.59	35.00	547.27
TOTAL	143653.38	44323.66	30.85	15650.15	723.46	27950.06

ORNL-DWG 83-8026

AREA (SQ MI) IN PJM REGION UNACCEPTABLE FOR NUCLEAR POWER PLANT SITES, CATEGORIZED BY STATE PORTIONS

CASE: 5

STATE	PORTION OF STATE IN PJM (SQ MI)	AREA OF STATE PORTION EXCLUDED	PERCENT OF STATE PORTION EXCLUDED	AREA EXCLUDED BY SECTOR CRITERIA (ORANGE)	AREA EXCLUDED BY RADIAL CRITERIA (BLUE)	AREA EXCLUDED BY BOTH CRITERIA (RED)
CONNECTICUT	4422.30	2779.12	62.84	265.92	242.36	2270.84
DELAWARE	2014.75	397.52	19.73	42.80	65.38	289.34
DISTRICT OF COLUMBIA	67.04	67.04	100.00	0.0	0.0	67.04
MARYLAND	9917.59	4147.32	41.82	883.82	120.88	3142.63
MASSACHUSETTS	3361.20	893.09	26.57	199.94	84.51	608.64
NEW HAMPSHIRE	508.12	49.43	9.73	7.48	14.99	26.95
NEW JERSEY	7528.35	5164.27	68.60	183.84	337.29	4643.14
NEW YORK	26695.83	6220.99	23.30	1433.97	544.33	4242.69
OHIO	3256.73	847.92	26.04	177.44	60.36	610.12
PENNSYLVANIA	44720.32	10409.67	23.28	1911.92	1067.77	7429.98
VERMONT	710.36	43.47	6.12	0.0	22.48	20.99
VIRGINIA	25733.84	2946.69	11.45	766.15	247.82	1932.71
WEST VIRGINIA	14717.08	677.14	4.60	94.87	123.53	458.75
TOTAL	143653.38	34643.64	24.12	5968.16	2931.69	25743.79

ORNL-DWG 83-8027

AREA (SQ MI) IN PJM REGION UNACCEPTABLE FOR NUCLEAR POWER PLANT SITES, CATEGORIZED BY STATE PORTIONS

CASE: 6

STATE	PORTION OF STATE IN PJM (SQ MI)	AREA OF STATE PORTION EXCLUDED	PERCENT OF STATE PORTION EXCLUDED	AREA EXCLUDED BY SECTOR CRITERIA (ORANGE)	AREA EXCLUDED BY RADIAL CRITERIA (BLUE)	AREA EXCLUDED BY BOTH CRITERIA (RED)
CONNECTICUT	4422.30	2537.70	57.38	24.50	628.27	1884.93
DELAWARE	2014.75	356.32	17.69	1.61	82.87	271.85
DISTRICT OF COLUMBIA	67.04	67.04	100.00	0.0	0.0	67.04
MARYLAND	9917.59	3783.58	38.15	520.07	214.80	3048.71
MASSACHUSETTS	3361.20	720.38	21.43	27.22	176.83	516.33
NEW HAMPSHIRE	508.12	44.93	8.84	2.99	20.98	20.96
NEW JERSEY	7528.35	5025.18	66.75	44.16	724.93	4256.09
NEW YORK	26695.83	5333.58	19.98	546.20	951.19	3836.19
OHIO	3256.73	712.07	21.86	41.58	164.04	506.44
PENNSYLVANIA	44720.32	9205.84	20.59	707.31	1966.68	6531.85
VERMONT	710.36	43.47	6.12	0.0	31.47	12.00
VIRGINIA	25733.84	2385.02	9.27	204.48	429.42	1751.12
WEST VIRGINIA	14717.08	613.90	4.17	31.63	237.38	344.90
TOTAL	143653.38	30829.00	21.46	2151.76	5628.84	23048.40

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ORNL-DWG 83-8028

AREA (SQ MI) IN CHICAGO REGION UNACCEPTABLE FOR' NUCLEAR POWER PLANT SITES, CATEGORIZED BY STATE PORTIONS

CASE: 1

STATE	PORTION OF STATE IN CHI (SQ MI)	AREA OF STATE PORTION EXCLUDED	PERCENT OF STATE PORTION EXCLUDED	AREA EXCLUDED BY SECTOR CRITERIA (ORANGE)	AREA EXCLUDED BY RADIAL CRITERIA (BLUE)	AREA EXCLUDED BY BOTH CRITERIA (RED)
ILLINOIS	41670.81	12314.71	29.55	6820.38	65.15	5429.18
INDIANA	26790.32	10509.41	39.23	6367.46	56.21	4085.74
IOWA	12528.54	2181.82	17.41	1597.18	13.62	571.02
KENTUCKY	178.39	178.39	100.00	4.78	0.0	173.61
MICHIGAN	36716.54	13543.34	36.89	7158.45	37.37	6347.54
MINNESOTA	1524.28	172.30	11.30	111.97	0.0	60.33
MISSOURI	4478.59	189.40	4.23	146.68	0.0	42.72
OHIO	26200.54	12139.25	46.33	6281.36	49.89	5808.02
WEST VIRGINIA	3.19	3.19	100.00	0.0	0.0	3.19
WISCONSIN	31751.79	7134.33	22.47	3881.43	54.96	3197.94
TOTAL	181842.69	58366.11	32.10	32369.66	277.18	25719.27

ORNL-DWG 83-8029

AREA (SQ MI) IN CHICAGO REGION UNACCEPTABLE FOR NUCLEAR POWER PLANT SITES, CATEGORIZED BY STATE PORTIONS

CASE: 2

STATE	PORTION OF STATE IN CHI (SQ MI)	AREA OF STATE PORTION EXCLUDED	PERCENT OF STATE PORTION EXCLUDED	AREA EXCLUDED BY SECTOR CRITERIA (ORANGE)	AREA EXCLUDED BY RADIAL CRITERIA (BLUE)	AREA EXCLUDED BY BOTH CRITERIA (RED)
ILLINOIS	41670.81	8507.63	20.42	3013.01	277.63	5216.99
INDIANA	26790.32	7472.20	27.89	3330.23	269.87	3872.10
IOWA	12528.54	1289.13	10.29	704.48	65.30	519.35
KENTUCKY	178.39	178.39	100.00	4.78	0.0	173.61
MICHIGAN	36716.54	9523.41	25.94	3138.39	214.40	6170.62
MINNESOTA	1524.28	113.33	7.43	53.00	0.0	60.33
MISSOURI	4478.59	88.47	1.98	45.75	1.59	41.13
OHIO	26200.54	9276.21	35.40	3418.06	277.49	5580.67
WEST VIRGINIA	3.19	3.19	100.00	0.0	1.59	1.59
WISCONSIN	31751.79	4884.45	15.38	1631.55	179.09	3073.81
TOTAL	181842.69	41336.37	22.73	15339.22	1286.96	24710.19

ORNL-DWG 83-8030

AREA (SQ MI) IN CHICAGO REGION UNACCEPTABLE FOR' NUCLEAR POWER PLANT SITES, CATEGORIZED BY STATE PORTIONS

CASE: 3

STATE	PORTION OF STATE IN CHI (SQ MI)	AREA OF STATE PORTION EXCLUDED	PERCENT OF STATE PORTION EXCLUDED	AREA EXCLUDED BY SECTOR CRITERIA (ORANGE)	AREA EXCLUDED BY RADIAL CRITERIA (BLUE)	AREA EXCLUDED BY BOTH CRITERIA (RED)
ILLINOIS	41670.81	6836.25	16.41	1341.30	567.46	4927.49
INDIANA	26790.32	5635.09	21.03	1493.13	525.63	3616.34
IOWA	12528.54	955.70	7.63	371.05	88.17	496.48
KENTUCKY	178.39	178.39	100.00	4.78	0.0	173.61
MICHIGAN	36716.54	7513.76	20.46	1128.10	640.60	5745.06
MINNESOTA	1524.28	67.70	4.44	7.37	1.47	58.86
MISSOURI	4478.59	47.44	1.06	4.72	4.77	37.95
OHIO	26200.54	7436.63	28.38	1578.14	565.49	5293.00
WEST VIRGINIA	3.19	3.19	100.00	0.0	3.19	0.0
WISCONSIN	31751.79	3945.39	12.43	692.48	322.10	2930.81
TOTAL	181842.69	32619.52	17.94	6621.06	2718.88	23279.58

ORNL-DWG 83-8031

AREA (SQ MI) IN CHICAGO REGION UNACCEPTABLE FOR' NUCLEAR POWER PLANT SITES, CATEGORIZED BY STATE PORTIONS

CASE: 4

STATE	PORTION OF STATE IN CHI (SQ MI)	AREA OF STATE PORTION EXCLUDED	PERCENT OF STATE PORTION EXCLUDED	AREA EXCLUDED BY SECTOR CRITERIA (ORANGE)	AREA EXCLUDED BY RADIAL CRITERIA (BLUE)	AREA EXCLUDED BY BOTH CRITERIA (RED)
ILLINOIS	41670.81	8794.63	21.10	4172.96	94.44	4527.23
INDIANA	26790.32	7688.49	28.70	4458.57	103.05	3126.87
IOWA	12528.54	1346.88	10.75	850.72	13.62	482.54
KENTUCKY	178.39	178.39	100.00	33.46	0.0	144.94
MICHIGAN	36716.54	9700.16	26.42	4765.38	65.87	4868.91
MINNESOTA	1524.28	117.74	7.72	60.37	0.0	57.38
MISSOURI	4478.59	91.63	2.05	52.05	0.0	39.58
OHIO	26200.54	9521.98	36.34	5227.70	62.32	4231.95
WEST VIRGINIA	3.19	3.19	100.00	0.0	0.0	3.19
WISCONSIN	31751.79	5080.51	16.00	2665.67	57.89	2356.95
TOTAL	181842.69	42523.58	23.38	22286.87	397.19	19839.52

ORNL-DWG 83-8032

AREA (SQ MI) IN CHICAGO REGION UNACCEPTABLE FOR' NUCLEAR POWER PLANT SITES, CATEGORIZED BY STATE PORTIONS

CASE: 5

STATE	PORTION OF STATE IN CHI (SQ MI)	AREA OF STATE PORTION EXCLUDED	PERCENT OF STATE PORTION EXCLUDED	AREA EXCLUDED BY SECTOR CRITERIA (ORANGE)	AREA EXCLUDED BY RADIAL CRITERIA (BLUE)	AREA EXCLUDED BY BOTH CRITERIA (RED)
ILLINOIS	41670.81	6288.09	15.09	1666.13	329.65	4292.30
INDIANA	26790.32	4969.86	18.55	1739.93	357.21	2872.72
IOWA	12528.54	882.44	7.04	386.27	65.30	430.87
KENTUCKY	178.39	178.39	100.00	33.46	0.0	144.94
MICHIGAN	36716.54	6798.12	18.52	1862.93	361.70	4573.49
MINNESOTA	1524.28	67.69	4.44	10.31	0.0	57.38
MISSOURI	4478.59	50.62	1.13	11.04	1.59	37.99
OHIO	26200.54	6643.57	25.36	2349.12	360.57	3933.89
WEST VIRGINIA	3.19	3.19	100.00	0.0	1.59	1.59
WISCONSIN	31751.79	3698.51	11.65	1283.66	211.56	2203.30
TOTAL	181842.69	29580.43	16.27	9342.83	1689.17	18548.44

ORNL-DWG 83-8033

AREA (SQ MI) IN CHICAGO REGION UNACCEPTABLE FOR' NUCLEAR POWER PLANT SITES, CATEGORIZED BY STATE PORTIONS

CASE: 6

STATE	PORTION OF STATE IN CHI (SQ MI)	AREA OF STATE PORTION EXCLUDED	PERCENT OF STATE PORTION EXCLUDED	AREA EXCLUDED BY SECTOR CRITERIA (ORANGE)	AREA EXCLUDED BY RADIAL CRITERIA (BLUE)	AREA EXCLUDED BY BOTH CRITERIA (RED)
ILLINOIS	41670.81	5174.13	12.42	551.98	590.81	4031.34
INDIANA	26790.32	3865.56	14.43	635.63	649.15	2580.79
IOWA	12528.54	609.14	4.86	112.98	95.81	400.35
KENTUCKY	178.39	170.42	95.53	25.49	0.0	144.94
MICHIGAN	36716.54	5488.70	14.95	552.96	737.35	4198.38
MINNESOTA	1524.28	60.33	3.96	2.95	2.94	54.44
MISSOURI	4478.59	42.72	0.95	3.14	4.77	34.81
OHIO	26200.54	5131.01	19.58	836.56	712.74	3581.71
WEST VIRGINIA	3.19	3.19	100.00	0.0	3.19	0.0
WISCONSIN	31751.79	2981.71	9.39	566.85	387.25	2027.60
TOTAL	181842.69	23526.90	12.94	3288.55	3184.01	17054.35

