12
11/18/91
M.L.P.
1

PNL-7803
UC-507

A Research Report for Westinghouse
Hanford Company

Hanford Area 1990 Population and 50-Year Projections

October 1991

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by Battelle Memorial Institute

Battelle

PNL-7803

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor Battelle Memorial Institute, nor any of their employees, makes **any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights.** Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or Battelle Memorial Institute. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

PACIFIC NORTHWEST LABORATORY
operated by
BATTELLE MEMORIAL INSTITUTE
for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC06-76RLO 1830

Printed in the United States of America

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; prices available from (615) 576-8401. FTS 626-8401.

Available to the public from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Rd., Springfield, VA 22161.

PNL--7803

DE92 002937

A Research Report for
Westinghouse Hanford Company

HANFORD AREA 1990 POPULATION AND 50-YEAR PROJECTIONS

D. M. Beck
M. J. Scott
M. D. Davis[a]
S. F. Shindle
B. A. Napier
A. G. Thurman
D. B. Pittenger[b]
N. C. Batishko

October 1991

Prepared for
the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Richland, Washington 99352

(a) Westinghouse Hanford Company
Richland, Washington.
(b) The Demographics Laboratory
Olympia, Washington.

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

EXECUTIVE SUMMARY

The complex and comprehensive safety analysis activities carried out at Hanford for nonreactor nuclear facilities require data from a number of scientific and engineering disciplines. The types of data that are required include data pertaining to current population and population projections. In this regard, Pacific Northwest Laboratory (PNL) has worked in conjunction with a Westinghouse Hanford Company engineering staff person and a consultant from the private sector to produce a document which provides the demographic data required for ongoing safety analysis work at the Hanford Site.

The types of data found in this document include 1990 census totals for residential population within a 50-mile radius of the 100-N, 200, 300, and 400 Area meteorological towers. This document also contains 50-year projections for residential populations within a 50-mile radius of these four meteorological towers.

The analysis of population projections indicates that residential population within a 50-mile radius of the four meteorological towers in question will continue to grow through 2040, although at a slower rate each decade. In all cases, the highest growth is projected for the decade ending in the year 2000. The annual growth rate for this period is projected to be 0.646, 0.633, 0.543, and 0.570 in the 100-N, 200, 300, and 400 Areas, respectively. By 2040, these growth rates are projected to drop to 0.082, 0.068, 0.078, and 0.078, respectively.

CONTENTS

EXECUTIVE SUMMARY iii

1.0 HANFORD AREA POPULATION PROJECTIONS 1.1

2.0 POPULATION DISTRIBUTION AND TRENDS 2.1

2.1 CURRENT POPULATION 2.1

2.2 PROJECTED POPULATION 2.3

APPENDIX A - METHODOLOGY AND ASSUMPTIONS: HANFORD AREA COUNTY POPULATION PROJECTIONS, 1980-2040 . . . . . A.1

APPENDIX B - METHODOLOGY FOR DETERMINING POPULATIONS WITHIN SECTORS . . B.1

APPENDIX C - POPULATION PROJECTIONS BY GRID AREA C.1

FIGURES

2.1 Population (1990 Census) for Counties and Selected Cities Within a 50-Miles Radius of the Hanford Meteorological Station 2.3

C.1 Counties, Census Divisions, and Cities Around Hanford Site C.1

C.2 Cities Within 80 Kilometers (50 Miles) of the 100-N Meteorological Tower C.2

C.3 Cities Within 80 Kilometers (50 Miles) of the Hanford Meteorological Station C.3

C.4 Cities Within 80 Kilometers (50 Miles) of the 300 Area C.4

C.5 Cities Within 80 Kilometers (50 Miles) of the 400 Area Meteorological Tower C.5

C.6 Areas Within 80 Kilometers (50 Miles) of the 100-N Meteorological Tower C.6

C.7 Areas Within 80 Kilometers (50 Miles) of the Hanford Meteorological Station C.7

C.8 Areas Within 80 Kilometers (50 Miles) of the 300 Area Meteorological Tower C.8

C.9 Areas Within 80 Kilometers (50 Miles) of the 400 Area Meteorological Tower C.9

C.10 Areas Within 16 Kilometers (10 Miles) of the 100-N Meteorological Tower C.10

C.11 Areas Within 16 Kilometers (10 Miles) of the Hanford Meteorological Station C.11

C.12 Areas Within 16 Kilometers (10 Miles) of the 300 Area Meteorological Tower C.12

C.13 Areas Within 16 Kilometers (10 Miles) of the 400 Area Meteorological Tower C.13

C.14 Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the 100-N Meteorological Tower, by Population Grid Sector for 1990 . . . . . C.14

C.15 Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the 100-N Meteorological Tower, by Population Grid Sector for 2000 . . . . . C.15

C.16 Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the 100-N Meteorological Tower, by Population Grid Sector for 2010 . . . . . C.16

C.17 Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the 100-N Meteorological Tower, by Population Grid Sector for 2020 . . . . . C.17

C.18 Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the 100-N Meteorological Tower, by Population Grid Sector for 2030 . . . . . C.18

C.19 Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the 100-N Meteorological Tower, by Population Grid Sector for 2040 . . . . . C.19

C.20 Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 100-N Meteorological Tower, by Population Grid Sector for 1990 . . . . . C.20

C.21 Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 100-N Meteorological Tower, by Population Grid Sector for 2000 . . . . . C.21

C.22 Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 100-N Meteorological Tower, by Population Grid Sector for 2010 . . . . . C.22

C.23 Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 100-N Meteorological Tower, by Population Grid Sector for 2020 . . . . . C.23

C.24 Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 100-N Meteorological Tower, by Population Grid Sector for 2030 . . . . . C.24

C.25 Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 100-N Meteorological Tower, by Population Grid Sector for 2040 . . . . . C.25

C.26 Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the Hanford Meteorological Station, by Population Grid Sector for 1990 . . . . . C.26

C.27 Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the Hanford Meteorological Station, by Population Grid Sector for 2000 . . . . . C.27

C.28 Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the Hanford Meteorological Station, by Population Grid Sector for 2010 . . . . . C.28

C.29 Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the Hanford Meteorological Station, by Population Grid Sector for 2020 . . . . . C.29

C.30 Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the Hanford Meteorological Station, by Population Grid Sector for 2030 . . . . . C.30

C.31 Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the Hanford Meteorological Station, by Population Grid Sector for 2040 . . . . . C.31

C.32 Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the Hanford Meteorological Station, by Population Grid Sector for 1990 . . . . . C.32

C.33 Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the Hanford Meteorological Station, by Population Grid Sector for 2000 . . . . . C.33

C.34 Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the Hanford Meteorological Station, by Population Grid Sector for 2010 . . . . . C.34

C.35 Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the Hanford Meteorological Station, by Population Grid Sector for 2020 . . . . . C.35

C.36 Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the Hanford Meteorological Station, by Population Grid Sector for 2030 . . . . . C.36

C.37 Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the Hanford Meteorological Station, by Population Grid Sector for 2040 . . . . . C.37

C.38 Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the 300 Area Meteorological Tower, by Population Grid Sector for 1990 . . . . . C.38

C.39 Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the 300 Area Meteorological Tower, by Population Grid Sector for 2000 . . . . . C.39

C.40 Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the 300 Area Meteorological Tower, by Population Grid Sector for 2010 . . . . . C.40

C.41 Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the 300 Area Meteorological Tower, by Population Grid Sector for 2020 . . . . . C.41

C.42 Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the 300 Area Meteorological Tower, by Population Grid Sector for 2030 . . . . . C.42

C.43 Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the 300 Area Meteorological Tower, by Population Grid Sector for 2040 . . . . . C.43

C.44 Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 300 Area Meteorological Tower, by Population Grid Sector for 1990 . . . . . C.44

C.45 Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 300 Area Meteorological Tower, by Population Grid Sector for 2000 . . . . . C.45

C.46 Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 300 Area Meteorological Tower, by Population Grid Sector for 2010 . . . . . C.46

C.47 Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 300 Area Meteorological Tower, by Population Grid Sector for 2020 . . . . . C.47

C.48 Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 300 Area Meteorological Tower, by Population Grid Sector for 2030 . . . . . C.48

C.49 Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 300 Area Meteorological Tower, by Population Grid Sector for 2040 . . . . . C.49

C.50 Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the 400 Area Meteorological Tower, by Population Grid Sector for 1990 . . . . . C.50

C.51 Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the 400 Area Meteorological Tower, by Population Grid Sector for 2000 . . . . . C.51

C.52 Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the 400 Area Meteorological Tower, by Population Grid Sector for 2010 . . . . . C.52

C.53 Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the 400 Area Meteorological Tower, by Population Grid Sector for 2020 . . . . . C.53

C.54 Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the 400 Area Meteorological Tower, by Population Grid Sector for 2030 . . . . . C.54

C.55 Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the 400 Area Meteorological Tower, by Population Grid Sector for 2040 . . . . . C.55

C.56 Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 400 Area Meteorological Tower, by Population Grid Sector for 1990 . . . . . C.56

C.57 Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 400 Area Meteorological Tower, by Population Grid Sector for 2000 . . . . . C.57

C.58 Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 400 Area Meteorological Tower, by Population Grid Sector for 2010 . . . . . C.58

C.59 Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 400 Area Meteorological Tower, by Population Grid Sector for 2020 . . . . . C.59

C.60 Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 400 Area Meteorological Tower, by Population Grid Sector for 2030 . . . . . C.60

C.61 Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 400 Area Meteorological Tower, by Population Grid Sector for 2040 . . . . . C.61

TABLES

2.1 Projected Residential Population Within a 50-Mile Radius of the 100-N Meteorological Tower (1990 - 2040) 2.5

2.2 Projected Residential Population Within a 50-Mile Radius of the Hanford Meteorological Station (1990 - 2040) 2.5

2.3 Projected Residential Population Within a 50-Mile Radius of the 300 Area Meteorological Tower (1990 - 2040) 2.5

2.41 Projected Residential Population Within a 50-Mile Radius of the 400 Area Meteorological Tower (1990 - 2040) 2.6

1.0 HANFORD AREA POPULATION PROJECTIONS

The Pacific Northwest Laboratory (PNL) is currently supporting safety analysis of activities at Hanford. Federal regulatory requirements (NRC 1975; NRC 1988) mandate that population estimates and projections be prepared for the years 1990-2040 for the areas surrounding specific locations on the Hanford Site. Sommer et al. (1981) prepared estimates for an earlier safety analysis in 1981.

To remain consistent with Sommer et al., the population estimates and projections were prepared for a 50-mile radius from four origins on the Hanford Site: 100-N Meteorological Tower, 200 Area Hanford Meteorological Station (622-R), 400 Area Meteorological Tower, and the 300 Area Meteorological Tower (303C). These four 50-mile areas encompass twelve counties in two states. The Washington counties include Adams, Benton, Franklin, Grant, Kittitas, Klickitat, Walla Walla, and Yakima. The Oregon counties include Morrow and Umatilla. The 100 Area radius also includes small (unpopulated) portions of Chelan and Douglas Counties in Washington, which are not further analyzed.

The projected populations of the grid areas were determined in two steps. First, the population totals were estimated for each county for the years 1990-2040. Second, the projections in question were placed into a Geographic Information System (GIS) software package in order to produce projections for each grid area and to display these projections geographically.

Appendix A explains in detail the methodology and assumptions used to determine county population projections for the years 1990, 2000, 2010, 2020, 2030, and 2040. In brief, the ratio of each of the ten counties' share of the national population was determined for each census year retrospectively to 1910. These shares were trended and multiplied by national population projection figures. To more precisely adjust the estimates, a version of the cohort-component method addressing three core components of population change (births, deaths, and migration) was used. In the case of Benton County, the trended share was advanced by 10 years to account for near-term population

growth expected as a result of major projects at the Hanford site during the 1990s. No other county data were adjusted in this manner.

The county population projections for the six decennial years analyzed (1990, 2000, 2010, 2020, 2030, 2040) were then entered into the GIS package, ARC/INFO. (Appendix B explains the methodology used.) An existing ARC/INFO data set, developed on another project (Hanford Environmental Dose Reconstruction project), was used in a modified form for this project. This data set contains the boundaries of the counties and census tracts (CTs) for the 12-county study area. It also contains CT population estimates for 1990, to which the county population projections for all six years were added. The CT population projections for the remaining years were generated based on an assumption that the CT population growth rate corresponds to the county population growth rate and that population is evenly distributed throughout the CT. Therefore, a CT population projection for a given year was generated by multiplying the 1990 CT population by the ratio of the 1990 county population to the county population of the year in question. (See Appendix B for further details.)

The estimates produced for several of the nodes in the 1990 10-mile population wheel centered at the Hanford meteorological station in the 200 Area were compared with aerial photographs of the area. The photographs indicate that the simplifying assumption of even population distribution throughout CTs resulted in inaccurate estimates for those nodes lying closest to the Hanford Meterological Station. To compensate for this discrepancy in the short run, all of the nodes were constrained to zero, and the estimated population was reassigned to the nearest town. This modification was done only for the year 1990. Estimates for other decades were unchanged. Because population growth in these particular nodes is deemed very likely, the estimates are credible.

A longer term fix for this problem is to create artificial CTs for each of the larger towns in the study area. This device will provide a more accurate distinction between the population living in incorporated places and those living outside of incorporated places. Our research team hopes to make such refinements in the near future.

A 16-sector compass grid was then overlaid onto the existing map of the county and CT boundaries. The grid in question contains concentric rings at 10-mile intervals extending to 50 miles. It was placed at four distinct origins: the 100-N, 200, 300 and 400 Area meteorological towers. Each grid may therefore overlap county and CT boundaries, creating one or more polygons within the grid area. (The methodology for determining the population within these grids is further explained in Appendix B.)

Population projections by grid area for each of the four Hanford operational areas at 10-year increments from 1990 to 2040 are shown in Appendix C.

1.2 REFERENCES

U.S. Nuclear Regulatory Commission (NRC). 1975. Standard Format and Content of Safety Analysis Reports for Fuel Reprocessing Plants. Regulatory Guide 3.26, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1988. Standard Format and Content of a License Application for a Low-Level Radioactive Waste Disposal Facility. NUREG-1199, Revision 1, Washington, D.C.

Sommer, D. J., R. G. Rau, and D. C. Robinson. 1981. Population Estimates for the Areas Within a 50-Mile Radius of Four Reference Points on the Hanford Site. PNL-4010, Pacific Northwest Laboratory, Richland, Washington.

2.0 POPULATION DISTRIBUTION AND TRENDS

Population size and distribution are important criteria for assessing the magnitude of risk to the public from radionuclide exposure, whether from accidents or in the course of normal operations. Data pertaining to population size and distribution are required to ensure that nonreactor nuclear facility Safety Analysis Reports are in compliance with U.S. Nuclear Regulatory Commission (NRC) Regulations, U.S. Environmental Protection Agency (EPA) regulations, and U.S. Department of Energy (DOE) Orders relative to environment, safety and health. Population data are also one component in some of the radiological dose calculations carried out by Hanford scientists and engineers.

In addition, decision makers within the DOE, Westinghouse Hanford Company, Pacific Northwest Laboratory, or other Hanford contractors may be inclined to review recent data on population size and distribution, as well as long-term population projections, before making final determinations of future locations for new Hanford facilities. Also, management decisions regarding where on the Hanford Site new waste management processes or other related technological developments should be located may depend to some extent on the magnitude and location of anticipated population growth. This would be especially true in the case of population growth anticipated near the boundaries of the Hanford Site. Finally, elected officials and members of the public may use population data and population growth projections as one of the many variables on which to base their personal opinions regarding the potential offsite risks posed by onsite industrial activities.

2.1 CURRENT POPULATION

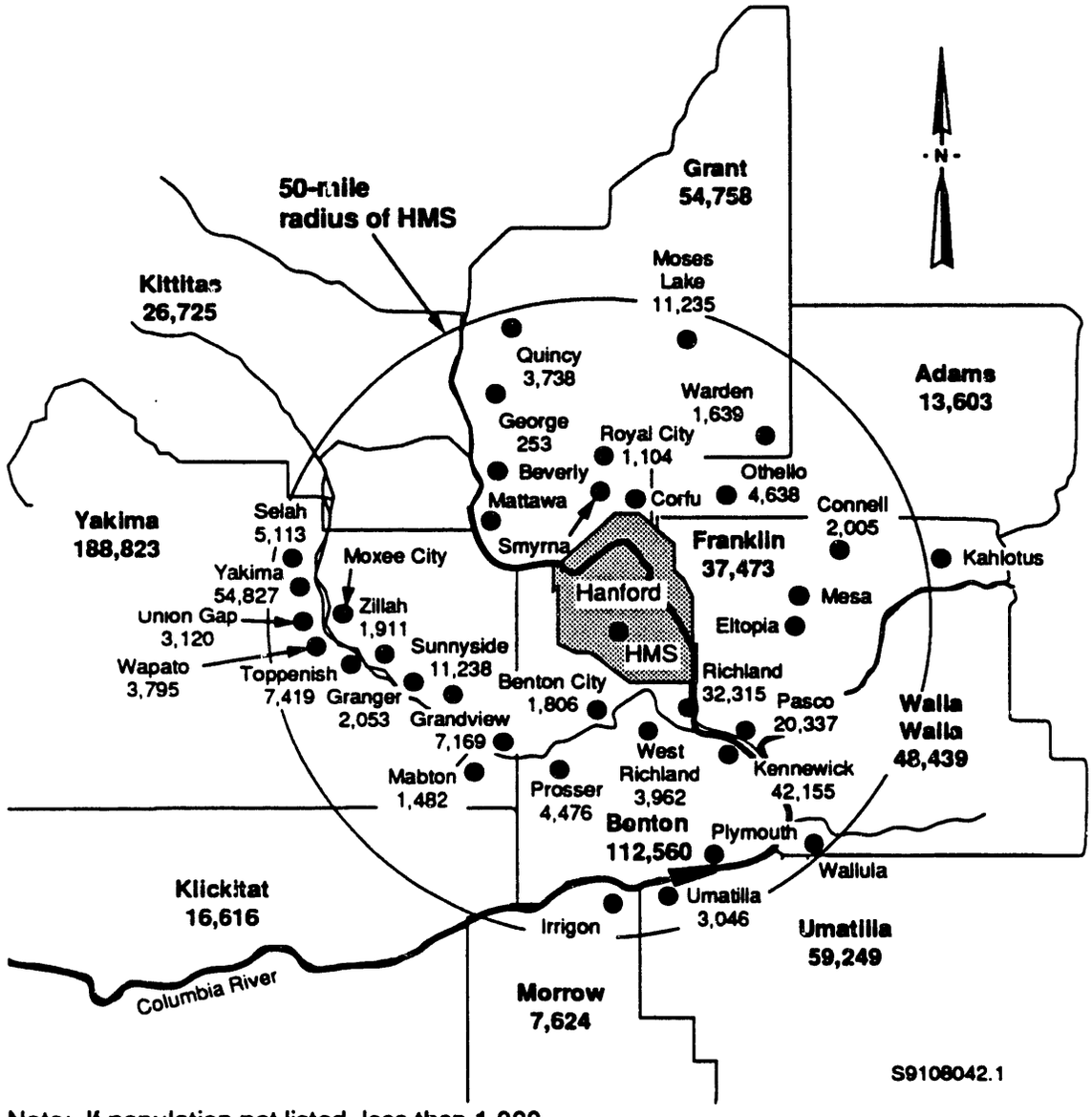
The 1990 population data contained in this section are based on population tabulations developed for locations within circles drawn at a 10-, 20-, 30-, 40- and 50-mile (80-kilometer) radius and divided radially into 16 compass point directions. The graphical depiction resembles a wagon wheel, so the 50-mile area is called a "population wheel." In the example of a 200 Area population wheel, the Hanford Meteorological Station would be the focus of the

concentric circles in question. Similarly, the nexuses of the 100-N, 300, and 400 Area population wheels are the respective meteorological towers within those three areas.

Census data delineating size and distribution of 1990 residential population, within a 50-mile (80-kilometer) radius of the four Hanford meteorological towers, are shown in Appendix C, Figures C.14, C.26, C.38, and C.50. These figures are essentially a plot of 16 compass point directions upon which, as mentioned previously, five concentric circles have been superimposed at 10-mile intervals for 50 miles (80 kilometers). There are 80 separate and distinct sectors per population wheel. The number of persons residing in a sector is reported for each of the 80 sectors in question.

There are currently no permanent residents on the Hanford Site. Communities closest to the Hanford Reservation include Richland, Kennewick, Pasco, West Richland, Benton City, Prosser, Sunnyside, Grandview, and Mesa, all of which are located in southeastern Washington state. The 1990 population of these and other nearby communities can be seen in Figure 2.1. The closest major city to any facility sited on the Hanford Reservation is Richland, Washington. Richland is located in Benton County and had a 1990 population of 32,315.

During the late 1970s and early 1980s, the population of Benton and Franklin Counties, where most Hanford employees reside, grew at an annual rate among the highest in the nation. However, during the early 1980s, there were profound regional economic reversals, associated with Washington Public Power Supply System's (WPPSS's) bond defaults, and the virtual cessation of plutonium production activities at the Hanford Reservation. Many workers employed in WPPSS reactor construction or in weapons grade plutonium production lost their jobs and were forced to leave the area. This had the effect in Benton and Franklin Counties of cutting the average annual rate of population growth for the decade of the 1980s to 0.378%.



Note: If population not listed, less than 1,000

HMS = Hanford Meteorological Station

FIGURE 2.1. Population (1990 Census) for Counties and Selected Cities Within a 50-Mile Radius of the Hanford Meteorological Station

2.2 PROJECTED POPULATION

Population growth is highly correlated with regional economic growth. It is also closely related to such variables as the present size, age structure, and ratio of men to women of the indigenous population. Birth and death

rates, as well as migration into and out of a given area, are also key parameters in estimating population growth. Growth projections for 80 population sectors within a 50-mile (80-kilometer) radius of the respective Hanford Area meteorological towers are based on computer simulation techniques incorporating parameters delineated in Appendixes A and B. Figures in Appendix C show population sector estimates within a 50-mile radius of each Hanford Area meteorological tower. Sector estimates are derived from computer simulations for the decennial census years 2000, 2010, 2020, 2030, and 2040, respectively.