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ORNL-DWG 83-8034

AREA (SQ MI) IN WA-OR REGION UNACCEPTABLE FOR NUCLEAR POWER PLANT SITES, CATEGORIZED BY STATE PORTIONS

CASE: 1

STATE	PORTION OF STATE IN WAOR (SQ MI)	AREA OF STATE PORTION EXCLUDED	PERCENT OF STATE PORTION EXCLUDED	AREA EXCLUDED BY SECTOR CRITERIA (ORANGE)	AREA EXCLUDED BY RADIAL CRITERIA (BLUE)	AREA EXCLUDED BY BOTH CRITERIA (RED)
CALIFORNIA	3642.30	3.00	0.08	1.50	0.0	1.50
IDAHO	21608.91	1079.58	5.00	745.92	1.44	332.22
MONTANA	92.61	0.0	0.0	0.0	0.0	0.0
NEVADA	3452.05	0.0	0.0	0.0	0.0	0.0
OREGON	92151.63	5203.50	5.65	3102.35	59.08	2042.07
WASHINGTON	64123.66	7692.25	12.00	4388.07	21.64	3282.54
TOTAL	185071.13	13978.33	7.55	8237.84	82.16	5658.33

ORNL-DWG 83-8035

AREA (SQ MI) IN WA-OR REGION UNACCEPTABLE FOR NUCLEAR POWER PLANT SITES, CATEGORIZED BY STATE PORTIONS

CASE: 2

STATE	PORTION OF STATE IN WAOR (SQ MI)	AREA OF STATE PORTION EXCLUDED	PERCENT OF STATE PORTION EXCLUDED	AREA EXCLUDED BY SECTOR CRITERIA (ORANGE)	AREA EXCLUDED BY RADIAL CRITERIA (BLUE)	AREA EXCLUDED BY BOTH CRITERIA (RED)
CALIFORNIA	3642.30	1.50	0.04	0.0	0.0	1.50
IDAHO	21608.91	726.86	3.36	393.20	9.60	324.06
MONTANA	92.61	0.0	0.0	0.0	0.0	0.0
NEVADA	3452.05	0.0	0.0	0.0	0.0	0.0
OREGON	92151.63	3724.90	4.04	1623.74	159.82	1941.34
WASHINGTON	64123.66	5545.01	8.65	2240.82	127.79	3176.40
TOTAL	185071.13	9998.26	5.40	4257.76	297.21	5443.29

ORNL-DWG 83-8036

AREA (SQ MI) IN WA-OR REGION UNACCEPTABLE FOR NUCLEAR POWER PLANT SITES, CATEGORIZED BY STATE PORTIONS

CASE: 3

STATE	PORTION OF STATE IN WAOR (SQ MI)	AREA OF STATE PORTION EXCLUDED	PERCENT OF STATE PORTION EXCLUDED	AREA EXCLUDED BY SECTOR CRITERIA (ORANGE)	AREA EXCLUDED BY RADIAL CRITERIA (BLUE)	AREA EXCLUDED BY BOTH CRITERIA (RED)
CALIFORNIA	3642.30	1.50	0.04	0.0	1.50	0.0
IDAHO	21608.91	499.81	2.31	166.15	23.36	310.30
MONTANA	92.61	0.0	0.0	0.0	0.0	0.0
NEVADA	3452.05	0.0	0.0	0.0	0.0	0.0
OREGON	92151.63	2944.82	3.20	843.65	288.27	1812.90
WASHINGTON	64123.66	4264.83	6.65	960.63	313.64	2990.56
TOTAL	185071.13	7710.96	4.17	1970.43	626.77	5113.76

ORNL-DWG 83-8037

AREA (SQ MI) IN WA-OR REGION UNACCEPTABLE FOR NUCLEAR POWER PLANT SITES, CATEGORIZED BY STATE PORTIONS

CASE: 4

STATE	PORTION OF STATE IN WAOR (SQ MI)	AREA OF STATE PORTION EXCLUDED	PERCENT OF STATE PORTION EXCLUDED	AREA EXCLUDED BY SECTOR CRITERIA (ORANGE)	AREA EXCLUDED BY RADIAL CRITERIA (BLUE)	AREA EXCLUDED BY BOTH CRITERIA (RED)
CALIFORNIA	3642.30	3.00	0.08	1.50	0.0	1.50
IDAHO	21608.91	743.79	3.44	461.01	8.15	274.63
MONTANA	92.61	0.0	0.0	0.0	0.0	0.0
NEVADA	3452.05	0.0	0.0	0.0	0.0	0.0
OREGON	92151.63	3856.37	4.18	2247.23	72.14	1537.00
WASHINGTON	64123.66	5662.38	8.83	3171.50	41.94	2448.94
TOTAL	185071.13	10265.54	5.55	5881.25	122.24	4262.06

ORNL-DWG 83-8038

AREA (SQ MI) IN WA-OR REGION UNACCEPTABLE FOR NUCLEAR POWER PLANT SITES, CATEGORIZED BY STATE PORTIONS

CASE: 5

STATE	PORTION OF STATE IN WAOR (SQ MI)	AREA OF STATE PORTION EXCLUDED	PERCENT OF STATE PORTION EXCLUDED	AREA EXCLUDED BY SECTOR CRITERIA (ORANGE)	AREA EXCLUDED BY RADIAL CRITERIA (BLUE)	AREA EXCLUDED BY BOTH CRITERIA (RED)
CALIFORNIA	3642.30	1.50	0.04	0.0	0.0	1.50
IDAHO	21608.91	477.26	2.21	194.48	21.90	260.88
MONTANA	92.61	0.0	0.0	0.0	0.0	0.0
NEVADA	3452.05	0.0	0.0	0.0	0.0	0.0
OREGON	92151.63	2657.31	2.88	1048.16	188.82	1420.33
WASHINGTON	64123.66	3838.57	5.99	1347.67	209.12	2281.78
TOTAL	185071.13	6974.64	3.77	2590.32	419.84	3964.49

ORNL-DWG 83-8039

AREA (SQ MI) IN WA-OR REGION UNACCEPTABLE FOR NUCLEAR POWER
PLANT SITES, CATEGORIZED BY STATE PORTIONS

CASE: 6

STATE	PORTION OF STATE IN WAOR (SQ MI)	AREA OF STATE PORTION EXCLUDED	PERCENT OF STATE PORTION EXCLUDED	AREA EXCLUDED BY SECTOR CRITERIA (ORANGE)	AREA EXCLUDED BY RADIAL CRITERIA (BLUE)	AREA EXCLUDED BY BOTH CRITERIA (RED)
CALIFORNIA	3642.30	1.50	0.04	0.0	1.50	0.0
IDAHO	21608.91	356.90	1.65	74.13	34.32	248.46
MONTANA	92.61	0.0	0.0	0.0	0.0	0.0
NEVADA	3452.05	0.0	0.0	0.0	0.0	0.0
OREGON	92151.63	1870.60	2.03	261.44	358.78	1250.38
WASHINGTON	64123.66	2840.48	4.43	349.57	466.66	2024.24
TOTAL	185071.13	5069.48	2.74	685.14	861.26	3523.08

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APPENDIX B

LISTING OF ALL NUCLEAR SITES IN THE DATA BASE (SORTED BY PLANT NAME AND STATE)

COMMERCIAL NUCLEAR POWER REACTOR SITES
SORTED BY REACTOR NAME

STATE CODE	NAME	PRIMARY SITE	LATITUDE dd-mm-ss	LONGITUDE ddd-mm-ss	STATUS
TX	ALLENS CREEK	YES	29-40-43	96-06-15	Application for construction permit pending (docketed)
AR	ARKANSAS	YES	35-18-36	93-13-51	License in effect for operating reactors
IA	ARNOLD	YES	42-06-02	91-46-38	License in effect for operating reactors
WV	ARROYO (ERIE)		40-34-	80-39-	Alternate site
OH	ASHTABULA E (PERRY)		41-55-	80-44-	Alternate site
NY	ATHENS (PASNY)		42-16-	73-50-	Alternate site
NJ	ATLANTIC		39-28-20	74-15-20	Application withdrawn
MI	AU GRES		44-06-40	83-34-50	Hypothetical site
TX	BAFFIN BAY		27-12-00	97-32-00	Hypothetical site
IN	BAILLY	YES	41-38-30	87-07-30	Inactive construction permit application, cancellation announced
MD	BAINBRIDGE (MD)		39-36-45	76-05-35	Alternate site
AL	BARTON		32-45-00	86-24-00	Inactive construction permit application, cancellation announced
MA	BEAR SWAMP (NEP)		42-42-	72-53-	Alternate site
OH	BEAVER (ERIE)		41-25-30	82-15-30	Alternate site
OR	BEAVER (TRJN)		46-10-	123-11-	Alternate site
PA	BEAVER VALLEY	YES	40-37-19	80-26-02	License in effect for operating reactors
NY	BELL		42-36-30	76-37-55	Application withdrawn
AL	BELLEFONTE	YES	34-42-32	85-55-38	Construction permit in effect and operating license docketed
MD	BELVEDERE (DOUG)		38-14-	76-36-	Alternate site
PA	BIG BEND HILL (ERIE)		41-18-	80-21-	Alternate site
IN	BIG GRAHAM CR (MRBI)		38-56-53	85-33-05	Alternate site
MI	BIG ROCK POINT	YES	45-21-33	85-11-41	License in effect for operating reactors
OK	BLACK FOX	YES	36-07-01	95-32-54	Application for construction permit pending (docketed)
TX	BLUE HILLS		31-08-39	93-41-32	Inactive construction permit application, cancellation announced
OR	BOARDMAN		45-40-35	119-49-00	No application (not listed)
CA	BODEGA BAY		38-18-00	123-03-18	Application withdrawn
CA	BOLSA ISLAND		33-42-30	118-01-54	Application withdrawn
DE	BOWERS (SUMM)		39-03-	75-23-	Alternate site
OR	BRADWOOD (TRJN)		46-10-	123-27-	Alternate site
IL	BRAIDWOOD	YES	41-14-37	88-13-44	Construction permit in effect and operating license docketed
AL	BROWNS FERRY	YES	34-42-15	87-07-07	License in effect for operating reactors
NC	BRUNSWICK	YES	33-57-30	78-00-38	License in effect for operating reactors
PA	BUCKINGHAM MT (LIM)		40-19-	75-01-	Alternate site
NJ	BURLINGTON		40-04-36	74-52-47	No application (not listed)
IL	BYRON	YES	42-04-30	89-16-55	Construction permit in effect and operating license docketed
MO	CALLAWAY	YES	38-45-40	91-46-54	Construction permit in effect and operating license docketed
MD	CALVERT CLIFFS	YES	38-26-05	76-26-31	License in effect for operating reactors
MD	CANAL (FULT)		39-32-	75-49-	Alternate site
IL	CARROLL COUNTY		42-02-01	90-03-46	No application (not listed)
MD	CARROLL POND (DOUG)		38-12-	76-23-	Alternate site
SC	CATAWBA	YES	35-03-05	81-04-10	Construction permit in effect and operating license docketed
WA	CENTERVILLE (SKGT)		45-42-	121-04-	Alternate site

STATE CODE	NAME	PRIMARY SITE	LATITUDE dd-mm-ss	LONGITUDE ddd-mm-ss	STATUS
SC	CHEROKEE	YES	35-02-12	81-30-43	Construction permit in effect
PA	CHESTER CO (FULT)		39-56-	75-51-	Alternate site
MD	CHURCH CR (MMFS)		38-30-25	76-08-05	Alternate site
MD	CLAIBORNE (SUMM)		38-49-	76-18-	Alternate site
OH	CLARINGTON		39-43-10	80-50-40	Hypothetical site
TN	CLINCH RIVER BREEDER		35-53-24	84-22-57	Application for construction permit pending (docketed)
IL	CLINTON	YES	40-10-19	88-50-03	Construction permit in effect and operating license docketed
OH	COAL RUN (ERIE)		39-33-30	81-35-30	Alternate site
TX	COMANCHE PEAK	YES	32-17-52	97-47-06	Construction permit in effect and operating license docketed
OH	CONESVILLE (ERIE)		40-11-	81-53-	Alternate site
MI	COOK	YES	41-58-34	86-33-59	License in effect for operating reactors
NE	COOPER	YES	40-21-43	95-38-28	License in effect for operating reactors
MD	CORSICA (SUMM)		39-04-	76-09-	Alternate site
FL	CRYSTAL RIVER	YES	28-57-26	82-41-56	License in effect for operating reactors
WA	CUSIC (SKGT)		48-22-	117-18-	Alternate site
SC	CVTR		34-15-43	81-19-45	License terminated
OH	DAVIS-BESSE	YES	41-35-50	83-05-11	License in effect for operating reactors
MD	DEEP BR (MMFS)		38-18-05	75-49-15	Alternate site
OR	DEER IS (TRJN)		45-56-	122-50-	Alternate site
MD	DENTON (SUMM)		38-56-	75-48-	Alternate site
CA	DIABLO CANYON	YES	35-12-42	120-51-16	Construction permit in effect and operating license docketed
MD	DOUGLAS POINT		38-26-44	77-15-24	Inactive construction permit application, cancellation announced
IL	DRESDEN	YES	41-23-23	88-16-16	License in effect for operating reactors
NY	EASTON		42-59-42	73-36-36	Application withdrawn
IN	EGYPT BOTTOM (MRBL)		38-47-40	84-49-50	Alternate site
MN	ELK RIVER		45-17-18	93-33-06	License terminated
NJ	ELSINBORO (FULT)		39-33-	75-31-	Alternate site
WA	ELTOPIA (SKGT)		46-29-	119-12-	Alternate site
OH	ERIE		41-20-44	82-28-49	Application withdrawn
MD	FAIRLEE (MMFS)		39-13-25	76-13-10	Alternate site
AL	FARLEY	YES	31-13-22	85-06-45	License in effect for operating reactors
MI	FERMI	YES	41-57-48	83-15-31	Construction permit in effect and operating license docketed
NY	FITZPATRICK	YES	43-31-26	76-23-54	License in effect for operating reactors
NJ	FORKED RIVER	YES	39-48-36	74-12-36	Inactive construction permit application, cancellation announced
NE	FORT CALHOUN	YES	41-31-15	96-04-36	License in effect for operating reactors
CO	FORT ST VRAIN	YES	40-14-41	104-52-28	License in effect for operating reactors
PA	FULTON		39-45-50	76-14-15	Application withdrawn
OH	GENEVA (ERIE)		41-50-	80-58-	Alternate site
NY	GINNA	YES	43-16-40	77-18-32	License in effect for operating reactors
PA	GPU/AI		42-00-15	76-00-15	No application (not listed)
MS	GRAND GULF	YES	32-00-27	91-02-53	Construction permit in effect and operating license docketed
NY	GREENE COUNTY		42-09-00	73-54-41	Application withdrawn