Tables 2.1 through 2.4 show total population within a 50-mile (80-kilometer) radius of the meteorological towers for the decades 1990 - 2000 through 2030 - 2040, and the corresponding average annual growth rate for the decades in question. The highest average annual growth rate for Benton and Franklin Counties will occur between 1990 and 2000. The average annual population growth rate is then projected to attenuate during the decade of 2000 - 2010 and plateau thereafter for the remainder of the period during which population is being projected.

Benton and Franklin Counties are currently experiencing growing pains associated with a strong economic recovery fueled by the change of mission at Hanford from weapons material production to environmental restoration and remediation (Scott and Belzer 1991). Hanford employment level continue to be significant factors in the economic growth of the Tri-Cities. This phenomenon has precipitated shortages of affordable housing in Richland, Pasco, and

TABLE 2.1. Projected Residential Population Within a 50-Mile Radius of the 100-N Meteorological Tower (1990 - 2040)

Year	Decade	Average Annual Rate of Growth During Decade (%)	Population
1990			375,249
2000	1990 - 2000	0.646	400,225
2010	2000 - 2010	0.421	417,415
2020	2010 - 2020	0.351	432,304
2030	2020 - 2030	0.158	439,163
2040	2030 - 2040	0.082	442,788

TABLE 2.2. Projected Residential Population Within a 50-Mile Radius of the Hanford Meteorological Station (1990 - 2040)

Year	Decade	Average Annual Rate of Growth During Decade (%)	Population
1990			375,860
2000	1990 - 2000	0.633	400,346
2010	2000 - 2010	0.413	417,200
2020	2010 - 2020	0.351	432,062
2030	2020 - 2030	0.157	438,909
2040	2030 - 2040	0.068	441,911

TABLE 2.3. Projected Residential Population Within a 50-Mile Radius of the 300 Area Meteorological Tower (1990 - 2040)

Year	Decade	Average Annual Rate of Growth During Decade (%)	Population
1990			281,609
2000	1990 - 2000	0.543	297,275
2010	2000 - 2010	0.376	308,658
2020	2010 - 2020	0.330	318,995
2030	2020 - 2030	0.141	323,512
2040	2030 - 2040	0.078	326,057

TABLE 2.4. Projected Residential Population Within a 50-Mile Radius of the 400 Area Meteorological Tower (1990 - 2040)

Year	Decade	Average Annual Rate of Growth During Decade (%)	Population
1990			283,229
2000	1990 - 2000	0.570	299,793
2010	2000 - 2010	0.394	311,813
2020	2010 - 2020	0.330	322,249
2030	2020 - 2030	0.140	326,802
2040	2030 - 2040	0.078	329,364

Kennewick and raised some concern regarding the ability of the communities to provide required levels of affordable housing and community services. Even so, based on data generated by local public utilities after the 1990 census, area population continues to grow at a rate correlated to the number of new jobs being created.

Long-term economic and demographic projections are at best indeterminate, even when done with the greatest of care and methodological rigor. However, it is not unreasonable to predict that the environmental restoration and remediation program at Hanford, along with expansion in regional construction and manufacturing sectors, will continue to fuel regional population growth well into the next century.

2.3 REFERENCES

Scott, M. J., and D. B. Belzer. 1991. Tri-Cities Economy Review and Outlook: March 1991 Update. Pacific Northwest Laboratory, Richland, Washington.

APPENDIX A

METHODOLOGY AND ASSUMPTIONS: HANFORD AREA COUNTY POPULATION PROJECTIONS, 1980-2040

Methodology and Assumptions: Hanford Area County Population Projections, 1980-2040

Donald B. Pittenger
The Demographics Laboratory
2065 Lakemoor Drive, S.W.
Olympia, Washington 98502
(206) 352-3039

April 25, 1991

Countywide 1990-2040 population projections by sex and five-year age group for ten counties in the Hanford area were prepared under Battelle Subcontract 141471-A-K1. This report deals with the projection assumptions and key methodological details. Key computer code, tables, and graphs are appended.

STRATEGY

It may be wise to abandon normal assumption-building procedures and methods when dealing with extremely long range projections.

For example, unforeseen technological changes can alter both national and local economies and thereby make assumptions about an area's future economic base inappropriate. Consider changes between 1940 and 1990 in the Hanford area. Could knowledge of 1940 employment by industry help forecast industry employment in 1990? Probably not. Industrial sector analysis may be satisfactory in forecasting to perhaps a 20-year horizon. Therefore, it was not considered for this 50-year projection. Another reason why this otherwise reasonable approach was not used was the highly changeable nature of Federal policy, both from the Administration and Congress, regarding nuclear activities in the Reservation. A case in point was the sudden Congressional action removing Hanford from consideration as a repository site a few years ago.

Another appoach would have been to trend components of population change (rates of fertility, mortality, and net migration). Since age-sex detail has not yet been released from the 1990 census, we cannot get 1980-90 net migration by age and sex to calibrate a demographic projection model. We can estimate net migration over the decade for the population only, but this statistic, when compared with the same statistic for earlier decades, is partly influenced by changes in the age structure.

Another measure of local change is the local population's share of the national population. For the ten-county study area, it was possible to calculate such ratios back to the year 1910. This statistic combines the effects of local variations from the nation in terms of age structure and rates of component change; but for the most part, it reflects local variation in migration and fertility.

For a closer horizon--say 20 or 30 years--use of component change rates makes the most sense. But for distant

horizons, a single, simple, summary measure is appealing. J. Scott Armstrong, in his book Long-Range Forecasting (Wiley-Interscience, 1978) favors simplifying methods as horizons become distant, and the present writer is inclined to agree. Therefore, total population was based on trended national shares, and demographic detail was adjusted to suit this constraint.

METHODOLOGY

County shares of the national population were calculated for each census inclusive of 1910 and 1990 and graphed on semi-log paper (see the appended graph). These shares were trended and then multiplied by the most recent 'Middle Series' U.S. Census Bureau national population projection (see Current Population Reports, Series P-25, No. 1018, Table 1.B). This projection series shows the U.S. population peaking in 2038.

The age-sex data were calculated using a version of the standard cohort-component approach. Because data were required for individual calendar years, a model was built that deals with single years of age (up through age 84). The data on the enclosed disk are for population aggregated into five-year age groups (0-4, 5-9, 10-14, ..., 80-84, 85+). The computation procedures are fairly standard, except that age-sex specific migration flows were calculated rather than net rates (various kinds of directional migration flow techniques are becoming more common, however). Also, the rates of mortality and migration were derived by using rates at key ages as parameters and then interpolating weighted averages of model patterns dealing with all 86 age groups. Age-specific fertility rates (for five-year age groups) were used directly, without interpolation.

APL code for the key projection computation programs are appended. Not enclosed are programs dealing with data input, etc.

ASSUMPTIONS

The population share data were trended judgmentally, based mostly on the most recent two or three censuses. Our general assumption was that shares would become constant starting in 2010. This is unlikely to occur, but most of the counties showed small 1980-1990 share changes, so it is a long-range assumption that might not be too unlikely.

Besides the graph, a table is appended showing historical and projected shares by county from 1910 to 2040. On disc are annual shares for the period 1991-2040.

Given the uncertainty about the future of activities at the Hanford Reservation, the assumptions seem reasonable. It is possible to examine a 'worst-case' scenario in which the Reservation is abandoned and the economies of the surrounding counties stagnate. An optimistic scenario would have a new projects underway in the Reservation and growth in other counties similar to that experienced in California's (similar) Central Valley during the 1980s. If the first case is zero and the second case is 10, our scenario would start out at three on the scale and move to five in 2010.

How does this compare with other projections? Here are the most recent numbers from key government agencies.

Population in Thousands

	1990			2000		
County	BPA	State	Census	BPA	State	DBP
Adams	14.1	13.6	13.6	14.9	14.5	13.7
Benton	107.2	104.6	112.6	123.0	105.9	114.8
Franklin	37.8	34.0	37.5	40.3	34.7	39.4
Grant	55.2	52.1	54.8	59.8	56.5	60.1
Kittitas	25.1	25.4	26.7	26.4	25.4	27.9
Klickitat	17.7	16.8	16.6	20.1	17.1	16.9
Morrow	8.0	8.8	7.6	8.4	12.1	7.5
Umatilla	58.9	67.4	59.2	62.1	80.0	60.4
Walla Walla	48.6	48.9	48.4	52.2	48.8	50.2
Yakima	191.9	189.7	188.8	208.4	207.5	201.2

BPA is the Bonneville Power Administration Economic Analysis Section numbers issued January, 1990. Census is the most recent release of 1990 census data. State is Washington State's Office of Financial Management, which issued projections in 1989. For Oregon, it represents the Center for Population and Census at Portland State University. Its most recent projections were made in 1986 and grossly over-projected Morrow and Umatilla counties for 1990. DBP is the present writer's projections for 2000, which are generally not too different from the recent BPA and OFM numbers.

Birth data were based on 1980-vintage age-specific fertility rates and were adjusted so that model births in the late 1980s approximated reported births. Death rates were assumed to decline until 2010. Migration varied so that

total population agreed with the projected control values.

OTHER NOTES

The appended material includes two printed tables that are also on disc in ASCII format; they could be retrieved and displayed or printed using technology available to the reader. Also included is a listing of files on the disc; the county-based files are the age-sex data. A copy of the program used to create the county ASCII files is enclosed both in hardcopy and on disc; it contains information on the layout of the data.

Population Projections: Hanford Area Counties, 1980-2040.

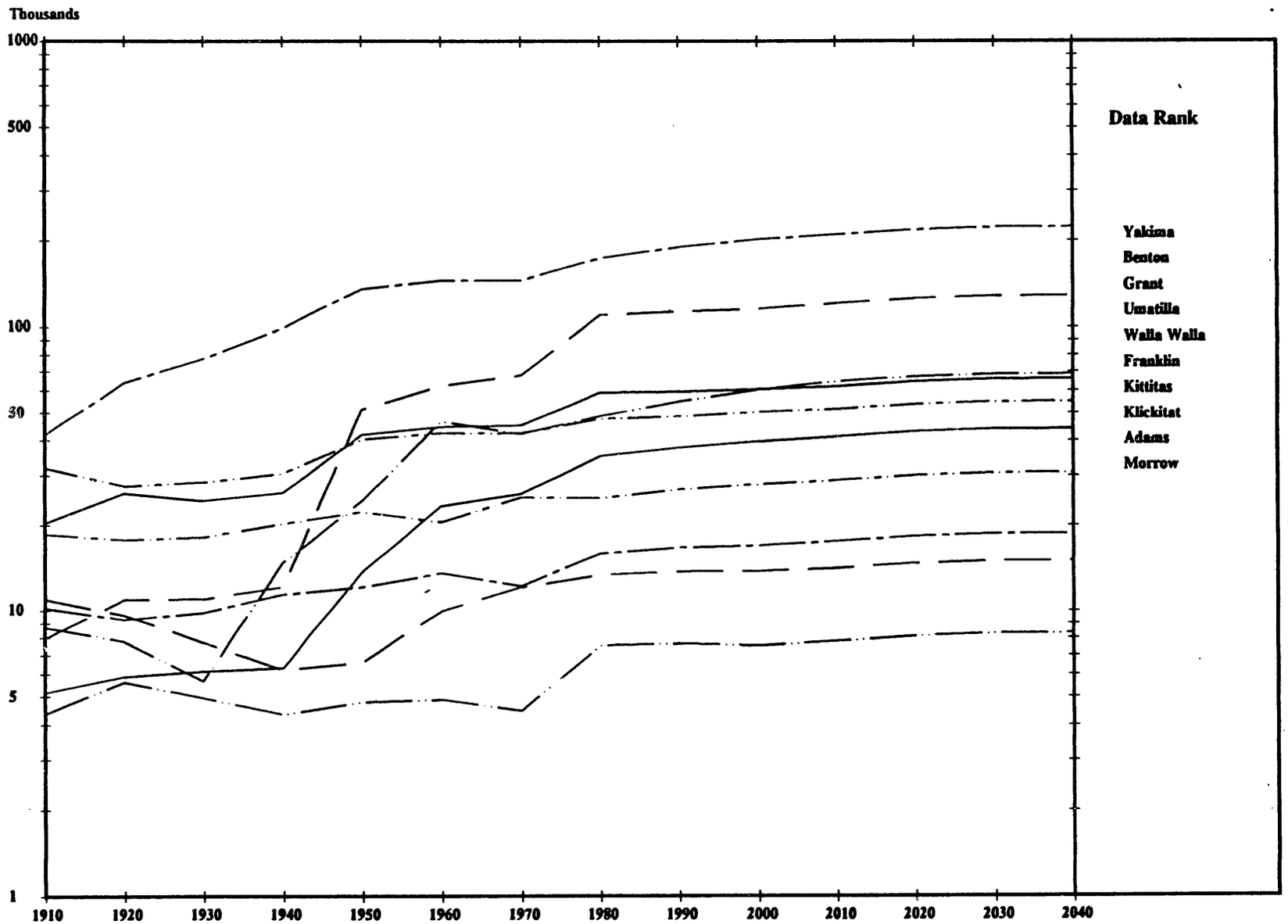
Year	ADAMS	BENTON	FRNKLN	GRANT	KITTAS	KLICKT	MORROW	UMATLA	WWALLA	YAKIMA
1980	13267	109444	35025	48522	24877	15822	7519	58861	47435	172508
1981	13101	113399	36701	48600	25102	16200	7601	59402	47900	175000
1982	13100	111700	36200	48598	25100	16200	7701	60000	48300	175203
1983	13602	108700	36000	49100	24900	16303	7802	60395	48200	177000
1984	13708	107701	36300	49500	24997	16500	7819	60500	48502	179999
1985	13795	105196	35700	49898	25000	16699	7996	60800	48403	182500
1986	13914	104001	35305	50506	24998	16602	7990	60700	48498	183599
1987	13994	104100	35500	52100	25097	16600	7900	60399	48300	184399
1988	14000	104099	35497	52599	25001	16500	7499	60000	48300	186301
1989	13399	104101	34201	51900	25400	16600	7603	59600	48797	187806
1990	13602	112560	37473	54761	26728	16613	7624	59249	48439	188823
1991	13636	113120	37873	55550	26891	16667	7600	59589	48732	190892
1992	13642	113262	38076	56122	26980	16672	7573	59558	48867	192291
1993	13644	113360	38266	56678	27108	16670	7514	59499	48985	193633
1994	13640	113408	38441	57222	27229	16663	7537	59676	49084	194916
1995	13629	113680	38631	57751	27366	16649	7466	59832	49294	196144
1996	13617	113914	38809	58267	27502	16706	7454	59969	49491	197321
1997	13625	114114	38978	58766	27590	16761	7455	60088	49677	198447
1998	13629	114280	39138	59241	27683	16811	7478	60191	49850	199396
1999	13630	114427	39289	59670	27793	16857	7495	60281	50013	200314
2000	13659	114817	39435	60092	27900	16901	7514	60360	50166	201204
2001	13678	115194	39603	60510	28002	16971	7540	60429	50313	202062
2002	13700	115553	39712	60952	28102	17036	7565	60490	50452	202896
2003	13724	115904	39871	61361	28199	17100	7595	60543	50589	203718
2004	13736	116519	40029	61769	28295	17161	7622	60589	50721	204527
2005	13782	117132	40183	62204	28387	17225	7648	60633	50848	205325
2006	13824	117741	40336	62611	28476	17287	7675	60808	50972	206112
2007	13866	118338	40480	63010	28564	17347	7699	60980	51092	206882
2008	13908	118930	40632	63411	28654	17406	7723	61172	51211	207639
2009	13947	119516	40802	63779	28739	17460	7747	61389	51321	208382
2010	13984	120094	40973	64146	28822	17520	7771	61602	51432	209106
2011	14054	120664	41170	64449	28959	17600	7808	61888	51672	210098
2012	14116	121224	41359	64747	29091	17684	7844	62181	51912	211072
2013	14185	121772	41546	65040	29225	17766	7880	62461	52152	212026
2014	14243	122308	41728	65326	29353	17842	7914	62736	52376	212956
2015	14305	122827	41903	65601	29478	17920	7945	62999	52597	213858
2016	14367	123324	42075	65869	29593	17991	7980	63261	52811	214728
2017	14428	123797	42239	66126	29713	18061	8011	63504	53014	215563
2018	14495	124261	42395	66370	29823	18127	8040	63740	53211	216360
2019	14539	124694	42544	66602	29927	18191	8069	63961	53400	217117
2020	14585	125105	42683	66821	30024	18251	8094	64170	53570	217826
2021	14624	125488	42814	67026	30117	18308	8119	64369	53740	218498
2022	14674	125845	42937	67214	30204	18359	8143	64550	53891	219119
2023	14696	126176	43043	67393	30275	18411	8164	64721	54033	219695
2024	14743	126480	43153	67554	30355	18451	8184	64877	54163	220224

2025	14764	126758	43247	67702	30423	18492	8201	65019	54282	220706
2026	14793	127007	43332	67836	30483	18526	8218	65148	54389	221148
2027	14819	127234	43407	67958	30537	18559	8233	65264	54488	221537
2028	14842	127436	43478	68061	30580	18597	8245	65366	54573	221884
2029	14862	127613	43538	68159	30627	18617	8257	65458	54649	222195
2030	14881	127767	43591	68243	30664	18638	8268	65537	54714	222465
2031	14897	127900	43636	68315	30695	18658	8275	65605	54771	222695
2032	14910	128012	43675	68374	30723	18675	8283	65661	54819	222891
2033	14919	128104	43706	68423	30745	18688	8288	65710	54860	223049
2034	14929	128177	43733	68460	30763	18696	8294	65748	54890	223184
2035	14934	128228	43750	68492	30776	18707	8297	65776	54914	223277
2036	14941	128271	43762	68512	30785	18713	8300	65796	54930	223342
2037	14942	128294	43771	68525	30790	18716	8302	65805	54940	223385
2038	14944	128299	43773	68527	30791	18717	8303	65810	54943	223394
2039	14942	128291	43764	68522	30791	18715	8301	65806	54939	223375
2040	14939	128264	43760	68510	30783	18714	8300	65795	54929	223338

Shares of U.S. Population (times 1 million); Hanford Area Counties, 1910-2040.

Year	ADAMS	BENTON	FRNKLN	GRANT	KITTAS	KLICKT	MORROW	UMATLA	WWALLA	YAKIMA
1910	118.4	86.1	55.9	94.3	201.3	110.4	47.2	220.2	346.2	452.2
1920	90.8	102.8	55.4	73.3	167.3	87.4	53.0	244.7	259.7	600.9
1930	62.7	88.9	49.8	46.0	147.4	79.7	40.1	198.0	230.8	628.2
1940	47.0	91.2	47.7	111.0	153.1	85.9	32.8	197.0	231.1	749.2
1950	43.5	339.5	89.6	160.9	146.9	79.6	31.6	275.6	265.2	896.9
1960	55.4	346.1	130.2	259.2	114.1	75.0	27.2	247.3	235.3	809.2
1970	59.1	332.2	127.0	206.0	123.2	59.7	22.0	221.0	207.5	714.3
1980	58.6	483.1	154.6	214.2	109.8	69.8	33.2	259.8	209.4	761.5
1990	54.5	450.9	150.1	219.4	107.1	66.6	30.5	237.3	194.0	756.4
2000	50.9	428.0	147.0	224.0	104.0	63.0	28.0	225.0	187.0	750.0
2010	49.5	425.0	145.0	227.0	102.0	62.0	27.5	218.0	182.0	740.0
2020	49.5	425.0	145.0	227.0	102.0	62.0	27.5	218.0	182.0	740.0
2030	49.5	425.0	145.0	227.0	102.0	62.0	27.5	218.0	182.0	740.0
2040	49.5	425.0	145.0	227.0	102.0	62.0	27.5	218.0	182.0	740.0

Historical and Forecast Population: Hanford Area Counties , 1910-2040.