STATE CODE	NAME	PRIMARY SITE	LATITUDE dd-mm-ss	LONGITUDE ddd-mm-ss	STATUS
MI	GREENWOOD		43-05-31	82-41-40	Inactive construction permit application, cancellation announced
CT	HADDAM NECK	YES	41-28-55	72-29-57	License in effect for operating reactors
NE	HALLAM		40-33-18	96-47-12	License terminated
WA	HANFORD (CRBR)		46-26-00	119-23-00	Alternate site
WA	HANFORD 22/1 (SKGT)		46-34-	119-27-	Alternate site
WA	HANFORD 22/2 (SKGT)		46-37-	119-36-	Alternate site
WA	HANFORD 23 (SKGT)		46-38-	119-20-	Alternate site
NC	HARRIS	YES	35-38-00	78-57-22	Construction permit in effect and operating license docketed
TN	HARTSVILLE	YES	36-21-15	86-05-10	Construction permit in effect
GA	HATCH	YES	31-56-03	82-20-40	License in effect for operating reactors
WI	HAVEN		43-50-54	87-43-47	Inactive construction permit application, cancellation announced
NJ	HOPE CREEK	YES	39-28-04	75-32-17	Construction permit in effect
CA	HUMBOLDT BAY		40-44-28	124-12-33	License in effect for operating reactors
CA	HUNTER LIGGETT		35-43-50	121-17-10	Hypothetical site
OH	HURON (ERIE)		41-22-	82-32-	Alternate site
ID	IDAHO FALLS (CRBR)		43-40-00	112-30-00	Alternate site
NY	INDIAN POINT	YES	41-16-17	73-57-09	License in effect for operating reactors
NY	JAMESPORT		40-59-24	72-35-39	Application withdrawn
WA	JOHNSON CR (SKGT)		46-02-	122-41-	Alternate site
WI	KEWAUNEE	YES	44-20-35	87-32-10	License in effect for operating reactors
WI	KOSHKONONG		42-51-29	88-53-19	No application (not listed)
WI	LA CROSSE	YES	43-33-30	91-13-50	License in effect for operating reactors
IL	LA SALLE	YES	41-14-38	88-40-15	Construction permit in effect and operating license docketed
UT	LAKE POWELL		37-50-50	110-16-20	Hypothetical site
NH	LAMPREY POND (SEAB)		42-57-	70-49-	Alternate site
PA	LIMERICK	YES	40-13-12	75-35-24	Construction permit in effect and operating license docketed
NH	LITCHFIELD (SEAB)		42-52-	71-28-	Alternate site
NY	LIVINGSTON (GCNP)		42-07-	73-47-	Alternate site
NY	LLOYD (GCNP)		41-46-	73-59-	Alternate site
PA	LOCK HAVEN		41-05-00	77-34-30	Hypothetical site
WA	LYONS RD (SKGT)		45-58-	122-45-	Alternate site
WA	MAGALLON (SKGT)		46-33-	118-23-	Alternate site
ME	MAINE YANKEE	YES	43-57-02	69-41-46	License in effect for operating reactors
CA	MALIBU		34-02-06	118-44-30	Application withdrawn
IN	MARBLE HILL	YES	38-36-00	85-26-53	Construction permit in effect
OH	MARBLEHEAD (ERIE)		41-31-	82-47-30	Alternate site
PA	MARTINS CR (SUSQ)		40-47-	75-09-	Alternate site
OR	MAYGER (TRJN)		46-09-	123-05-	Alternate site
PA	MC ELHATTAN (SUSQ)		41-09-	77-26-	Alternate site
NC	MCGUIRE	YES	35-25-56	80-56-54	License in effect for operating reactors
CA	MENDOCINO		38-55-25	123-43-05	Application withdrawn
IN	MEXICO BOTTOM (MRBL)		38-52-21	84-47-45	Alternate site
MI	MIDLAND	YES	43-35-10	84-13-23	Construction permit in effect and operating license docketed

STATE CODE	NAME	PRIMARY SITE	LATITUDE dd-mm-ss	LONGITUDE ddd-mm-ss	STATUS
NY	MILLIKEN (NYSEG)		42-36-	76-38-	Alternate site
CT	MILLSTONE	YES	41-18-31	72-10-05	License in effect for operating reactors
MO	MOILIA		40-15-20	91-30-00	Hypothetical site
MA	MONTAGUE		42-34-34	72-31-36	Inactive construction permit application, cancellation announced
MN	MONTICELLO	YES	45-20-00	93-50-54	License in effect for operating reactors
KY	MOOLEYVILLE		38-01-10	86-30-40	Hypothetical site
NH	MOORE POND (SEAB)		44-20-	71-49-	Alternate site
NY	MORRISON (NYSEG)		43-22-	78-20-	Alternate site
OH	NASHPORT (ERIE)		40-05-30	82-11-	Alternate site
CA	NEEDLES		34-20-40	114-11-30	Hypothetical site
OH	NEVADA (ERIE)		40-47-	83-09-	Alternate site
RI	NEW ENGLAND		41-21-46	71-39-38	Application withdrawn
NY	NEW HAVEN		43-29-01	76-17-43	Application withdrawn
NJ	NEWBOLD ISLAND		40-07-45	74-45-20	No application (not listed)
NY	NINE MILE POINT	YES	43-31-20	76-24-36	License in effect for operating reactors
VA	NORTH ANNA	YES	38-03-39	77-47-26	License in effect for operating reactors
OH	NORTH PERRY (ERIE)		41-48-	81-08-	Alternate site
SC	OCONEE	YES	34-47-30	82-53-55	License in effect for operating reactors
DE	ODESSA (SUMM)		39-27-	75-37-	Alternate site
NJ	OYSTER CREEK	YES	39-48-51	74-12-23	License in effect for operating reactors
MI	PALISADES	YES	42-19-20	86-18-55	License in effect for operating reactors
AZ	PALO VERDE	YES	33-23-23	112-51-43	Construction permit in effect and operating license docketed
SD	PATHFINDER		43-35-54	96-37-48	License terminated
PA	PEACH BOTTOM	YES	39-45-32	76-16-09	License in effect for operating reactors
OR	PEBBLE SPR S (SKGT)		45-40-	120-11-	Alternate site
OR	PEBBLE SPRINGS	YES	45-42-05	120-08-17	Application for construction permit pending (docketed)
NC	PERKINS	YES	35-50-53	80-27-10	Application for construction permit pending (docketed)
OH	PERRY	YES	41-48-04	81-08-36	Construction permit in effect and operating license docketed
PA	PERRY BLUFF (ERIE)		41-58-30	80-29-	Alternate site
MD	PERRYMAN		39-26-15	76-13-30	Application withdrawn
ME	PHILLIPS COVE (SEAB)		43-12-	70-36-	Alternate site
TN	PHIPPS BEND	YES	36-27-47	82-48-32	Construction permit in effect
MA	PILGRIM	YES	41-56-40	70-34-46	License in effect for operating reactors
PA	PINE FORGE (LIM)		40-18-	75-43-	Alternate site
OH	PIQUA		40-08-54	84-14-30	License terminated
WI	POINT BEACH	YES	44-16-51	87-32-10	License in effect for operating reactors
MN	PRAIRIE ISLAND	YES	44-37-19	92-37-59	License in effect for operating reactors
IL	QUAD-CITIES	YES	41-43-34	90-18-36	License in effect for operating reactors
MI	QUANICASSE		43-35-44	83-42-53	Application withdrawn
NY	QUARRY (PASNY)		41-38-	73-56-	Alternate site
CA	RANCHO SECO	YES	38-20-40	121-07-12	License in effect for operating reactors
NY	RAVENSWOOD		40-45-48	73-56-30	Application withdrawn
OH	RAYLAND (PERRY)		40-11-	80-41-	Alternate site
NY	RED HOOK (CONED)		42-03-	73-49-	Alternate site

STATE CODE	NAME	PRIMARY SITE	LATITUDE dd-mm-ss	LONGITUDE ddd-mm-ss	STATUS
DE	RED LION (SUMM)		39-37-	75-37-	Alternate site
LA	RIVER BEND	YES	30-45-26	91-19-54	Construction permit in effect and operating license docketed
SC	ROBINSON	YES	34-24-09	80-09-31	License in effect for operating reactors
WA	ROCK CREEK (SKGT)		45-44-	120-23-	Alternate site
RI	ROME POINT		41-32-30	71-24-30	No application (not listed)
NJ	SALEM	YES	39-27-46	75-32-09	License in effect for operating reactors
CA	SAN JOAQUIN		35-39-35	119-29-25	No application (not listed)
CA	SAN ONOFRE	YES	33-22-13	117-33-25	License in effect for operating reactors
SC	SAVANNAH R (CRER)		33-19-00	81-32-00	Alternate site
WA	SCOTIA (SKGT)		48-03-	117-03-	Alternate site
NH	SEABROOK	YES	42-53-53	70-51-05	Construction permit in effect and operating license docketed
ME	SEARS ISLAND		44-26-10	68-52-23	No application (not listed)
TN	SEQUOYAH	YES	35-13-24	85-05-16	License in effect for operating reactors
NH	SHELBURNE (SEAB)		44-25-	71-03-	Alternate site
MI	SHELBY		43-37-50	86-30-20	Hypothetical site
NY	SHERIDAN (NMPC)		42-30-	79-15-	Alternate site
PA	SHIPPINGPORT		40-37-18	80-26-02	Operating, NRC liscense not required
NY	SHOREHAM	YES	40-57-30	72-52-00	Construction permit in effect and operating license docketed
IN	SITE B (MRBL)		38-31-32	85-31-02	Alternate site
MA	SITE 1 (PILG)		42-41-	71-32-	Alternate site
MA	SITE 18 (PILG)		41-51-	70-33-	Alternate site
MA	SITE 19 (PILG)		41-43-	70-40-	Alternate site
MA	SITE 2 (PILG)		42-41-	71-25-	Alternate site
MA	SITE 20 (PILG)		41-43-	70-44-	Alternate site
WA	SKAGIT	YES	48-32-00	122-07-26	No application (not listed)
WA	SKAGIT/HANFORD		46-29-15	119-25-57	Application for construction permit pending (docketed)
NY	SOMERSET (NYSEG)		43-22-	78-34-	Alternate site
TX	SOUTH TEXAS	YES	28-47-42	96-02-53	Construction permit in effect and operating license docketed
PA	SPRINGFIELD N (ERIE)		41-59-	80-27-	Alternate site
NY	ST LAWRENCE		44-30-00	75-30-00	No application (not listed)
FL	ST LUCIE	YES	27-20-55	80-14-47	License in effect for operating reactors
NY	STERLING		43-23-11	76-39-01	Application withdrawn
OH	STOCKPORT N (ERIE)		39-34-	81-47-	Alternate site
NY	STUYVESANT (NYSEG)		42-27-	73-46-	Alternate site
SC	SUMMER	YES	34-17-45	81-19-13	Construction permit in effect and operating license docketed
DE	SUMMIT		39-31-21	75-41-11	Inactive construction permit application, cancellation announced
PA	SUNBURY (SUSQ)		40-51-	76-50-	Alternate site
CA	SUNDESERT		33-27-07	114-47-00	Inactive construction permit application, cancellation announced
VA	SURRY	YES	37-09-56	76-41-54	License in effect for operating reactors
PA	SUSQUEHANNA	YES	41-05-30	76-08-55	Construction permit in effect and operating license docketed
OH	SYMMES CR (ERIE)		40-05-	82-00-	Alternate site
TX	TEXARKOMA		33-45-00	94-53-00	Hypothetical site
PA	THREE MILE ISLAND	YES	40-09-11	76-43-30	License in effect for operating reactors

STATE CODE	NAME	PRIMARY SITE	LATITUDE dd-mm-ss	LONGITUDE ddd-mm-ss	STATUS
MD	TILGHMAN NECK (MMFS)		39-00-50	76-08-40	Alternate site
PA	TIONESTA		41-30-50	79-26-10	Hypothetical site
PA	TOHICON (FULT)		40-26-	75-04-	Alternate site
PA	TOWANDA		41-48-50	76-29-40	Hypothetical site
OR	TROJAN	YES	46-02-27	122-53-04	License in effect for operating reactors
WA	TUCANNON (SKGT)		46-33-	118-05-	Alternate site
FL	TURKEY POINT	YES	25-26-06	80-19-53	License in effect for operating reactors
OH	TURTLE CREEK (ERIE)		41-36-	83-14-	Alternate site
WI	TYRONE		44-41-50	91-49-56	Inactive construction permit application, cancellation announced
FL	VENICE		26-51-00	82-10-50	Hypothetical site
OH	VERMILION (ERIE)		41-25-30	82-20-	Alternate site
VT	VERMONT YANKEE	YES	42-46-49	72-30-57	License in effect for operating reactors
NY	VERPLANCK		41-15-40	73-57-49	Application withdrawn
CA	VIDAL		34-10-25	114-27-46	No application (not listed)
MD	VIENNA (SUMM)		38-29-	75-48-	Alternate site
GA	VOGTLE	YES	33-08-31	81-45-53	Construction permit in effect
OH	WAKATOMIKA (ERIE)		40-08-	82-03-	Alternate site
OH	WARRENTON (PERRY)		40-12-	80-40-	Alternate site
OR	WARRENTON (TRJN)		46-08-	123-55-	Alternate site
PA	WASHINGTON CR (LIM)		40-18-	74-54-	Alternate site
LA	WATERFORD	YES	29-59-42	90-28-16	Construction permit in effect and operating license docketed
TN	WATTS BAR	YES	35-36-10	84-47-25	Construction permit in effect and operating license docketed
RI	WESTERLY (NEP)		41-21-	71-44-	Alternate site
NY	WESTPORT		44-09-00	73-25-00	Hypothetical site
KS	WOLF CREEK	YES	38-14-20	95-41-20	Construction permit in effect and operating license docketed
WI	WOOD		42-38-36	89-46-32	No application (not listed)
WA	WPPSS 14	YES	46-28-03	119-18-51	Construction permit in effect
WA	WPPSS 2		46-28-17	119-19-59	Construction permit in effect and operating license docketed
WA	WPPSS 35	YES	46-57-11	123-28-11	Construction permit in effect
MA	YANKEE-ROWE	YES	42-43-41	72-55-44	License in effect for operating reactors
MS	YELICW CREEK	YES	34-57-24	88-12-57	Construction permit in effect
OH	ZIMMER	YES	38-51-57	84-13-44	Construction permit in effect and operating license docketed
IL	ZION	YES	42-26-44	87-48-08	License in effect for operating reactors
OH	ZOARVILLE (ERIE)		40-35-	81-24-	Alternate site

COMMERCIAL NUCLEAR POWER REACTOR SITES
GROUPED BY STATE

NAME	PRIMARY SITE	LATITUDE dd-mm-ss	LONGITUDE ddd-mm-ss	STATUS
ALABAMA				
BARTON		32-45-00	86-24-00	Inactive construction permit application, cancellation announced
BELLEFONTE	YES	34-42-32	85-55-38	Construction permit in effect and operating license docketed
BROWNS FERRY	YES	34-42-15	87-07-07	License in effect for operating reactors
FARLEY	YES	31-13-22	85-06-45	License in effect for operating reactors
ARIZONA				
PALO VERDE	YES	33-23-23	112-51-43	Construction permit in effect and operating license docketed
ARKANSAS				
ARKANSAS	YES	35-18-36	93-13-51	License in effect for operating reactors
CALIFORNIA				
BODEGA BAY		38-18-00	123-03-18	Application withdrawn
BOLSA ISLAND		33-42-30	118-01-54	Application withdrawn
DIABLO CANYON	YES	35-12-42	120-51-16	Construction permit in effect and operating license docketed
HUMBOLDT BAY		40-44-28	124-12-33	License in effect for operating reactors
HUNTER LIGGETT		35-43-50	121-17-10	Hypothetical site
MALIBU		34-02-06	118-44-30	Application withdrawn
MENDOCINO		38-55-25	123-43-05	Application withdrawn
NEEDLES		34-20-40	114-11-30	Hypothetical site
RANCHO SECO	YES	38-20-40	121-07-12	License in effect for operating reactors
SAN JOAQUIN		35-39-35	119-29-25	No application (not listed)
SAN ONOFRE	YES	33-22-13	117-33-25	License in effect for operating reactors
SUNDESERT		33-27-07	114-47-00	Inactive construction permit application, cancellation announced
VIDAL		34-10-25	114-27-46	No application (not listed)
COLORADO				
FORT ST VRAIN	YES	40-14-41	104-52-28	License in effect for operating reactors

COMMERCIAL NUCLEAR POWER REACTOR SITES
GROUPED BY STATE

NAME	PRIMARY SITE	LATITUDE dd-mm-ss	LONGITUDE ddd-mm-ss	STATUS
CONNECTICUT				
HADDAM NECK	YES	41-28-55	72-29-57	License in effect for operating reactors
MILLSTONE	YES	41-18-31	72-10-05	License in effect for operating reactors
DELAWARE				
BOWERS (SUMM)		39-03-	75-23-	Alternate site
ODESSA (SUMM)		39-27-	75-37-	Alternate site
RED LION (SUMM)		39-37-	75-37-	Alternate site
SUMMIT		39-31-21	75-41-11	Inactive construction permit application, cancellation announced
FLORIDA				
CRYSTAL RIVER	YES	28-57-26	82-41-56	License in effect for operating reactors
ST LUCIE	YES	27-20-55	80-14-47	License in effect for operating reactors
TURKEY POINT	YES	25-26-06	80-19-53	License in effect for operating reactors
VENICE		26-51-00	82-10-50	Hypothetical site
GEORGIA				
HATCH	YES	31-56-03	82-20-40	License in effect for operating reactors
VOGTLE	YES	33-08-31	81-45-53	Construction permit in effect
IDAHO				
IDAHO FALLS (CRBR)		43-40-00	112-30-00	Alternate site
ILLINOIS				
BRAIDWOOD	YES	41-14-37	88-13-44	Construction permit in effect and operating license docketed
BYRON	YES	42-04-30	89-16-55	Construction permit in effect and operating license docketed
CARROLL COUNTY		42-02-01	90-03-46	No application (not listed)
CLINTON	YES	40-10-19	88-50-03	Construction permit in effect and operating license docketed
DRESDEN	YES	41-23-23	88-16-16	License in effect for operating reactors
LA SALLE	YES	41-14-38	88-40-15	Construction permit in effect and operating license docketed
QUAD-CITIES	YES	41-43-34	90-18-36	License in effect for operating reactors
ZION	YES	42-26-44	87-48-08	License in effect for operating reactors

NAME	PRIMARY SITE	LATITUDE dd-mm-ss	LONGITUDE ddd-mm-ss	STATUS
INDIANA				
BAILLY	YES	41-38-30	87-07-30	Inactive construction permit application, cancellation announced
BIG GRAHAM CR (MRBL)		38-56-53	85-33-05	Alternate site
EGYPT BOTTOM (MRBL)		38-47-40	84-49-50	Alternate site
MARBLE HILL	YES	38-36-00	85-26-53	Construction permit in effect
MEXICO BOTTOM (MRBL)		38-52-21	84-47-45	Alternate site
SITE B (MRBL)		38-31-32	85-31-02	Alternate site
IOWA				
ARNOLD	YES	42-06-02	91-46-38	License in effect for operating reactors
KANSAS				
WOLF CREEK	YES	38-14-20	95-41-20	Construction permit in effect and operating license docketed
KENTUCKY				
MOOLEYVILLE		38-01-10	86-30-40	Hypothetical site
LOUISIANA				
RIVER BEND	YES	30-45-26	91-19-54	Construction permit in effect and operating license docketed
WATERFORD	YES	29-59-42	90-28-16	Construction permit in effect and operating license docketed
MAINE				
MAINE YANKEE	YES	43-57-02	69-41-46	License in effect for operating reactors
PHILLIPS COVE (SEAB)		43-12-	70-36-	Alternate site
SEARS ISLAND		44-26-10	68-52-23	No application (not listed)
MARYLAND				
BAINBRIDGE (MD)		39-36-45	76-05-35	Alternate site
BELVEDERE (DOUG)		38-14-	76-36-	Alternate site

NAME	PRIMARY SITE	LATITUDE dd-mm-ss	LONGITUDE ddd-mm-ss	STATUS
CALVERT CLIFFS	YES	38-26-05	76-26-31	License in effect for operating reactors
CANAL (FULT)		39-32-	75-49-	Alternate site
CARROLL POND (DOUG)		38-12-	76-23-	Alternate site
CHURCH CR (MMFS)		38-30-25	76-08-05	Alternate site
CLAIBORNE (SUMM)		38-49-	76-18-	Alternate site
CORSICA (SUMM)		39-04-	76-09-	Alternate site
DEEP BR (MMFS)		38-18-05	75-49-15	Alternate site
DENTON (SUMM)		38-56-	75-48-	Alternate site
DOUGLAS POINT		38-26-44	77-15-24	Inactive construction permit application, cancellation announced
FAIRLEE (MMFS)		39-13-25	76-13-10	Alternate site
PERRYMAN		39-26-15	76-13-30	Application withdrawn
TILGHMAN NECK (MMFS)		39-00-50	76-08-40	Alternate site
VIENNA (SUMM)		38-29-	75-48-	Alternate site
MASSACHUSETTS				
BEAR SWAMP (NEP)		42-42-	72-53-	Alternate site
MONTAGUE		42-34-34	72-31-36	Inactive construction permit application, cancellation announced
PILGRIM	YES	41-56-40	70-34-46	License in effect for operating reactors
SITE 1 (PILG)		42-41-	71-32-	Alternate site
SITE 18 (PILG)		41-51-	70-33-	Alternate site
SITE 19 (PILG)		41-43-	70-40-	Alternate site
SITE 2 (PILG)		42-41-	71-25-	Alternate site
SITE 20 (PILG)		41-43-	70-44-	Alternate site
YANKEE-ROWE	YES	42-43-41	72-55-44	License in effect for operating reactors
MICHIGAN				
AU GRES		44-06-40	83-34-50	Hypothetical site
BIG ROCK POINT	YES	45-21-33	85-11-41	License in effect for operating reactors
COOK	YES	41-58-34	86-33-59	License in effect for operating reactors
FERMI	YES	41-57-48	83-15-31	Construction permit in effect and operating license docketed
GREENWOOD		43-05-31	82-41-40	Inactive construction permit application, cancellation announced
MIDLAND	YES	43-35-10	84-13-23	Construction permit in effect and operating license docketed
PALISADES	YES	42-19-20	86-18-55	License in effect for operating reactors
QUANICASSE		43-35-44	83-42-53	Application withdrawn
SHELBY		43-37-50	86-30-20	Hypothetical site

NAME	PRIMARY SITE	LATITUDE dd-mm-ss	LONGITUDE ddd-mm-ss	STATUS
MINNESOTA				
ELK RIVER		45-17-18	93-33-06	License terminated
MONTICELLO	YES	45-20-00	93-50-54	License in effect for operating reactors
PRAIRIE ISLAND	YES	44-37-19	92-37-59	License in effect for operating reactors
MISSISSIPPI				
GRAND GULF	YES	32-00-27	91-02-53	Construction permit in effect and operating license docketed
YELLOW CREEK	YES	34-57-24	88-12-57	Construction permit in effect
MISSOURI				
CALLAWAY	YES	38-45-40	91-46-54	Construction permit in effect and operating license docketed
MOILIA		40-15-20	91-30-00	Hypothetical site
NEBRASKA				
COOPER	YES	40-21-43	95-38-28	License in effect for operating reactors
FORT CALHOUN	YES	41-31-15	96-04-36	License in effect for operating reactors
HALLAM		40-33-18	96-47-12	License terminated
NEW HAMPSHIRE				
LAMPREY POND (SEAB)		42-57-	70-49-	Alternate site
LITCHFIELD (SEAB)		42-52-	71-28-	Alternate site
MOORE POND (SEAB)		44-20-	71-49-	Alternate site
SEABROOK	YES	42-53-53	70-51-05	Construction permit in effect and operating license docketed
SHELBURNE (SEAB)		44-25-	71-03-	Alternate site
NEW JERSEY				
ATLANTIC		39-28-20	74-15-20	Application withdrawn
BURLINGTON		40-04-36	74-52-47	No application (not listed)
ELSINBORO (FULT)		39-33-	75-31-	Alternate site
FORKED RIVER	YES	39-48-36	74-12-36	Inactive construction permit application, cancellation announced
HOPE CREEK	YES	39-28-04	75-32-17	Construction permit in effect
NEWBOLD ISLAND		40-07-45	74-45-20	No application (not listed)