Version 52.95.95

The Demographics Laboratory

```
      ∇POPCTRL1[0]∇
[0]   POPCTRL1;MOPARS;POPT1;POPT1A;POPT2;DEATHS;SURVPOP;FRATES;FP1;FP2;IF;OF;MIG
SCL;RETSCL;CNT;TEMPPOP;QDEATHS;BIRTHS1;BIRTHS2;TBIRTHS;MBIRTHS;FBIRTHS;YRPOS;CDI
FF;CNT;ICDIFF;OCDIFF;INADJ;OUTADJ;MASK;TEMP1;TEMP2;SINK
[1]  ⍝ ------------------------------------------------------------------
[2]  ⍝ TASK: Single-year population projection--using population total
[3]  ⍝   controls.  Subroutine of CONTROL1.
[4]  ⍝ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
[5]  ⍝ Input: CNTYR (from CONTROL1); DRATES, MIGRATES, FRATES (from sub-
[6]  ⍝   routines); MO, MG, RM (from GETPARMS); POP, POP1Y, BTH, BTH1Y, DTH,
[7]  ⍝   DTH1Y, MIG (from SETMATS); CNTRLPOP (from GETDATA); AREAS (from
[8]  ⍝   SIMPLPOP)
[9]  ⍝ Subroutines: DODRATES, SETMIG1Y, DOMIG1YR, GROUPAGE
[10] ⍝ Output: POP, POP1Y, BTH, DTH, MIG
[11] ⍝ ------------------------------------------------------------------
[12]  MOPARS←MO[;⍳12;CNTYR-1]÷100000
[13]  DODRATES
[14]  DRATES←(AREAS,2,86)⍴DRATES
[15] ⍝
[16]  POPT1←POP1Y[CNTYR-1;;;]
[17]  POPT1A←(AREAS,2,-86)↑POPT1[;;⍳84],+/POPT1[;; 85 86]
[18]  DEATHS←POPT1A×DRATES
[19]  SURVPOP←POPT1A-DEATHS
[20] ⍝
[21]  FRATES←FE[;;CNTYR-1]÷1000
[22]  FP1←⍉(+/POPT1A[;2;15+⍳5]),[1](+/POPT1A[;2;20+⍳5]),[1](+/POPT1A[;2;25+⍳5]),
[1](+/POPT1A[;2;30+⍳5]),[1](+/POPT1A[;2;35+⍳5]),[1](+/POPT1A[;2;40+⍳5]),[.5]+/PO
PT1A[;2;45+⍳5]
[23]  FP2←⍉(+/SURVPOP[;2;15+⍳5]),[1](+/SURVPOP[;2;20+⍳5]),[1](+/SURVPOP[;2;25+⍳5
]),[1](+/SURVPOP[;2;30+⍳5]),[1](+/SURVPOP[;2;35+⍳5]),[1](+/SURVPOP[;2;40+⍳5]),[.
5]+/SURVPOP[;2;45+⍳5]
[24]  BIRTHS1←(0.5×FP1+FP2)×FRATES
[25] ⍝
[26]  SETMIG1Y ⋄ →(YRS(3)/DLC+1
[27]  MIGSCL←MG[;;;5;CNTYR-1]
[28]  RETSCL←RM[;;;2;CNTYR-1]
[29] ⍝
[30] ⍝
[31]  CNT←0
[32] AGAIN:
[33]  DOMIG1YR
[34]  INMIG←SURVPOP×MIGRATES[;1;;]
[35]  OUTMIG←SURVPOP×MIGRATES[;2;;]
[36]  TEMPPOP←SURVPOP+INMIG-OUTMIG
[37] ⍝
[38]  IF←⍉(+/INMIG[;2;15+⍳5]),[1](+/INMIG[;2;20+⍳5]),[1](+/INMIG[;2;25+⍳5]),[1](
+/INMIG[;2;30+⍳5]),[1](+/INMIG[;2;35+⍳5]),[1](+/INMIG[;2;40+⍳5]),[.5]+/INMIG[;2;
45+⍳5]
[39]  OF←⍉(+/OUTMIG[;2;15+⍳5]),[1](+/OUTMIG[;2;20+⍳5]),[1](+/OUTMIG[;2;25+⍳5]),[
1](+/OUTMIG[;2;30+⍳5]),[1](+/OUTMIG[;2;35+⍳5]),[1](+/OUTMIG[;2;40+⍳5]),[.5]+/OUT
```

```
MIG[;2;45+⍳5]
[40]  BIRTHS2←(IF-OF)×FRATES
[41]  TBIRTHS←BIRTHS1+BIRTHS2
[42]  MBIRTHS←TBIRTHS×0.512
[43]  FBIRTHS←TBIRTHS-MBIRTHS
[44]  BIRTHS←⌊0.5+MBIRTHS,[1.5]FBIRTHS
[45] ⍝
[46]  TEMPPOP[;;1]←+/BIRTHS
[47]  QDEATHS←DEATHS+(INMIG-OUTMIG)×((1+DRATES)*÷2)-1
[48]  QDEATHS[;;1]←DRATES[;;1]×TEMPPOP[;;1]
[49]  QDEATHS←⌊0.5+DEATHS
[50]  INMIG[;;1]←⌊0.5+TEMPPOP[;;1]×MIGRATES[;1;;1]
[51]  OUTMIG[;;1]←⌊0.5+TEMPPOP[;;1]×MIGRATES[;2;;1]
[52]  MIG86A←INMIG,[0.5]OUTMIG
[53]  TEMPPOP[;;1]←TEMPPOP[;;1]-QDEATHS[;;1]+INMIG[;;1]-OUTMIG[;;1]
[54]  POPT2←⌊0.5+TEMPPOP
[55] ⍝
[56]  CDIFF←CNTRLPOP[;CNTYR]-+/+/POPT2
[57]  CNT←CNT+1
[58]  →(5E¯5>|CDIFF÷CNTRLPOP[;CNTYR])⍴OUT
[59]  ICDIFF←CDIFF×0.75
[60]  OCDIFF←CDIFF×0.25
[61]  INADJ←MIGSCL[;1;]×⍉(2,AREAS)⍴(ICDIFF÷+/+/INMIG)+1
[62]  OUTADJ←MIGSCL[;2;]×⍉(2,AREAS)⍴((¯1×OCDIFF)÷+/+/OUTMIG)+1
[63] ⍝
[64]  MASK←INADJ>0
[65]  TEMP1←INADJ×MASK
[66]  TEMP2←(~MASK)×MIGSCL[;1;]×.5
[67]  MIGSCL[;1;]←TEMP1+TEMP2
[68] ⍝
[69]  MASK←OUTADJ>0
[70]  TEMP1←OUTADJ×MASK
[71]  TEMP2←(~MASK)×MIGSCL[;2;]×.5
[72]  MIGSCL[;2;]←TEMP1+TEMP2
[73] ⍝
[74]  →(CNT>20)/OUT
[75]  →AGAIN
[76] ⍝
[77] OUT:
[78] ⍝
[79] ⍝
[80] FILLMATS:
[81]  →(0≠+/+/+/POP1Y[CNTYR;;;])/⎕LC+1 ⋄ POP1Y[CNTYR;;;]←POPT2
[82]  →(0≠+/+/+/POP[CNTYR;;;])/⎕LC+1 ⋄ MAT←POPT2 ⋄ GROUPAGE ⋄ POP[CNTYR;;;]←RESU
LT
[83]  MAT←QDEATHS ⋄ GROUPAGE ⋄ DTH[CNTYR-1;;;]←RESULT
[84]  BTH[CNTYR-1;;;]←BIRTHS
[85]  MAT←INMIG ⋄ GROUPAGE
[86]  MIG[CNTYR-1;;1;;]←RESULT
[87]  MAT←OUTMIG ⋄ GROUPAGE
[88]  MIG[CNTYR-1;;2;;]←RESULT
[89] ⍝ ------------------------------------------------------------------
[90]  SINK←⎕EX 'DRATES MIGRATES RESULT'
```

```
      ∇DODRATES[⎕]∇
[0]   DODRATES;RANGE1;RANGE2;RANGE3;RANGE4;MODLMHI;MODLMLO;MODLFHI;MODLFLO;TRGTM
;TRGTF;WGTS
[1]   ⍝ ---------------------------------------------------------------------
[2]   ⍝ TASK: Interpolates death rates for current FINT.  Subroutine of
[3]   ⍝   POPCTRL1, POPCTRL5, MIGCTRL1, or MIGCTRL5.
[4]   ⍝ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
[5]   ⍝ Input: MOPARS (from control program); DRATPATS (from GETPATS); AREAS
[6]   ⍝   (from SIMPLPOP)
[7]   ⍝ Output: DRATES (Sex, Ages)⍴, Ages = 86
[8]   ⍝ ---------------------------------------------------------------------
[9]   RANGE1←0.1×⍳9
[10]  RANGE2←0.1×⍳9
[11]  RANGE3←0.1×⍳9
[12]  RANGE4←0.025×⍳39
[13]  ⍝
[14]  ⍝ Below are rates in DRATPATS for endages 1, 11, 21, 31, 71.
[15]  MODLMHI← 10⍴.055 .00078 .00201 .00281 .06344
[16]  MODLMLO← 10⍴.0054 .00016 .00071 .00069 .03057
[17]  MODLFHI← 10⍴.044 .00062 .00133 .00202 .0467
[18]  MODLFLO← 10⍴.0027 .00008 .0002 .00024 .00945
[19]  ⍝
[20]  TRGTM←10⍴MOPARS[;1 2 3 4 5 6]
[21]  TRGTF←10⍴MOPARS[;7 8 9 10 11 12]
[22]  ⍝
[23]  WGTS←(AREAS,2,5)⍴0
[24]  WGTS[;1;]←(TRGTM[;⍳5]-(AREAS,5)⍴MODLMLO)÷(AREAS,5)⍴MODLMHI-MODLMLO
[25]  WGTS[;2;]←(TRGTF[;⍳5]-(AREAS,5)⍴MODLFLO)÷(AREAS,5)⍴MODLFHI-MODLFLO
[26]  ⍝
[27]  DRATES←(AREAS,2,86)⍴0
[28]  DRATES[;1; 1 11 21 31 71 86]←TRGTM
[29]  DRATES[;2; 1 11 21 31 71 86]←TRGTF
[30]  ⍝
[31]  DRATES[;;1+⍳9]←((((AREAS,2,9)⍴1-RANGE1)×((AREAS,2,9)⍴DRATPATS[1 3;1+⍳9])×3
 1 2⍉(9,AREAS,2)⍴WGTS[;;1])+(((AREAS,2,9)⍴1-RANGE1)×((AREAS,2,9)⍴DRATPATS[2 4;1+
⍳9])×3 1 2⍉(9,AREAS,2)⍴1-WGTS[;;1]))+(((AREAS,2,9)⍴RANGE1)×((AREAS,2,9)⍴DRATPATS
[1 3;1+⍳9])×3 1 2⍉(9,AREAS,2)⍴WGTS[;;2])+(((AREAS,2,9)⍴RANGE1)×((AREAS,2,9)⍴DRATP
ATS[2 4;1+⍳9])×3 1 2⍉(9,AREAS,2)⍴1-WGTS[;;2]
[32]  DRATES[;;11+⍳9]←((((AREAS,2,9)⍴1-RANGE2)×((AREAS,2,9)⍴DRATPATS[1 3;11+⍳9])
×3 1 2⍉(9,AREAS,2)⍴WGTS[;;2])+(((AREAS,2,9)⍴1-RANGE2)×((AREAS,2,9)⍴DRATPATS[2 4;
11+⍳9])×3 1 2⍉(9,AREAS,2)⍴1-WGTS[;;2]))+(((AREAS,2,9)⍴RANGE2)×((AREAS,2,9)⍴DRATP
ATS[1 3;11+⍳9])×3 1 2⍉(9,AREAS,2)⍴WGTS[;;3])+(((AREAS,2,9)⍴RANGE2)×((AREAS,2,9)⍴D
RATPATS[2 4;11+⍳9])×3 1 2⍉(9,AREAS,2)⍴1-WGTS[;;3]
[33]  DRATES[;;21+⍳9]←((((AREAS,2,9)⍴1-RANGE3)×((AREAS,2,9)⍴DRATPATS[1 3;21+⍳9])
×3 1 2⍉(9,AREAS,2)⍴WGTS[;;3])+(((AREAS,2,9)⍴1-RANGE3)×((AREAS,2,9)⍴DRATPATS[2 4;
21+⍳9])×3 1 2⍉(9,AREAS,2)⍴1-WGTS[;;3]))+(((AREAS,2,9)⍴RANGE3)×((AREAS,2,9)⍴DRATP
ATS[1 3;21+⍳9])×3 1 2⍉(9,AREAS,2)⍴WGTS[;;4])+(((AREAS,2,9)⍴RANGE3)×((AREAS,2,9)⍴D
RATPATS[2 4;21+⍳9])×3 1 2⍉(9,AREAS,2)⍴1-WGTS[;;4]
[34]  DRATES[;;31+⍳39]←((((AREAS,2,39)⍴1-RANGE4)×((AREAS,2,39)⍴DRATPATS[1 3;31+⍳
39])×3 1 2⍉(39,AREAS,2)⍴WGTS[;;4])+(((AREAS,2,39)⍴1-RANGE4)×((AREAS,2,39)⍴DRATPA
```

```
TS[2 4;31+⍳39])×3 1 2⍉(39,AREAS,2)⍴1-WGTS[;;4]))+(((AREAS,2,39)⍴RANGE4)×((AREAS,
2,39)⍴DRATPATS[1 3;31+⍳39])×3 1 2⍉(39,AREAS,2)⍴WGTS[;;5])+((AREAS,2,39)⍴RANGE4)×
((AREAS,2,39)⍴DRATPATS[2 4;31+⍳39])×3 1 2⍉(39,AREAS,2)⍴1-WGTS[;;5]
[35]  DRATES[;;71+⍳14]←(((AREAS,2,14)⍴DRATPATS[1 3;71+⍳14])×3 1 2⍉(14,AREAS,2)⍴W
GTS[;;5])+((AREAS,2,14)⍴DRATPATS[2 4;71+⍳14])×3 1 2⍉(14,AREAS,2)⍴1-WGTS[;;5]
[36] ⍝
[37]  DRATES←10*DRATES
[38] ⍝ ------------------------------------------------------------------
```

```
      ∇SETMIG1Y[⎕]∇
[0]   SETMIG1Y:SINK;RANGE;WEIGHTS;BASEPOS;LIDPOS;RPATS;LID;BASE;CNTIO;CNTSX;RETP
ATS;MAX;CMAX
[1]  ⍝ ------------------------------------------------------------------
[2]  ⍝ TASK: Builds migration rates from parameters, model patterns.  Sub-
[3]  ⍝   routine of POPCTRL1.
[4]  ⍝ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
[5]  ⍝ Input: MIGPATS1, RETPATS1 (from GETPATS); MG, RM (from GETPARMS or
[6]  ⍝   PARSETUP); CNTYR (from CONTROL1); AREAS (from SIMPLPOP)
[7]  ⍝ Output: BASMIGPATS (AREAS, I/O, Sex, Ages) ⍴ , Ages = 86; RETMIGPATS
[8]  ⍝   (AREAS, I/O, Sex, Ages) ⍴ , Ages = 71
[9]  ⍝ ------------------------------------------------------------------
[10]  MODLHILO←MIGPATS1[; 11 21 46]
[11]  RATPARS←MG[;;; 2 3 4;CNTYR-1]
[12]  RATWGTS←((10⍟RATPARS)-(AREAS,2,2,3)⍴MODLHILO[2;])÷(AREAS,2,2,3)⍴(MODLHILO[
1;])-MODLHILO[2;]
[13] ⍝
[14]  TEMP←(AREAS,2,2,82)⍴0
[15]  TEMP[;;;16]←10⍟1
[16]  TEMP[;;;⍳15]←((AREAS,2,2,15)⍴MIGPATS1[2;⍳15])+(4 1 2 3⍉(15,AREAS,2,2)⍴RATW
GTS[;;;1])×(AREAS,2,2,15)⍴MIGPATS1[1;⍳15]-MIGPATS1[2;⍳15]
[17]  TEMP[;;;16+⍳5]←((AREAS,2,2,5)⍴MIGPATS1[2;16+⍳5])+(4 1 2 3⍉(5,AREAS,2,2)⍴RA
TWGTS[;;;2])×(AREAS,2,2,5)⍴MIGPATS1[1;16+⍳5]-MIGPATS1[2;16+⍳5]
[18]  W1←(4 1 2 3⍉(24,AREAS,2,2)⍴RATWGTS[;;;3])×(AREAS,2,2,24)⍴(⍳24)÷25
[19]  W2←(4 1 2 3⍉(24,AREAS,2,2)⍴RATWGTS[;;;2])×(AREAS,2,2,24)⍴(⌽⍳24)÷25
[20]  T1←W1×(AREAS,2,2,24)⍴MIGPATS1[1;21+⍳24]-MIGPATS1[2;21+⍳24]
[21]  T2←W2×(AREAS,2,2,24)⍴MIGPATS1[1;21+⍳24]-MIGPATS1[2;21+⍳24]
[22]  TEMP[;;;21+⍳24]←((AREAS,2,2,24)⍴MIGPATS1[2;21+⍳24])+T1+T2
[23]  TEMP[;;;45+⍳37]←((AREAS,2,2,37)⍴MIGPATS1[2;45+⍳37])+(4 1 2 3⍉(37,AREAS,2,2
)⍴RATWGTS[;;;3])×(AREAS,2,2,37)⍴MIGPATS1[1;45+⍳37]-MIGPATS1[2;45+⍳37]
[24]  ROT←19-MG[;;;1;CNTYR-1]
[25]  TEMP2←10*(AREAS,2,2,-71)↑ROT⍉TEMP
[26]  MAXTEMP2←⌈/TEMP2
[27]  BASMIGPATS←TEMP2× 4 1 2 3⍉(71,AREAS,2,2)⍴1÷MAXTEMP2
[28]  SINK←⍎⍕ 'MODLHILO RATPARS RATWGTS TEMP W1 W2 T1 T2 ROT TEMP2 MAXTEMP2'
[29] ⍝
[30] ⍝
[31]  RETPATMODES←(AREAS,2,2,3)⍴ 60 67.5 82.5
[32]  GTHAN←RETPATMODES- 4 1 2 3⍉(3,AREAS,2,2)⍴RM[;;;1;CNTYR-1]
[33]  LTHAN←(4 1 2 3⍉(3,AREAS,2,2)⍴RM[;;;1;CNTYR-1])-RETPATMODES
[34]  MASK←GTHAN=0
[35]  OVER←⌈/[4](GTHAN20)×÷GTHAN+MASK
[36]  UNDER←(÷⌈/[4](LTHAN20)×÷LTHAN+MASK)-⌈/[4]MASK
[37]  RANGE←OVER+UNDER
[38]  WEIGHTS←UNDER÷RANGE
[39]  BASEPOS←+/[4]LTHAN20
[40]  LIDPOS←BASEPOS+1
[41]  SINK←⍎⍕ 'RETPATMODES GTHAN LTHAN MASK OVER UNDER RANGE'
[42] ⍝ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
[43] ⍝ ABOVE establishes model pat positions bracketing modes.
```

```
[44] ⍝ BELOW, interpolation & scaling so Max = unity.
[45] ⍝ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
[46]  RPATS←(AREAS,3,71)⍴RETPATS1
[47]  LID←(AREAS,2,2,71)⍴0
[48]  BASE←(AREAS,2,2,71)⍴0
[49]  CNTIO←0
[50] LOOPIO:CNTIO←CNTIO+1
[51]  CNTSX←0
[52] LOOPSX:CNTSX←CNTSX+1
[53]  LID[;CNTIO;CNTSX;]←(AREAS,71)⍴RPATS[;(LIDPOS[;CNTIO;CNTSX]);]
[54]  BASE[;CNTIO;CNTSX;]←(AREAS,71)⍴RPATS[;(BASEPOS[;CNTIO;CNTSX]);]
[55]  →(CNTSX<2)⍴LOOPSX
[56]  →(CNTIO<2)⍴LOOPIO
[57]  WEIGHTS← 4 1 2 3⍉(71,AREAS,2,2)⍴WEIGHTS
[58]  RETPATS←(BASE×1-WEIGHTS)+LID×WEIGHTS
[59]  MAX←⌈/[4]RETPATS
[60]  CMAX←1÷MAX
[61]  RETPATS←RETPATS× 4 1 2 3⍉(71,AREAS,2,2)⍴CMAX
[62]  RETMIGPATS←RETPATS× 4 1 2 3⍉(71,AREAS,2,2)⍴RM[;;;2;CNTYR-1]
[63] ⍝ ---------------------------------------------------------------------
```

```
      ∇DOMIG1YR[⎕]∇
[0]    DOMIG1YR;BASRATES;RETRATES;YNGRATES
[1]   ⍝ ---------------------------------------------------------------------
[2]   ⍝ TASK: Builds rates.  Subroutine of BASPOP1, POPCTRL1, MIGCTRL1.
[3]   ⍝ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
[4]   ⍝ Input: MIGSCL, RETSCL (from control program); BASMIGPATS, RETMIGPATS
[5]   ⍝   (from SETMIG1Y); AREAS (from SIMPLPOP)
[6]   ⍝ Subroutine: MGSXADJ1
[7]   ⍝ Output: MIGRATES (AREAS, I/O, Sex, Ages)⍴
[8]   ⍝ ---------------------------------------------------------------------
[9]    MIGRATES←(AREAS,2,2,86)⍴0
[10]  ⍝
[11]   BASRATES←BASMIGPATS×4 1 2 3⍉(71,AREAS,2,2)⍴MIGSCL
[12]   MGSXADJ1
[13]  ⍝
[14]   RETRATES←RETMIGPATS×4 1 2 3⍉(71,AREAS,2,2)⍴RETSCL
[15]  ⍝
[16]   MIGRATES[;;;15+⍳71]←BASRATES+RETRATES
[17]  ⍝
[18]   YNGRATES←3 1 2 4⍉(2,AREAS,2,18)⍴MIGRATES[;;2;27+⍳18]
[19]  ⍝
[20]   MIGRATES[;;;⍳17]←YNGRATES[;;;⍳17]
[21]   MIGRATES[;;;18]←(.4×MIGRATES[;;;18])+.6×YNGRATES[;;;18]
[22]   MIGRATES[;;;1]←.5×MIGRATES[;;;1]
[23]  ⍝ ---------------------------------------------------------------------
```

```
      ∇MGSXADJ1[⎕]∇
[0]    MGSXADJ1;TEMP;CUM;RATIOS;ADJ;TEST;CNTD
[1]   ⍝ ------------------------------------------------------------------
[2]   ⍝ TASK: Seeks sex ratio balance in migration over ages 15-85+ by
[3]   ⍝   adjusting male rates based on cumulative in and out migration.
[4]   ⍝   Subroutine of DOMIG1YR.
[5]   ⍝ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
[6]   ⍝ Input: BASRATES (from control: (In/Out, Sex, Ages)⍴); SXRTOL (from
[7]   ⍝   .....  --sex ratio tolerance ages 15-85+: (High/Low)⍴);
[8]   ⍝   AREAS (from SIMPLPOP)
[9]   ⍝ Output: BASRATES
[10]  ⍝ ------------------------------------------------------------------
[11]   TEMP←BASRATES
[12]   CUM←+/TEMP
[13]   RATIOS←CUM[;;1]÷CUM[;;2]
[14]   ADJ←RATIOS*÷2
[15]   TEST←((RATIOS>SXRTOL[1])∨RATIOS<SXRTOL[2])
[16]  ⍝
[17]   CNTD←0
[18]  LOOPD:CNTD←CNTD+1
[19]   →(0=+/TEST[;CNTD])/DOWND
[20]   TEMP[;CNTD;;]←TEMP[;CNTD;;]×3 2 1⍉(71,2,AREAS)⍴(÷ADJ[;CNTD]),[.5]ADJ[;CNTD
]
[21]  DOWND:
[22]   →(CNTD<2)/LOOPD
[23]  ⍝
[24]   BASRATES←TEMP
[25]  ⍝ ------------------------------------------------------------------
```

```
      ∇FILEDATA[⎕]∇
[0]   FILEDATA;YEARS;SEX;ANAMES;EOL;EOF;DATA;DDIM;JUNK;CNTA;FNAME;CNTYR;CNTSX;LE
ADER;LINE
[1]   ⍝ ------------------------------------------------------------------
[2]   ⍝ TASK: Puts age-sex data into ASCII files--one file per county.
[3]   ⍝ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
[4]   ⍝ Input: Pop array (Time, Area, Sex, Age)⍴
[5]   ⍝ Output: To disk.
[6]   ⍝ ------------------------------------------------------------------
[7]   YEARS←4 0⍕61 1⍴1980,1980+⍳60
[8]   SEX←2 1⍴'MF'
[9]   ANAMES←10 8⍴'ADAMS   BENTON  FRANKLINGRANT   KITTITASKLICKTATMORROW  UMATI
LLAWLLAWLLAYAKIMA  '
[10]  EOL←⎕TCNL,⎕TCLF
[11]  EOF←⎕AV[27]
[12] ⍝
[13]  ⎕TCFF
[14]  ' Enter age-sex data array.' ⋄ ' '
[15]  DATA←⎕ ⋄ ' '
[16]  DDIM←⍴DATA
[17] ⍝
[18]  ⎕TCFF
[19]  ' Output data disk should be in Drive A.' ⋄ ' '
[20]  '   ..Press <ENTER> to continue.' ⋄ ' ' ⋄ JUNK←⎕ ⋄ ' '
[21] ⍝
[22] ⍝
[23]  CNTA←0
[24] LOOPA:CNTA←CNTA+1
[25] ⍝
[26]  FNAME←ANAMES[CNTA;]
[27]  FNAME←(FNAME≠' ')/FNAME
[28]  FNAME←FNAME,'.DAT'
[29]  ('A:',FNAME)⎕NCREATE ¯1
[30] ⍝
[31]  CNTYR←0
[32] LOOPYR:CNTYR←CNTYR+1
[33]  CNTSX←0
[34] LOOPSX:CNTSX←CNTSX+1
[35] ⍝
[36]  LEADER←YEARS[CNTYR;],' ',SEX[CNTSX;],'  '
[37]  LINE←LEADER,(6 0⍕DATA[CNTYR;CNTA;CNTSX;]),EOL
[38]  LINE ⎕NAPPEND ¯1
[39] ⍝
[40]  →(CNTSX<DDIM[3])/LOOPSX
[41]  →(CNTYR<DDIM[1])/LOOPYR
[42] ⍝
[43]  EOF ⎕NAPPEND ¯1
[44]  ⎕NUNTIE ¯1
[45]  ' File ',FNAME,' filled.'
[46]  →(CNTA<DDIM[2])/LOOPA
```

```
[47] ⍝
[48]  ' Filing completed.' ⋄ ' '
[49] ⍝ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
[50] ⍝  NOTE: File line format is...
[51] ⍝
[52] ⍝                Char(s)    1-4 = Year
[53] ⍝                              5 = blank
[54] ⍝                              6 = Sex
[55] ⍝                            7,8 = blank
[56] ⍝                          6-116 = Age data (6 chars per number), ages
[57] ⍝                                    0-4, 5-9, 10-14, ..., 80-84, 85+
[58] ⍝                        117,118 = End-of-line code
[59] ⍝
[60] ⍝                 Final character in file is end-of-file code.
[61] ⍝ ------------------------------------------------------------------
```