NAME	PRIMARY SITE	LATITUDE dd-mm-ss	LONGITUDE ddd-mm-ss	STATUS
OYSTER CREEK	YES	39-48-51	74-12-23	License in effect for operating reactors
SALEM	YES	39-27-46	75-32-09	License in effect for operating reactors
NEW YORK				
ATHENS (PASNY)		42-16-	73-50-	Alternate site
BELL		42-36-30	76-37-55	Application withdrawn
EASTON		42-59-42	73-36-36	Application withdrawn
FITZPATRICK	YES	43-31-26	76-23-54	License in effect for operating reactors
GINNA	YES	43-16-40	77-18-32	License in effect for operating reactors
GREENE COUNTY		42-09-00	73-54-41	Application withdrawn
INDIAN POINT	YES	41-16-17	73-57-09	License in effect for operating reactors
JAMESPORT		40-59-24	72-35-39	Application withdrawn
LIVINGSTON (GCNP)		42-07-	73-47-	Alternate site
LLOYD (GCNP)		41-46-	73-59-	Alternate site
MILLIKEN (NYSEG)		42-36-	76-38-	Alternate site
MORRISON (NYSEG)		43-22-	78-20-	Alternate site
NEW HAVEN		43-29-01	76-17-43	Application withdrawn
NINE MILE POINT	YES	43-31-20	76-24-36	License in effect for operating reactors
QUARRY (PASNY)		41-38-	73-56-	Alternate site
RAVENSWOOD		40-45-48	73-56-30	Application withdrawn
RED HOOK (CONED)		42-03-	73-49-	Alternate site
SHERIDAN (NMPC)		42-30-	79-15-	Alternate site
SHOREHAM	YES	40-57-30	72-52-00	Construction permit in effect and operating license docketed
SOMERSET (NYSEG)		43-22-	78-34-	Alternate site
ST LAWRENCE		44-30-00	75-30-00	No application (not listed)
STERLING		43-23-11	76-39-01	Application withdrawn
STUYVESANT (NYSEG)		42-27-	73-46-	Alternate site
VERPLANCK		41-15-40	73-57-49	Application withdrawn
WESTPORT		44-09-00	73-25-00	Hypothetical site
NORTH CAROLINA				
BRUNSWICK	YES	33-57-30	78-00-38	License in effect for operating reactors
HARRIS	YES	35-38-00	78-57-22	Construction permit in effect and operating license docketed
MCGUIRE	YES	35-25-56	80-56-54	License in effect for operating reactors
PERKINS	YES	35-50-53	80-27-10	Application for construction permit pending (docketed)
OHIO				
ASHTABULA E (PERRY)		41-55-	80-44-	Alternate site
BEAVER (ERIE)		41-25-30	82-15-30	Alternate site

NAME	PRIMARY SITE	LATITUDE dd-mm-ss	LONGITUDE ddd-mm-ss	STATUS
CLARINGTON		39-43-10	80-50-40	Hypothetical site
COAL RUN (ERIE)		39-33-30	81-35-30	Alternate site
CONESVILLE (ERIE)		40-11-	81-53-	Alternate site
DAVIS-BESSE	YES	41-35-50	83-05-11	License in effect for operating reactors
ERIE		41-20-44	82-28-49	Application withdrawn
GENEVA (ERIE)		41-50-	80-58-	Alternate site
HURON (ERIE)		41-22-	82-32-	Alternate site
MARBLEHEAD (ERIE)		41-31-	82-47-30	Alternate site
NASHPORT (ERIE)		40-05-30	82-11-	Alternate site
NEVADA (ERIE)		40-47-	83-09-	Alternate site
NORTH PERRY (ERIE)		41-48-	81-08-	Alternate site
PERRY	YES	41-48-04	81-08-36	Construction permit in effect and operating license docketed
PICQUA		40-08-54	84-14-30	License terminated
RAYLAND (PERRY)		40-11-	80-41-	Alternate site
STOCKPORT N (ERIE)		39-34-	81-47-	Alternate site
SYMMES CR (ERIE)		40-05-	82-00-	Alternate site
TURTLE CREEK (ERIE)		41-36-	83-14-	Alternate site
VERMILION (ERIE)		41-25-30	82-20-	Alternate site
WAKATOMIKA (ERIE)		40-08-	82-03-	Alternate site
WARRENTON (PERRY)		40-12-	80-40-	Alternate site
ZIMMER	YES	38-51-57	84-13-44	Construction permit in effect and operating license docketed
ZOARVILLE (ERIE)		40-35-	81-24-	Alternate site
OKLAHOMA				
BLACK FOX	YES	36-07-01	95-32-54	Application for construction permit pending (docketed)
OREGON				
BEAVER (TRJN)		46-10-	123-11-	Alternate site
BOARDMAN		45-40-35	119-49-00	No application (not listed)
BRADWOOD (TRJN)		46-10-	123-27-	Alternate site
DEER IS (TRJN)		45-56-	122-50-	Alternate site
MAYGER (TRJN)		46-09-	123-05-	Alternate site
PEBBLE SPR S (SKGT)		45-40-	120-11-	Alternate site
PEBBLE SPRINGS	YES	45-42-05	120-08-17	Application for construction permit pending (docketed)
TROJAN	YES	46-02-27	122-53-04	License in effect for operating reactors
WARRENTON (TRJN)		46-08-	123-55-	Alternate site

COMMERCIAL NUCLEAR POWER REACTOR SITES
GROUPED BY STATE

NAME	PRIMARY SITE	LATITUDE dd-mm-ss	LONGITUDE ddd-mm-ss	STATUS
PENNSYLVANIA				
BEAVER VALLEY	YES	40-37-19	80-26-02	License in effect for operating reactors
BIG BEND HILL (ERIE)		41-18-	80-21-	Alternate site
BUCKINGHAM MT (LIM)		40-19-	75-01-	Alternate site
CHESTER CO (FULT)		39-56-	75-51-	Alternate site
FULTON		39-45-50	76-14-15	Application withdrawn
GPU/AI		42-00-15	76-00-15	No application (not listed)
LIMERICK	YES	40-13-12	75-35-24	Construction permit in effect and operating license docketed
LOCK HAVEN		41-05-00	77-34-30	Hypothetical site
MARTINS CR (SUSQ)		40-47-	75-09-	Alternate site
MC ELHATTAN (SUSQ)		41-09-	77-26-	Alternate site
PEACH BOTTOM	YES	39-45-32	76-16-09	License in effect for operating reactors
PERRY BLUFF (ERIE)		41-58-30	80-29-	Alternate site
PINE FORGE (LIM)		40-18-	75-43-	Alternate site
SHIPPINGPORT		40-37-18	80-26-02	Operating, NRC liscense not required
SPRINGFIELD N (ERIE)		41-59-	80-27-	Alternate site
SUNBURY (SUSQ)		40-51-	76-50-	Alternate site
SUSQUEHANNA	YES	41-05-30	76-08-55	Construction permit in effect and operating license docketed
THREE MILE ISLAND	YES	40-09-11	76-43-30	License in effect for operating reactors
TIONESTA		41-30-50	79-26-10	Hypothetical site
TOHICON (FULT)		40-26-	75-04-	Alternate site
TOWANDA		41-48-50	76-29-40	Hypothetical site
WASHINGTON CR (LIM)		40-18-	74-54-	Alternate site
RHODE ISLAND				
NEW ENGLAND		41-21-46	71-39-38	Application withdrawn
ROME POINT		41-32-30	71-24-30	No application (not listed)
WESTERLY (NEP)		41-21-	71-44-	Alternate site
SOUTH CAROLINA				
CATAWBA	YES	35-03-05	81-04-10	Construction permit in effect and operating license docketed
CHEROKEE	YES	35-02-12	81-30-43	Construction permit in effect
CVTR		34-15-43	81-19-45	License terminated
OCONEE	YES	34-47-30	82-53-55	License in effect for operating reactors
ROBINSON	YES	34-24-09	80-09-31	License in effect for operating reactors
SAVANNAH R (CRBR)		33-19-00	81-32-00	Alternate site
SUMMER	YES	34-17-45	81-19-13	Construction permit in effect and operating license docketed

NAME	PRIMARY SITE	LATITUDE dd-mm-ss	LONGITUDE ddd-mm-ss	STATUS
SOUTH DAKOTA				
PATHFINDER		43-35-54	96-37-48	License terminated
TENNESSEE				
CLINCH RIVER BREEDER		35-53-24	84-22-57	Application for construction permit pending (docketed)
HARTSVILLE	YES	36-21-15	86-05-10	Construction permit in effect
PHIPPS BEND	YES	36-27-47	82-48-32	Construction permit in effect
SEQUOYAH	YES	35-13-24	85-05-16	License in effect for operating reactors
WATTS BAR	YES	35-36-10	84-47-25	Construction permit in effect and operating license docketed
TEXAS				
ALIENS CREEK	YES	29-40-43	96-06-15	Application for construction permit pending (docketed)
BAFFIN BAY		27-12-00	97-32-00	Hypothetical site
BLUE HILLS		31-08-39	93-41-32	Inactive construction permit application, cancellation announced
COMANCHE PEAK	YES	32-17-52	97-47-06	Construction permit in effect and operating license docketed
SOUTH TEXAS	YES	28-47-42	96-02-53	Construction permit in effect and operating license docketed
TEXARKOMA		33-45-00	94-53-00	Hypothetical site
UTAH				
LAKE POWELL		37-50-50	110-16-20	Hypothetical site
VERMONT				
VERMONT YANKEE	YES	42-46-49	72-30-57	License in effect for operating reactors
VIRGINIA				
NORTH ANNA	YES	38-03-39	77-47-26	License in effect for operating reactors
SURRY	YES	37-09-56	76-41-54	License in effect for operating reactors

NAME	PRIMARY SITE	LATITUDE dd-mm-ss	LONGITUDE ddd-mm-ss	STATUS
WASHINGTON				
CENTERVILLE (SKGT)		45-42-	121-04-	Alternate site
CUSIC (SKGT)		48-22-	117-18-	Alternate site
ELTOPIA (SKGT)		46-29-	119-12-	Alternate site
HANFORD (CRBR)		46-26-00	119-23-00	Alternate site
HANFORD 22/1 (SKGT)		46-34-	119-27-	Alternate site
HANFORD 22/2 (SKGT)		46-37-	119-36-	Alternate site
HANFORD 23 (SKGT)		46-38-	119-20-	Alternate site
JOHNSON CR (SKGT)		46-02-	122-41-	Alternate site
LYCNS RD (SKGT)		45-58-	122-45-	Alternate site
MAGALLON (SKGT)		46-33-	118-23-	Alternate site
ROCK CREEK (SKGT)		45-44-	120-23-	Alternate site
SCOTIA (SKGT)		48-03-	117-03-	Alternate site
SKAGIT	YES	48-32-00	122-07-26	No application (not listed)
SKAGIT/HANFORD		46-29-15	119-25-57	Application for construction permit pending (docketed)
TUCANNON (SKGT)		46-33-	118-05-	Alternate site
WPPSS 14	YES	46-28-03	119-18-51	Construction permit in effect
WPPSS 2		46-28-17	119-19-59	Construction permit in effect and operating license docketed
WPPSS 35	YES	46-57-11	123-28-11	Construction permit in effect
WEST VIRGINIA				
ARROYO (ERIE)		40-34-	80-39-	Alternate site
WISCONSIN				
HAVEN		43-50-54	87-43-47	Inactive construction permit application, cancellation announced
KEWAUNEE	YES	44-20-35	87-32-10	License in effect for operating reactors
KOSHKONONG		42-51-29	88-53-19	No application (not listed)
LA CROSSE	YES	43-33-30	91-13-50	License in effect for operating reactors
POINT BEACH	YES	44-16-51	87-32-10	License in effect for operating reactors
TYRONE		44-41-50	91-49-56	Inactive construction permit application, cancellation announced
WOOD		42-38-36	89-46-32	No application (not listed)

APPENDIX C

POPULATION THRESHOLD LEVELS FOR SIX ALTERNATIVE CRITERIA

Appendix C

ORNL-DWG 83-8432

Maximum Allowable Population Limits for
Six Alternative Criteria

Radial Distance (Miles)	Radial Criteria: Cumulative Population Out to Radial Distance	Sector Criteria: Cumulative Population Within Two Adjacent 22-1/2° Sectors	Radial Area: Cumulative Area (mi^2) Out to Radial Distance	Sector Area: Cumulative Area (mi^2) Within Two Adjacent 22-1/2° Sectors
Case 1:				
0-2	3,142	785	12.566	1.571
0-5	36,128	9,032	78.540	9.817
0-10	153,938	38,484	314.159	39.270
0-15	350,287	87,572	706.858	88.357
0-20	625,176	156,294	1256.636	157.079
0-25	978,605	244,651	1963.494	245.437
0-30	1,410,573	352,643	2827.431	253.429
Case 2:				
0-2	3,142	1,178	12,566	1.571
0-5	36,128	13,548	78.540	9.817
0-10	153,938	57,727	314.159	39.270
0-15	350,287	131,358	706.858	88.357
0-20	625,176	234,441	1256.636	157.079
0-25	978,605	366,977	1963.494	245.437
0-30	1,410,573	528,965	2827.431	253.429
Case 3:				
0-2	3,142	1,571	12,566	1.571
0-5	36,128	18,064	78.540	9.817
0-10	153,938	76,969	314.159	39.270
0-15	350,287	175,144	706.858	88.357
0-20	625,176	312,588	1256.636	157.079
0-25	978,605	489,303	1963.494	245.437
0-30	1,410,573	705,286	2827.431	253.429

ORNL-DWG 83-8433

Case 4:				
2-0	3,142	785	12,566	1.571
5-0	52,622	13,155	78.540	9.817
10-0	229,336	57,334	314.159	39.270
15-0	523,860	130,965	706.858	88.357
20-0	936,194	234,048	1256.636	157.079
25-0	1,466,336	366,584	1963.494	245.437
30-0	2,114,289	528,572	2827.431	253.429
Case 5:				
2-0	3,142	1,178	12,566	1.571
5-0	52,622	19,733	78.540	9.817
10-0	229,336	86,001	314.159	39.270
15-0	523,860	196,448	706.858	88.357
20-0	936,194	351,073	1256.636	157.079
25-0	1,466,336	549,876	1963.494	245.437
30-0	2,114,289	792,858	2827.431	253.429
Case 6:				
2-0	3,142	1,571	12,566	1.571
5-0	52,622	26,311	78.540	9.817
10-0	229,336	114,668	314.159	39.270
15-0	523,860	261,930	706.858	88.357
20-0	936,194	468,097	1256.636	157.079
25-0	1,466,336	733,168	1963.494	245.437
30-0	2,114,289	1,057,144	2827.431	253.429

APPENDIX D

DETAILED POPULATION COUNTS AND PASS-FAIL STATUS FOR SEVERAL EXAMPLE NUCLEAR SITES

ORNL-DWG 83-8056

WATTS BAR LATITUDE= 35.602768 LONGITUDE= 84.790268

INCREMENTAL POPULATION DATA

DISTANCE, MILES	0- 2	2- 5	5-10	10-15	15-20	20-25	25-30
N	57	169	591	822	1370	1106	567
NNE	0	152	494	935	7068	6086	10887
NE	56	116	379	1129	1851	7293	5869
ENE	0	113	403	875	1205	1742	9398
E	53	113	401	840	6088	3607	3484
ESE	0	124	740	1830	2378	4453	4119
SE	56	108	861	5674	11385	6634	2421
SSE	0	106	700	1237	1893	3083	2654
S	62	228	785	676	1656	3955	16824
SSW	0	155	530	750	645	2064	5025
SW	64	149	913	1106	2751	2109	4506
WSW	0	150	718	4550	4569	1335	962
W	58	150	394	698	1033	2230	1236
WNW	0	150	473	201	698	1263	1319
NW	57	213	797	678	918	1144	1309
NNW	0	334	2514	690	522	2964	9123
TOTAL	463	2530	11693	22691	46030	51068	79703

CUMULATIVE POPULATION DATA

DISTANCE, MILES	0- 2	0- 5	0-10	0-15	0-20	0-25	0-30
N	57	226	817	1639	3009	4115	4682
NNE	0	152	646	1581	8649	14735	25622
NE	56	172	551	1680	3531	10824	16693
ENE	0	113	516	1391	2596	4338	13736
E	53	166	567	1407	7495	11102	14586
ESE	0	124	864	2694	5072	9525	13644
SE	56	164	1025	6699	18084	24718	27139
SSE	0	106	806	2043	3936	7019	9673
S	62	290	1075	1751	3407	7362	24186
SSW	0	155	685	1435	2080	4144	9169
SW	64	213	1126	2232	4983	7092	11598
WSW	0	150	868	5418	9987	11322	12284
W	58	208	602	1300	2333	4563	5799
WNW	0	150	623	824	1522	2785	4104
NW	57	270	1067	1745	2663	3807	5116
NNW	0	334	2848	3538	4060	7024	16147
TOTAL	463	2993	14686	37377	83407	134475	214178

PASSED ALL CRITERIA

ORNL-DWG 83-8057

THREE MILE ISLAND LATITUDE= 40.153046 LONGITUDE= 76.724991

INCREMENTAL POPULATION DATA

DISTANCE, MILES	0- 2	2- 5	5-10	10-15	15-20	20-25	25-30
N	0	10542	7528	4577	2890	517	7330
NNE	0	631	10093	12705	4685	4163	3047
NE	375	524	2630	6883	20406	39669	11290
ENE	0	268	2511	3035	4948	4778	9800
E	0	290	9767	5796	17030	20609	27362
ESE	283	715	4713	12622	18287	106596	28292
SE	0	627	3518	15387	6360	4226	3844
SSE	0	313	2620	18713	20003	6372	5054
S	416	397	5952	83108	13378	6406	10471
SSW	66	2312	3758	9204	9343	7757	34579
SW	0	2194	2638	3401	9864	5684	10802
WSW	10	1210	2266	4025	4275	8988	4862
W	0	449	2390	7749	6439	26431	10650
WNW	0	590	15384	48818	9963	4457	5243
NW	19	1614	33174	98931	9430	7009	3895
NNW	161	3988	11650	29466	4160	3153	8165
TOTAL	1330	26664	120592	364420	161461	256815	184686

CUMULATIVE POPULATION DATA

DISTANCE, MILES	0- 2	0- 5	0-10	0-15	0-20	0-25	0-30
N	0	10542	18070	22647	25537	26054	33384
NNE	0	631	10724	23429	28114	32277	35324
NE	375	899	3529	10412	30818	70487	81777
ENE	0	268	2779	5814	10762	15540	25340
E	0	290	10057	15853	32883	53492	80854
ESE	283	998	5711	18333	36620	143216	171508
SE	0	627	4145	19532	25892	30118	33962
SSE	0	313	2933	21646	41649	48021	53075
S	416	813	6765	89873	103251	109657	120128
SSW	66	2378	6136	15340	24683	32440	67019
SW	0	2194	4832	8233	18097	23781	34583
WSW	10	1220	3486	7511	11786	20774	25636
W	0	449	2839	10588	17027	43458	54108
WNW	0	590	15974	64792	74755	79212	84455
NW	19	1633	34807	133738	143168	150177	154072
NNW	161	4149	15799	45265	49425	52578	60743
TOTAL	1330	27994	148586	513006	674467	931282	1115968

ORNL-DWG 83-8058

FAIL OR NEAR-FAIL AT LEAST ONE TEST -- '1' = PASSED, BUT WITHIN 10% OF FAIL
'*' = FAILED, BUT WITHIN 10% OF PASS
'X' = FAILED BY MORE THAN 10%

	CASE1							CASE2							CASE3							CASE4							CASE5							CASE6						
SEC/RAD	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7
N	.	X	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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ORNL-DWG 83-8059

FORKED RIVER LATITUDE= 39.809998 LONGITUDE= 74.209991

INCREMENTAL POPULATION DATA

DISTANCE,MILES	0- 2	2- 5	5-10	10-15	15-20	20-25	25-30
N	759	588	17885	33255	39109	41036	22070
NNE	137	556	14134	27340	50648	53996	69178
NE	810	1576	3135	7633	473	0	0
ENE	0	518	603	0	0	0	0
E	509	599	512	0	0	0	0
ESE	0	0	0	0	0	0	0
SE	1344	0	1107	0	0	0	0
SSE	0	510	498	1733	0	0	0
S	1	148	370	4114	3491	0	0
SSW	0	0	4467	2814	5930	1020	14098
SW	2	10	696	464	1097	1478	5862
WSW	0	9	779	940	372	541	3773
W	49	36	900	1376	769	1891	4601
WNW	0	98	483	5238	3717	32076	14354
NW	0	348	629	2992	341	12459	17944
NNW	315	315	801	5004	20239	8672	5324
TOTAL	3926	5311	46999	92903	126186	153169	157204

CUMULATIVE POPULATION DATA

DISTANCE,MILES	0- 2	0- 5	0-10	0-15	0-20	0-25	0-30
N	759	1347	19232	52487	91596	132632	154702
NNE	137	693	14827	42167	92815	146811	215989
NE	810	2386	5521	13154	13627	13627	13627
ENE	0	518	1121	1121	1121	1121	1121
E	509	1108	1620	1620	1620	1620	1620
ESE	0	0	0	0	0	0	0
SE	1344	1344	2451	2451	2451	2451	2451
SSE	0	510	1008	2741	2741	2741	2741
S	1	149	519	4633	8124	8124	8124
SSW	0	0	4467	7281	13211	14231	28329
SW	2	12	708	1172	2269	3747	9609
WSW	0	9	788	1728	2100	2641	6414
W	49	85	985	2361	3130	5021	9622
WNW	0	98	581	5819	9536	41612	55966
NW	0	348	977	3969	4310	16769	34713
NNW	315	630	1431	6435	26674	35346	40670
TOTAL	3926	9237	56236	149139	275325	428494	585698

ORNL-DWG 83-8060

FAIL OR NEAR-FAIL AT LEAST ONE TEST -- '1' = PASSED, BUT WITHIN 10% OF FAIL
'*' = FAILED, BUT WITHIN 10% OF PASS
'X' = FAILED BY MORE THAN 10%

	CASE1							CASE2							CASE3							CASE4							CASE5							CASE6						
SEC/RAD	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7
N	X	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
NNE	X	.	.	*	X	X	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
NE	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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CIRCLE	X	.	.	.	.	.	.	X	.	.	.	.	.	.	X	.	.	.	.	.	.	X	.	.	.	.	.	.	X	.	.	.	.	.	.	.	X	.	.	.	.	.	.

ORNL-DWG 83-8061

COMANCHE PEAK LATITUDE= 32.297775 LONGITUDE= 97.784988

INCREMENTAL POPULATION DATA

DISTANCE, MILES	0- 2	2- 5	5-10	10-15	15-20	20-25	25-30
N	0	254	2661	2765	160	612	3306
NNE	0	208	672	714	538	1257	2886
NE	73	152	663	667	478	579	1788
ENE	0	95	414	330	677	2476	9228
E	0	71	268	248	163	24352	3166
ESE	89	99	253	229	293	589	1041
SE	0	189	370	201	321	534	329
SSE	0	308	605	140	269	632	1112
S	0	194	275	209	347	360	463
SSW	93	110	97	161	242	381	770
SW	72	105	110	154	207	377	713
WSW	55	118	244	172	249	1275	6268
W	0	102	328	302	342	1416	4441
WNW	47	90	335	313	327	374	359
NW	0	104	430	866	750	454	582
NNW	71	181	1367	1688	297	277	558
TOTAL	500	2380	9092	9159	5660	35945	37010

CUMULATIVE POPULATION DATA

DISTANCE, MILES	0- 2	0- 5	0-10	0-15	0-20	0-25	0-30
N	0	254	2915	5680	5840	6452	9758
NNE	0	208	880	1594	2132	3389	6275
NE	73	225	888	1555	2033	2612	4400
ENE	0	95	509	839	1516	3992	13220
E	0	71	339	587	750	25102	28268
ESE	89	188	441	670	963	1552	2593
SE	0	189	559	760	1081	1615	1944
SSE	0	308	913	1053	1322	1954	3066
S	0	194	469	678	1025	1385	1848
SSW	93	203	300	461	703	1084	1854
SW	72	177	287	441	648	1025	1738
WSW	55	173	417	589	838	2113	8381
W	0	102	430	732	1074	2490	6931
WNW	47	137	472	785	1112	1486	1845
NW	0	104	534	1400	2150	2604	3186
NNW	71	252	1619	3307	3604	3881	4439
TOTAL	500	2880	11972	21131	26791	62736	99746

PASSED ALL CRITERIA

ORNL-DWG 83-8062

LIMERICK IATITUDE= 40.219986 LONGITUDE= 75.589996

INCREMENTAL POPULATION DATA

DISTANCE,MILES	0- 2	2- 5	5-10	10-15	15-20	20-25	25-30
N	0	2151	3787	5148	7862	34664	31332
NNE	812	775	2725	10044	18901	66125	130437
NE	0	391	3667	5037	16310	5746	6045
ENE	443	561	3744	18370	25960	21350	8659
E	0	1249	5247	13614	47832	42541	76492
ESE	1097	3846	9554	63972	63299	203012	542315
SE	0	7262	8142	39272	64848	283856	773415
SSE	835	5728	20417	23690	17733	55741	178476
S	0	2926	3888	11785	43886	9674	46316
SSW	0	1293	2479	12184	20283	9716	14920
SW	713	1225	1485	3233	11468	22728	8652
WSW	0	1842	1545	1496	6691	7923	14005
W	0	2398	3440	2930	5461	6957	17847
WNW	3014	4484	4716	7244	93212	68743	9414
NW	716	16492	7134	4719	6745	21271	11685
NNW	0	4570	10161	4614	3438	12345	3591
TOTAL	7630	57193	92131	227352	453929	872392	1873601

CUMULATIVE POPULATION DATA

DISTANCE,MILES	0- 2	0- 5	0-10	0-15	0-20	0-25	0-30
N	0	2151	5938	11086	18948	53612	84944
NNE	812	1587	4312	14356	33257	99382	229819
NE	0	391	4058	9095	25405	31151	37196
ENE	443	1004	4748	23118	49078	70428	79087
E	0	1249	6496	20110	67942	110483	186975
ESE	1097	4943	14497	78469	141768	344780	887095
SE	0	7262	15404	54676	119524	403380	1176795
SSE	835	6563	26980	50670	68403	124144	302620
S	0	2926	6814	18599	62485	72159	118475
SSW	0	1293	3772	15956	36239	45955	60875
SW	713	1938	3423	6656	18124	40852	49504
WSW	0	1842	3387	4883	11574	19497	33502
W	0	2398	5838	8768	14229	21186	39033
WNW	3014	7498	12214	19458	112670	181413	190827
NW	716	17208	24342	29061	35806	57077	68762
NNW	0	4570	14731	19345	22783	35128	38719
TOTAL	7630	64823	156954	384306	838235	1710627	3584228

ORNL-DWG 83-8063

FAIL OR NEAR-FAIL AT LEAST ONE TEST -- '1' = PASSED, BUT WITHIN 10% OF FAIL
'*' = FAILED, BUT WITHIN 10% OF PASS
'X' = FAILED BY MORE THAN 10%