APPENDIX B

METHODOLOGY FOR DETERMINING POPULATIONS WITHIN SECTORS

APPENDIX B

METHODOLOGY FOR DETERMINING POPULATIONS WITHIN SECTORS

This appendix explains the process by which approximate populations within sectors of a circular grid centered on four locations on the Hanford Site were determined.

A computerized geographic information system was used to store and process data on population within the various sectors. The software, ARC/INFO, was designed by Environmental Systems Research Institute (ESRI). Data consist of a map of the area of interest and tables of information about the map. The map can be digitized by entering coordinates from the keyboard or tracing with a mouse or another pointing device. The tables are databases with the capability of doing some calculations. Records consist of items that are calculated or keyed in. Calculated items are found using previously entered items and an equation set up by the user. Use of tables is possible not only inside a specific database, but from anywhere in ARC/INFO.

One data set, or coverage, contains all of the information concerning one map. When a coverage is created, the system automatically creates one record for each polygon in the map. The system then calculates the area and perimeter of the polygon, and assigns the polygon an ID number.

Three types of coverages were created for this project. The first coverage, MAP, contains a map of individual census tracts within the census divisions in twelve counties around the Hanford Site: Adams, Chelan, Douglas, Grant, Kitittas, Yakima, Klickitat, Franklin, Benton, Walla Walla, Morrow, and Umatilla.[a] Altogether, there are 58 census divisions. The table in this coverage contains both county and division populations for 1980, 1990, 2000, 2010, 2020, 2030, and 2040.

(a) In the small corners of Chelan and Douglas counties included in the 50-mile radius from the 100N meteorological tower, the population was assumed to be zero. In Morrow and Umatilla counties, only the county census divisions were used to allocate population.

The baseline populations include census tract populations for 1990 (CT90_1990) and county populations for all years (cnty_pop_XXXX). To determine all other year census tract populations (CT90_1980, CT90_2000, etc.), a ratio was used, based on the simplifying assumption that population growth rate for the census tract is the same as the county population growth rate. Population was assumed to be uniformly distributed within a census tract.

Therefore, the following equation was used to find division populations:

(CT90_POP) = (CT90_1990) * (CNTY_pop_2000)/(CNTY_pop_1990)

This calculation was made for each of the forecast years (e.g., the year 2020), for each of the 58 census divisions to complete the data in the MAP table.

The second coverage, GRID, is a circular grid consisting of five concentric rings, each divided into sixteen wedges. These wedges correspond to 16 different compass points. Each polygon is one sector. Each sector, except for the innermost 16 nearest the origin is created by the intersection of 2 contiguous compass points with 2 concentric radii (see Figures C.1 through C.4).

The final coverage, OVERLAY, consists of MAP overlaid with GRID. There are four OVERLAYs, one for each of the four locations on which the grid centers: 100-N Meteorological Tower, Hanford Meteorological Station, 300 Area Meteorological Tower, and 400 Area Meteorological Tower. Each OVERLAY is a unique set of polygons. The polygons signify nothing geographically because their boundaries may be either GRID lines, MAP lines, or a combination of these. However, they are very important because total population in each sector of the grid is determined by summing the populations of its constituent polygons.

The population in each polygon was determined using the ratio of population to area in square miles, again assuming that population in census tracts, and therefore in polygons, is evenly distributed.

(poly_pop_2000) = (poly_area) * (CT90_pop_2000) / (CT90_area)

The population of a sector is the summation of the populations of all the polygons within that sector (see Figures C.14 through C.61 and Tables 2.1 through 2.4).

$$(\text{sect\_pop\_2000}) = (\text{poly\_pop\_2000})_1 + (\text{poly\_pop\_2000})_2 + \ldots + (\text{poly\_pop\_2000})_n$$