	CASE1							CASE2							CASE3							CASE4							CASE5							CASE6						
SEC/RAD	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7
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ESE	X	.	.	X	X	X	X	1	.	.	.	.	X	X	.	.	.	.	.	1	X	X	.	.	.	.	X	X	1	.	.	.	.	.	X	.	.	.	.	.	.	*
SE	X	X	.	X	X	X	X	1	1	.	*	X	X	X	.	.	.	.	.	X	X	X	1	.	*	X	X	X	1	.	.	.	.	X	X	.	.	.	.	.	*	X
SSE	*	X	X	X	X	X	X	.	*	.	.	.	X	X	.	.	.	.	.	*	X	*	*	.	.	.	X	X	.	.	.	.	.	1	X	.	.	.	.	.	.	X
S	*	*	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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NW	X	X	1	.	1	1	.	X	X	.	.	.	.	.	X	X	.	.	.	.	.	X	X	.	.	.	.	.	X	X	.	.	.	.	.	X	1	.	.	.	.	.
NNW	1	X	*	.	.	.	.	.	X	.	.	.	.	.	.	X	.	.	.	.	.	1	X	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.
CIRCLE	X	X	*	*	X	X	X	X	X	*	*	X	X	X	X	X	*	*	X	X	X	X	X	.	.	.	X	X	X	X	.	.	.	X	X	X	X	.	.	.	X	X

APPENDIX E

PASS-FAIL SUMMARY TABLES FOR PRIMARY AND SECONDARY NUCLEAR SITES

ORNL-DWG 83-8064

PASS/FAIL OF NUCLEAR SITES BASED ON SECTOR-RADIAL CRITERIA - PRIMARY SITES

'.' = PASSED BY MORE THAN 10%
'1' = PASSED, BUT WITHIN 10% OF FAIL
'*' = FAILED, BUT WITHIN 10% OF PASS
'X' = FAILED BY MORE THAN 10%

NUCLEAR SITE	LATITUDE	LONGITUDE	CASE 1 SEC-RAD	CASE2 SEC-RAD	CASE3 SEC-RAD	CASE4 SEC-RAD	CASE5 SEC-RAD	CASE6 SEC-RAD
ALIENS CREEK	29.6786	96.1042	. .	. .	. .	. .	. .	. .
ARKANSAS	35.3100	93.2308	. .	. .	. .	. .	. .	. .
ARNOLD	42.1006	91.7772	X .	1 .	. .	1 .	. .	. .
BAILLY	41.6417	87.1250	X X	X X	X X	X *	X *	X *
BEAVER VALLEY	40.6219	80.4339	X X	X X	X X	X .	* .	. .
BELLEFONTE	34.7089	85.9272	. .	. .	. .	. .	. .	. .
BIG ROCK POINT	45.3592	85.1947	. .	. .	. .	. .	. .	. .
BLACK FOX	36.1169	95.5483	X .	. .	. .	. .	. .	. .
BRAIDWOOD	41.2436	88.2289	X 1	X 1	X 1	X 1	X 1	X 1
BROWNS FERRY	34.7042	87.1186	. .	. .	. .	. .	. .	. .
BRUNSWICK	33.9583	78.0105	* .	. .	. .	* .	. .	. .
BYRON	42.0750	89.2819	X .	. .	. .	. .	. .	. .
CALLAWAY	38.7611	91.7817	. .	. .	. .	. .	. .	. .
CALVERT CLIFFS	38.4347	76.4419	. .	. .	. .	. .	. .	. .
CATAWBA	35.0514	81.0694	X .	X .	. .	X .	. .	. .
CHEROKEE	35.0367	81.5119	. .	. .	. .	. .	. .	. .
CLINTON	40.1719	88.8342	. .	. .	. .	. .	. .	. .
COMANCHE PEAK	32.2978	97.7850	. .	. .	. .	. .	. .	. .
COOK	41.9761	86.5664	1 .	. .	. .	. .	. .	. .
COOPER	40.3619	95.6411	. .	. .	. .	. .	. .	. .
CRYSTAL RIVER	28.9572	82.6989	1 .	. .	. .	1 .	. .	. .
DAVIS-BESSE	41.5972	83.0864	X .	. .	. .	. .	. .	. .
DIABLO CANYON	35.2117	120.8544	. .	. .	. .	. .	. .	. .
DRESDEN	41.3897	88.2711	X .	X .	. .	X .	. .	. .
FARLEY	31.2228	85.1125	. .	. .	. .	. .	. .	. .
FERMI	41.9633	83.2586	X X	X X	X X	X 1	X 1	X 1
FITZPATRICK	43.5239	76.3983	. .	. .	. .	. .	. .	. .
FORKED RIVER	39.8100	74.2100	X X	X X	. X	X X	X X	. X
FORT CALHOUN	41.5208	96.0767	X .	X .	1 .	X .	. .	. .
FORT ST VRAIN	40.2447	104.8744	. .	. .	. .	. .	. .	. .
GINNA	43.2778	77.3089	X 1	X 1	X 1	X .	X .	* .
GRAND GULF	32.0075	91.0480	. .	. .	. .	. .	. .	. .
HADDAM NECK	41.4819	72.4992	X X	X X	* X	X .	1 .	. .
HARRIS	35.6333	78.9561	. .	. .	. .	. .	. .	. .
HARTSVILLE	36.3542	86.0861	. .	. .	. .	. .	. .	. .
HATCH	31.9342	82.3444	. .	. .	. .	. .	. .	. .
HOPE CREEK	39.4678	75.5381	X .	* .	. .	* .	. .	. .
INDIAN POINT	41.2714	73.9525	X X	X X	X X	X X	X X	X X
KEWAUNEE	44.3430	87.5361	. .	. .	. .	. .	. .	. .
LA CROSSE	43.5583	91.2305	. .	. .	. .	. .	. .	. .
LA SALLE	41.2439	88.6708	. .	. .	. .	. .	. .	. .
LIMERICK	40.2200	75.5900	X X	X X	X X	X X	X X	X X
MAINE YANKEE	43.9505	69.6961	. .	. .	. .	. .	. .	. .
MARBLE HILL	38.6000	85.4480	* .	. .	. .	. .	. .	. .
MCGUIRE	35.4322	80.9483	X 1	X 1	. 1	X .	. .	. .
MIDLAND	43.5861	84.2231	X X	X X	X X	X X	X X	X X
MILLSTONE	41.3086	72.1680	X X	X X	X X	X X	X X	X X
MONTICELLO	45.3333	93.8483	. .	. .	. .	. .	. .	. .
NINE MILE POINT	43.5222	76.4100	. .	. .	. .	. .	. .	. .
NORTH ANNA	38.0608	77.7905	. .	. .	. .	. .	. .	. .
OCONEE	34.7917	82.8986	. .	. .	. .	. .	. .	. .
OYSTER CREEK	39.8142	74.2064	X X	X X	. X	X X	X X	. X
PALISADES	42.3222	86.3153	. .	. .	. .	. .	. .	. .

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PALO VERDE	33.3897	112.8619	. .	. .	. .	. .	. .	. .
PEACH BOTTOM	39.7589	76.2692	. .	. .	. .	. .	. .	. .
PEEBLE SPRINGS	45.7014	120.1380	. .	. .	. .	. .	. .	. .
PERKINS	35.8481	80.4528	. .	. .	. .	. .	. .	. .
PERRY	41.8011	81.1433	X .	1 .	. .	1 .	. .	. .
PHIPPS BEND	36.4630	82.8089	. .	. .	. .	. .	. .	. .
PILGRIM	41.9444	70.5794	X .	. .	. .	X .	. .	. .
POINT BEACH	44.2808	87.5361	. .	. .	. .	. .	. .	. .
PRAIRIE ISLAND	44.6219	92.6330	. .	. .	. .	. .	. .	. .
QUAD-CITIES	41.7261	90.3100	X .	. .	. .	. .	. .	. .
RANCHO SECO	38.3444	121.1200	X .	X .	1 .	X .	. .	. .
RIVER BEND	30.7572	91.3317	* .	. .	. .	. .	. .	. .
ROBINSON	34.4025	80.1586	. .	. .	. .	. .	. .	. .
SALEM	39.4628	75.5358	X .	1 .	. .	1 .	. .	. .
SAN ONOFRE	33.3703	117.5569	* .	. .	. .	. .	. .	. .
SEABROOK	42.8980	70.8514	X *	X *	. *	X *	X *	. *
SEQUOYAH	35.2233	85.0878	X .	1 .	. .	1 .	. .	. .
SHOREHAM	40.9583	72.8667	X X	X X	* X	X .	1 .	. .
SKAGIT	48.5333	122.1239	. .	. .	. .	. .	. .	. .
SOUTH TEXAS	28.7950	96.0480	. .	. .	. .	. .	. .	. .
ST LUCIE	27.3486	80.2464	X .	X .	X .	X .	X .	X .
SUMMER	34.2958	81.3203	. .	. .	. .	. .	. .	. .
SURRY	37.1655	76.6983	X .	. .	. .	. .	. .	. .
SUSQUEHANNA	41.0917	76.1486	* .	. .	. .	. .	. .	. .
THREE MILE ISLAND	40.1530	76.7250	X X	X X	X X	X 1	* 1	. 1
TROJAN	46.0408	122.8844	X .	. .	. .	. .	. .	. .
TURKEY POINT	25.4350	80.3314	X .	X .	X .	X .	X .	* .
VERMONT YANKEE	42.7803	72.5158	. .	. .	. .	. .	. .	. .
VOGTLE	33.1419	81.7647	. .	. .	. .	. .	. .	. .
WATERFORD	29.9950	90.4711	X 1	X 1	X 1	X .	X .	X .
WATTS BAR	35.6028	84.7903	. .	. .	. .	. .	. .	. .
WOLF CREEK	38.2389	95.6889	. .	. .	. .	. .	. .	. .
WPPSS 14	46.4675	119.3142	. .	. .	. .	. .	. .	. .
WPPSS 35	46.9530	123.4697	. .	. .	. .	. .	. .	. .
YANKEE-ROWE	42.7280	72.9289	. .	. .	. .	. .	. .	. .
YELLOW CREEK	34.9567	88.2158	. .	. .	. .	. .	. .	. .
ZIMMER	38.8658	84.2289	X .	X .	X .	X .	X .	. .
ZION	42.4455	87.8022	X X	X X	X X	X X	X X	X X

PASS/FAIL OF NUCLEAR SITES BASED ON SECTOR-RADIAL CRITERIA - SECONDARY SITES

'.' = PASSED BY MORE THAN 10%
'1' = PASSED, BUT WITHIN 10% OF FAIL
'*' = FAILED, BUT WITHIN 10% OF PASS
'X' = FAILED BY MORE THAN 10%

NUCLEAR SITE	LATITUDE	LONGITUDE	CASE1 SEC-RAD	CASE2 SEC-RAD	CASE3 SEC-RAD	CASE4 SEC-RAD	CASE5 SEC-RAD	CASE6 SEC-RAD
ARROYO (ERIE)	40.5667	80.6500	X X	X X	X X	X X	X X	X X
ASHTABULA E (PERRY)	41.9167	80.7333	X .	* .	. .	X .	* .	. .
ATHENS (PASNY)	42.2667	73.8333	X .	. .	. .	. .	. .	. .
ATLANTIC	39.4722	74.2556	. .	. .	. .	. .	. .	. .
AU GRES	44.1111	83.5806	. .	. .	. .	. .	. .	. .
BAFFIN BAY	27.2000	97.5333	. .	. .	. .	. .	. .	. .
BAINBRIDGE (MD)	39.6125	76.0930	X X	X X	X X	X X	X X	X X
BARTON	32.7500	86.4000	. .	. .	. .	. .	. .	. .
BEAR SWAMP (NEP)	42.7000	72.8833	. .	. .	. .	. .	. .	. .
BEAVER (ERIE)	41.4250	82.2583	X X	X X	X X	X X	X X	X X
BEAVER (TRJN)	46.1667	123.1833	. .	. .	. .	. .	. .	. .
BELL	42.6083	76.6319	. .	. .	. .	. .	. .	. .
BELVEDERE (DOUG)	38.2333	76.6000	. .	. .	. .	. .	. .	. .
BIG BEND HILL (ERIE)	41.3000	80.3500	X .	* .	. .	* .	. .	. .
BIG GRAHAM CR (MRBL)	38.9480	85.5514	. .	. .	. .	. .	. .	. .
BLUE HILLS	31.1442	93.6922	. .	. .	. .	. .	. .	. .
BOARDMAN	45.6764	119.8167	. .	. .	. .	. .	. .	. .
BODEGA BAY	38.3000	123.0550	. .	. .	. .	. .	. .	. .
BOLSA ISLAND	33.7083	118.0317	X X	X X	X X	X X	X X	X X
BOWERS (SUMM)	39.0500	75.3833	. .	. .	. .	. .	. .	. .
BRAIDWOOD (TRJN)	46.1667	123.4500	. .	. .	. .	. .	. .	. .
BUCKINGHAM MT (LIM)	40.3167	75.0167	X X	X X	X X	X X	X X	X X
BURLINGTON	40.0767	74.8797	X X	X X	X X	X X	X X	X X
CANAL (FULT)	39.5333	75.8167	X .	* .	. .	* .	. .	. .
CARROLL COUNTY	42.0336	90.0628	. .	. .	. .	. .	. .	. .
CARROLL POND (DOUG)	38.2000	76.3833	. .	. .	. .	. .	. .	. .
CENTERVILLE (SKGT)	45.7000	121.0667	. .	. .	. .	. .	. .	. .
CHESTER CO (FULT)	39.9333	75.8500	X X	X X	X X	X 1	X 1	X 1
CHURCH CR (MMFS)	38.5069	76.1347	1 .	. .	. .	. .	. .	. .
CLAIBORNE (SUMM)	38.8167	76.3000	. .	. .	. .	. .	. .	. .
CLARINGTON	39.7194	80.8444	. .	. .	. .	. .	. .	. .
CLINCH RIVER BREEDER	35.8900	84.3825	. .	. .	. .	. .	. .	. .
COAL RUN (ERIE)	39.5583	81.5917	. .	. .	. .	. .	. .	. .
CONNESVILLE (ERIE)	40.1833	81.8833	. .	. .	. .	. .	. .	. .
CORSICA (SUMM)	39.0667	76.1500	X .	X .	* .	X .	1 .	. .
COSIC (SKGT)	48.3667	117.3000	. .	. .	. .	. .	. .	. .
CVTR	34.2619	81.3292	. .	. .	. .	. .	. .	. .
DEEP BR (MMFS)	38.3014	75.8208	. .	. .	. .	. .	. .	. .
DEER IS (TRJN)	45.9333	122.8333	X .	. .	. .	. .	. .	. .
DENTON (SUMM)	38.9333	75.8000	. .	. .	. .	. .	. .	. .
DOUGLAS POINT	38.4455	77.2567	X .	X .	* .	X .	1 .	. .
EASTON	42.9950	73.6100	X .	* .	. .	* .	. .	. .
EGYPT BOTTOM (MRBL)	38.7944	84.8306	X .	* .	. .	* .	. .	. .
EIK RIVER	45.2883	93.5517	X .	X .	X .	X .	X .	. .
ELSINBORO (FULT)	39.5500	75.5167	X 1	X 1	X 1	X .	* .	. .
ELTOPIA (SKGT)	46.4833	119.2000	. .	. .	. .	. .	. .	. .
ERIE	41.3456	82.4803	* .	. .	. .	* .	. .	. .
FAIRLEE (MMFS)	39.2236	76.2194	X X	X X	X X	X 1	X 1	X 1
FULTON	39.7639	76.2375	. .	. .	. .	. .	. .	. .
GENEVA (ERIE)	41.8333	80.9667	X X	X X	X X	X X	X X	X X
GPU/AI	42.0042	76.0042	X *	X *	* *	X .	1 .	. .
GREENE COUNTY	42.1500	73.9114	. .	. .	. .	. .	. .	. .
GREENWOOD	43.0919	82.6944	. .	. .	. .	. .	. .	. .

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HALLAM	40.5550	96.7867	. .	. .	. .	. .	. .	. .
HANFORD (CRBR)	46.4333	119.3833	. .	. .	. .	. .	. .	. .
HANFORD 22/1 (SKGT)	46.5667	119.4500	. .	. .	. .	. .	. .	. .
HANFORD 22/2 (SKGT)	46.6167	119.6000	. .	. .	. .	. .	. .	. .
HANFORD 23 (SKGT)	46.6333	119.3333	. .	. .	. .	. .	. .	. .
HAVEN	43.8483	87.7297	X .	. .	. .	. .	. .	. .
HUMBOLDT BAY	40.7411	124.2092	X .	X .	X .	X .	X .	1 .
HUNTER LIGGETT	35.7305	121.2861	. .	. .	. .	. .	. .	. .
HURON (ERIE)	41.3667	82.5333	X .	. .	. .	X .	. .	. .
IDAHO FALLS (CRBR)	43.6667	112.5000	. .	. .	. .	. .	. .	. .
JAMESPORT	40.9900	72.5942	1 .	. .	. .	1 .	. .	. .
JOHNSON CR (SKGT)	46.0333	122.6833	. .	. .	. .	. .	. .	. .
KOSHKONONG	42.8580	88.8886	. .	. .	. .	. .	. .	. .
LAKE POWELL	37.8472	110.2722	. .	. .	. .	. .	. .	. .
LAMPREY POND (SEAB)	42.9500	70.8167	X X	X X	X X	X X	X X	X X
LITCHFIELD (SEAB)	42.8667	71.4667	X X	X X	X X	X X	X X	X X
LIVINGSTON (GCNP)	42.1167	73.7833	. .	. .	. .	. .	. .	. .
LICYD (GCNP)	41.7667	73.9833	X *	X *	* *	X .	1 .	. .
LOCK HAVEN	41.0833	77.5750	. .	. .	. .	. .	. .	. .
LYONS ED (SKGT)	45.9667	122.7500	1 .	. .	. .	. .	. .	. .
MAGALLON (SKGT)	46.5500	118.3833	. .	. .	. .	. .	. .	. .
MALIBU	34.0350	118.7417	X X	X X	X X	X X	X X	X X
MARBLEHEAD (ERIE)	41.5167	82.7917	X .	. .	. .	X .	. .	. .
MARTINS CR (SUSQ)	40.7833	75.1500	X *	X *	* *	X .	1 .	. .
MAYGER (TRJN)	46.1500	123.0833	X .	. .	. .	. .	. .	. .
MC ELHATTAN (SUSQ)	41.1500	77.4333	X X	X X	X X	X X	X X	X X
MENDOCINO	38.9236	123.7180	. .	. .	. .	. .	. .	. .
MEXICO BOTTOM (MRBL)	38.8725	84.7958	X .	X .	X .	X .	* .	. .
MILLIKEN (NYSEG)	42.6000	76.6333	. .	. .	. .	. .	. .	. .
MOLINA	40.2556	91.5000	. .	. .	. .	. .	. .	. .
MONTAGUE	42.5761	72.5267	X X	X X	X X	X X	X X	X X
MOOLEYVILLE	38.0194	86.5111	. .	. .	. .	. .	. .	. .
MOORE POND (SEAB)	44.3333	71.8167	. .	. .	. .	. .	. .	. .
MORRISON (NYSEG)	43.3667	78.3333	. .	. .	. .	. .	. .	. .
NASHPORT (ERIE)	40.0917	82.1833	. .	. .	. .	. .	. .	. .
NEEDLES	34.3444	114.1917	. .	. .	. .	. .	. .	. .
NEVADA (ERIE)	40.7833	83.1500	. .	. .	. .	. .	. .	. .
NEW ENGLAND	41.3628	71.6606	. .	. .	. .	. .	. .	. .
NEW HAVEN	43.4836	76.2953	. .	. .	. .	. .	. .	. .
NEWBOLD ISLAND	40.1292	74.7556	X X	X X	X X	X X	X X	X X
NORTH PERRY (ERIE)	41.8000	81.1333	X .	* .	. .	X .	* .	. .
ODESSA (SUMM)	39.4500	75.6167	X .	. .	. .	. .	. .	. .
PATHFINDER	43.5983	96.6300	X .	X .	1 .	X .	. .	. .
PEBBLE SPR S (SKGT)	45.6667	120.1833	. .	. .	. .	. .	. .	. .
PERRY BLUFF (ERIE)	41.9750	80.4833	. .	. .	. .	. .	. .	. .
PERRYMAN	39.4375	76.2250	X X	X X	X X	X .	X .	X .
PHILLIPS COVE (SEAB)	43.2000	70.6000	. .	. .	. .	. .	. .	. .
PINE FORGE (IIM)	40.3000	75.7167	X X	X X	1 X	X X	1 X	. X
PIQUA	40.1483	84.2417	X X	X X	X X	X X	X X	X X
QUANICASSE	43.5956	83.7147	X .	1 .	. .	1 .	. .	. .
QUARRY (PASNY)	41.6333	73.9333	X X	X X	X X	X X	X X	X X
RAVENSWOOD	40.7633	73.9417	X X	X X	X X	X X	X X	X X
RAYLAND (PERRY)	40.1833	80.6833	X X	X X	X X	X X	X X	X X
RED HOOK (CONED)	42.0500	73.8167	. .	. .	. .	. .	. .	. .
RED LION (SUMM)	39.6167	75.6167	X X	X X	X X	X X	X X	X X
ROCK CREEK (SKGT)	45.7333	120.3833	. .	. .	. .	. .	. .	. .
ROBE POINT	41.5417	71.4083	X X	X X	X X	X .	* .	. .
SAN JOAQUIN	35.6597	119.4903	. .	. .	. .	. .	. .	. .
SAVANNAH R (CRBR)	33.3167	81.5333	. .	. .	. .	. .	. .	. .
SCOTIA (SKGT)	48.0500	117.0500	. .	. .	. .	. .	. .	. .
SEARS ISLAND	44.4361	68.8730	. .	. .	. .	. .	. .	. .
SHELBURNE (SEAB)	44.4167	71.0500	. .	. .	. .	. .	. .	. .
SEELBY	43.6306	86.5056	. .	. .	. .	. .	. .	. .
SHERIDAN (NMPC)	42.5000	79.2500	X .	X .	1 .	X .	. .	. .
SHIPPINGPORT	40.6217	80.4339	X X	X X	X X	X .	* .	. .
SITE B (MRBL)	38.5255	85.5172	X .	X .	1 .	X .	. .	. .

SITE 1 (PILG)	42.6833	71.5333	X X	X X	X X	X *	X *	. *
SITE 18 (PILG)	41.8500	70.5500	. .	. .	. .	. .	. .	. .
SITE 19 (PILG)	41.7167	70.6667	X .	1 .	. .	X .	1 .	. .
SITE 2 (PILG)	42.6833	71.4167	X X	X X	X X	X X	X X	X X
SITE 20 (PILG)	41.7167	70.7333	X X	X X	X X	X X	X X	X X
SKAGIT/HANFORD	46.4875	119.4325	. .	. .	. .	. .	. .	. .
SOMERSET (NYSEG)	43.3667	78.5667	. .	. .	. .	. .	. .	. .
SPRINGFIELD N (ERIE)	41.9833	80.4500	. .	. .	. .	. .	. .	. .
ST LAWRENCE	44.5000	75.5000	. .	. .	. .	. .	. .	. .
STERLING	43.3864	76.6503	. .	. .	. .	. .	. .	. .
STOCKPORT N (ERIE)	39.5667	81.7833	. .	. .	. .	. .	. .	. .
STUYVESANT (NYSEG)	42.4500	73.7667	X .	* .	. .	* .	. .	. .
SUMMIT	39.5225	75.6864	X .	X .	. .	X .	. .	. .
SUNBURY (SUSQ)	40.8500	76.8333	X X	X X	X X	X X	X X	X X
SUNDESERT	33.4519	114.7833	. .	. .	. .	. .	. .	. .
SYMMES CR (ERIE)	40.0833	82.0000	. .	. .	. .	. .	. .	. .
TEXARKOMA	33.7500	94.8833	. .	. .	. .	. .	. .	. .
TIIGHMAN NECK (MMFS)	39.0139	76.1444	X .	. .	. .	. .	. .	. .
TIONESTA	41.5139	79.4361	. .	. .	. .	. .	. .	. .
TCHICON (FULT)	40.4333	75.0667	X X	X X	X X	X X	X X	X X
TCWANDA	41.8139	76.4944	. .	. .	. .	. .	. .	. .
TUCANNON (SKGT)	46.5500	118.0833	. .	. .	. .	. .	. .	. .
TURTLE CREEK (ERIE)	41.6000	83.2333	X .	X .	* .	X .	1 .	. .
TYRONE	44.6972	91.8322	. .	. .	. .	. .	. .	. .
VENICE	26.8500	82.1805	. .	. .	. .	. .	. .	. .
VERMILION (ERIE)	41.4250	82.3333	X X	X X	X X	X X	X X	X X
VERPLANCK	41.2611	73.9636	X X	X X	X X	X X	X X	X X
VIDAL	34.1736	114.4628	. .	. .	. .	. .	. .	. .
VIENNA (SUMM)	38.4833	75.8000	. .	. .	. .	. .	. .	. .
WAKATOMIKA (ERIE)	40.1333	82.0500	* .	. .	. .	* .	. .	. .
WARRENTON (PERRY)	40.2000	80.6667	X .	. .	. .	. .	. .	. .
WARRENTON (TRJN)	46.1333	123.9167	. .	. .	. .	. .	. .	. .
WASHINGTON CR (LIM)	40.3000	74.9000	X X	X X	X X	X X	X X	X X
WESTERLY (NEP)	41.3500	71.7333	* .	. .	. .	. .	. .	. .
WESTPORT	44.1500	73.4167	. .	. .	. .	. .	. .	. .
WCCD	42.6433	89.7755	. .	. .	. .	. .	. .	. .
WPPSS 2	46.4714	119.3331	. .	. .	. .	. .	. .	. .
ZOARVILLE (ERIE)	40.5833	81.4000	X .	1 .	. .	1 .	. .	. .

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14. ABSTRACT (200 words or less)

The Nuclear Regulatory Commission is in the process of reviewing guidelines and regulations associated with population distribution criteria around nuclear power plant sites. The purpose of this paper is to describe the methodology for calculating population distributions in the U.S. and then evaluating specific population criteria and their effect upon the selection of future nuclear power plant sites. Through the use of computer systems, different alternatives may be evaluated for individual sites or for major regions of the country to determine their restrictiveness on siting nuclear plants. Two types of criteria were used. They involved the analysis of population distributions radially out from each possible site and the study of angular distributions around each site. Results are presented in both tabular and graphic form using national, regional, and site-level computer maps.

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