APPENDIX C

POPULATION PROJECTIONS BY GRID AREA

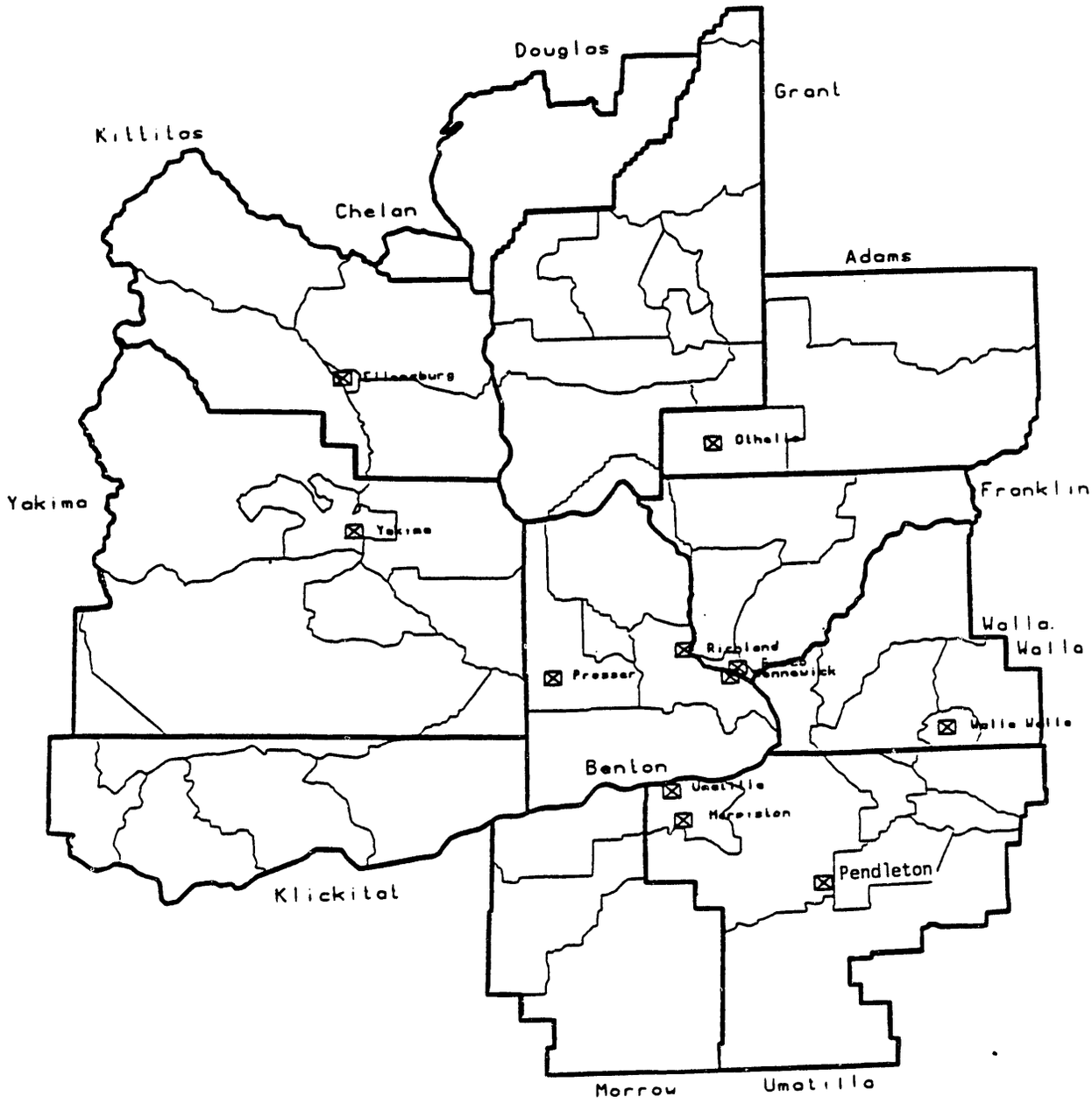


FIGURE C.1. Counties, Census Divisions, and Cities Around Hanford Site

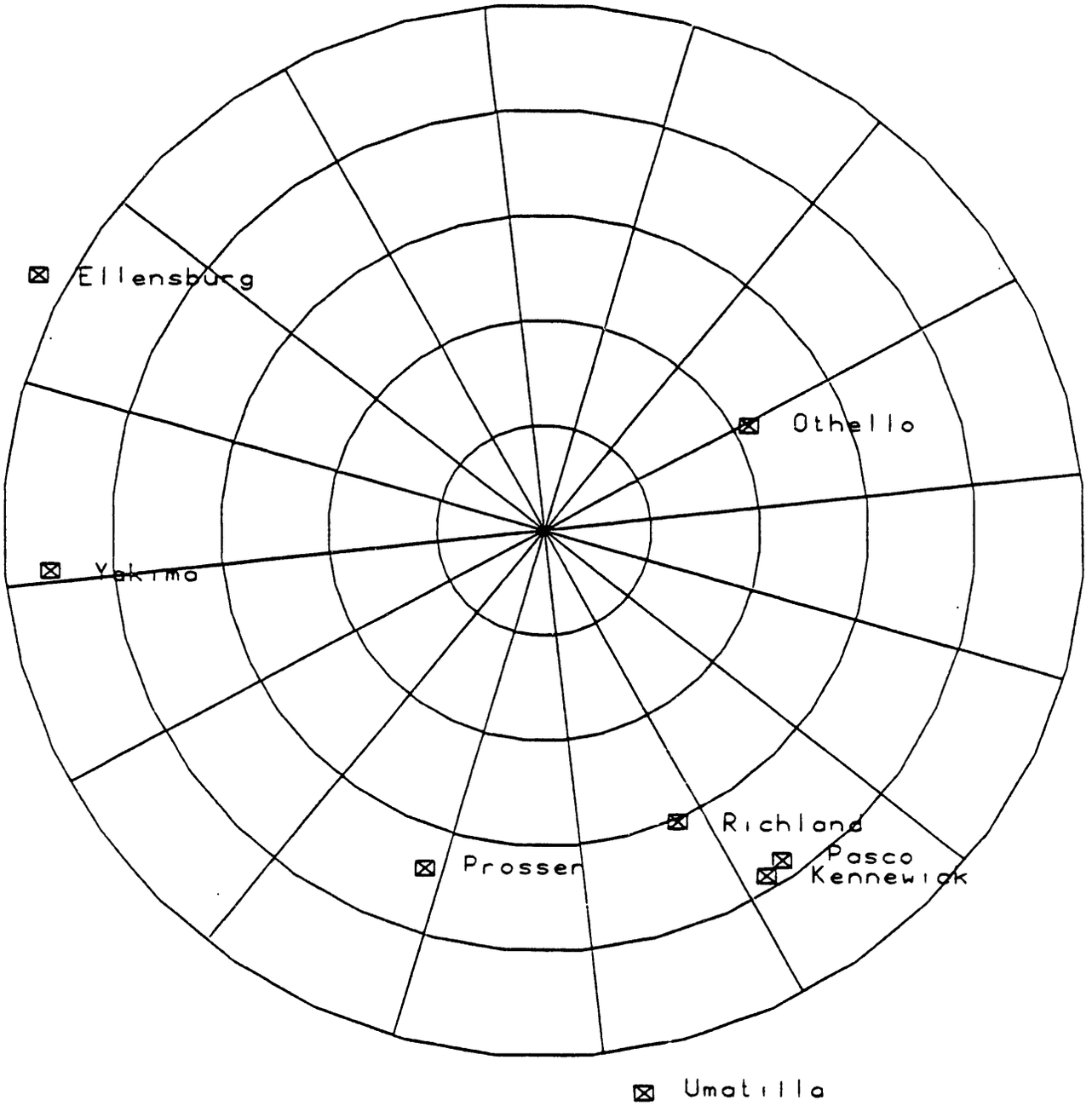


FIGURE C.2. Cities Within 80 Kilometers (50 Miles) of 100-N Meteorological Tower

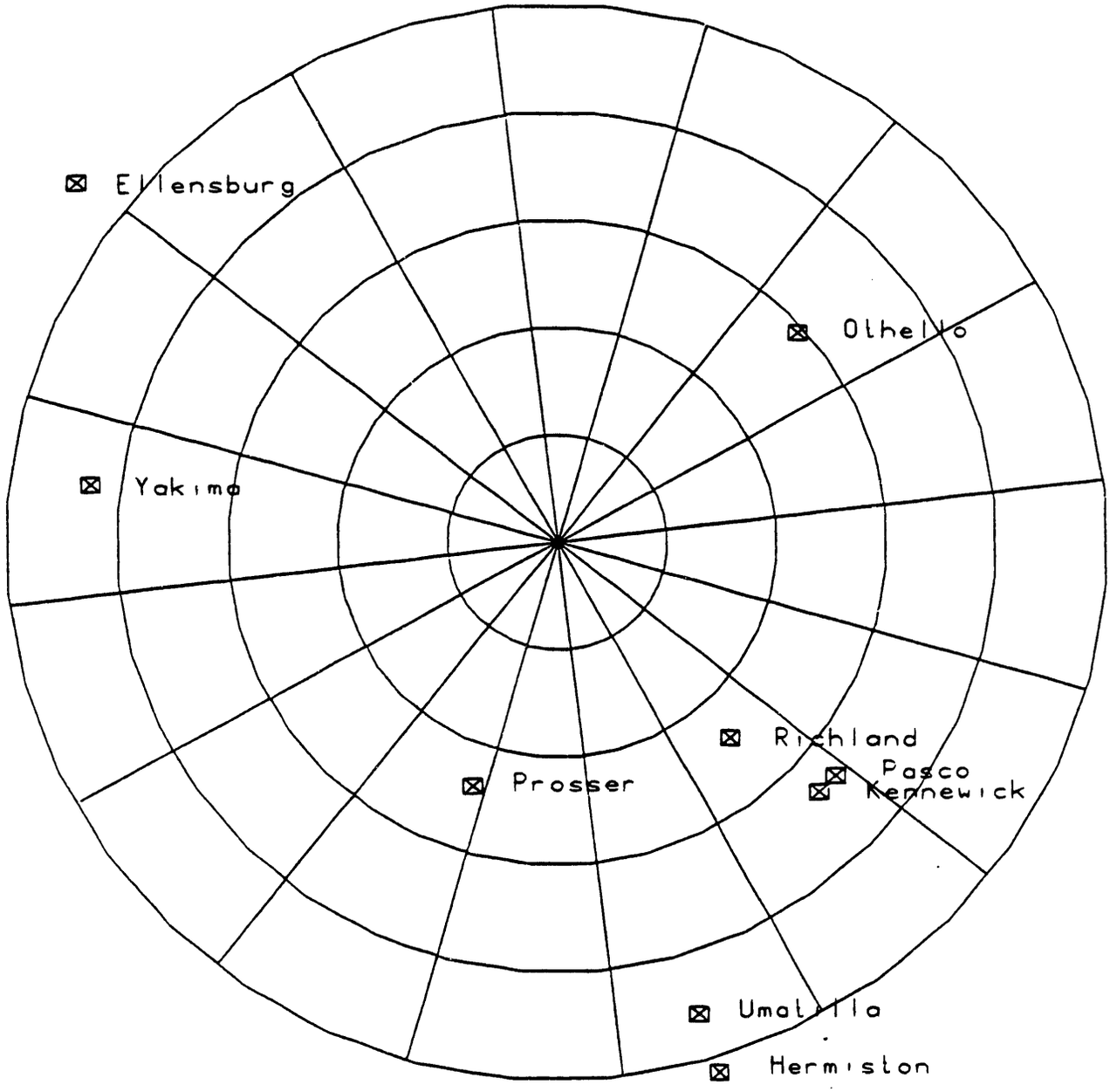


FIGURE C.3. Cities Within 80 Kilometers (50 Miles) of Hanford Meteorological Station

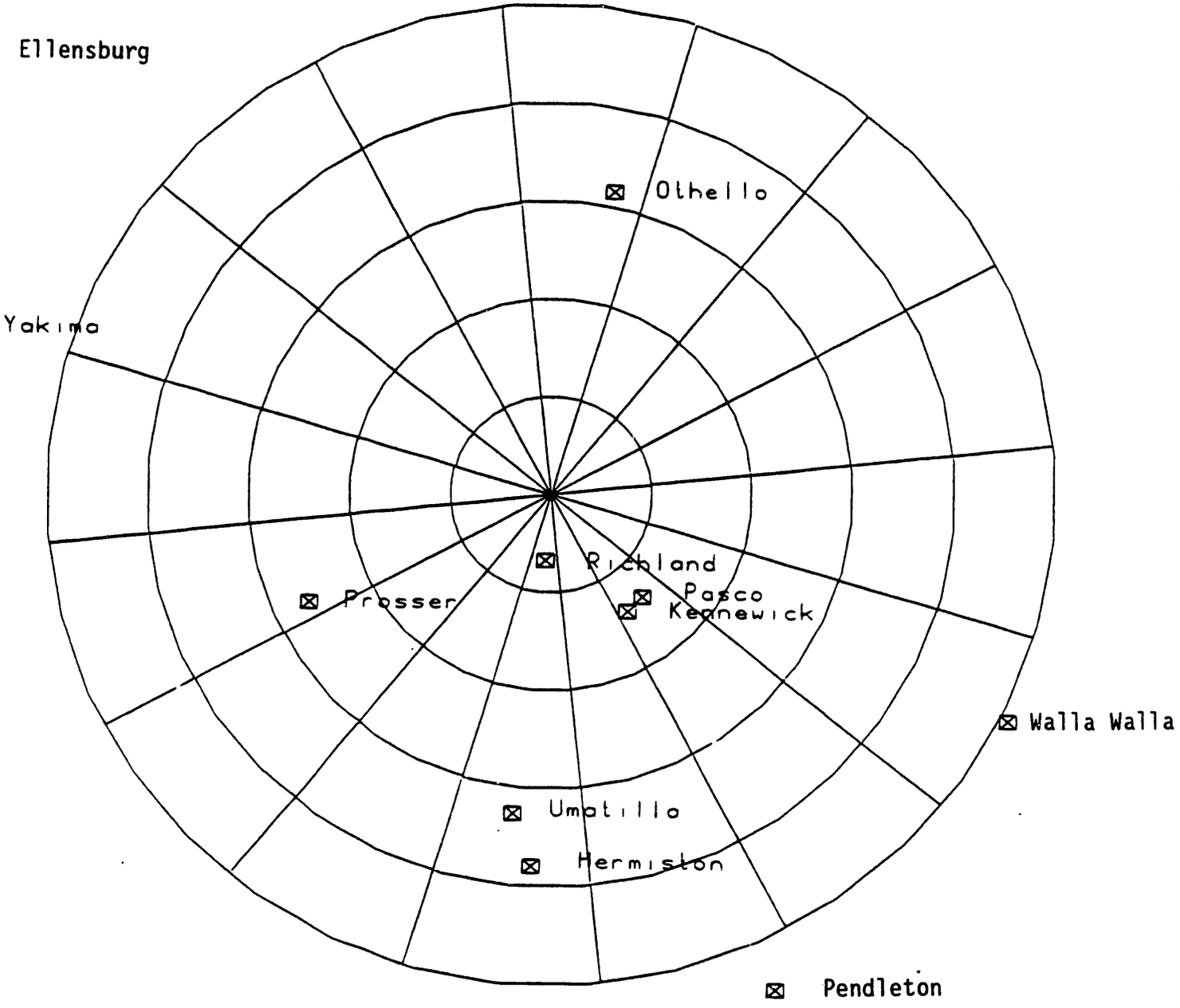


FIGURE C.4. Cities Within 80 Kilometers (50 Miles) of 300 Area Meteorological Tower

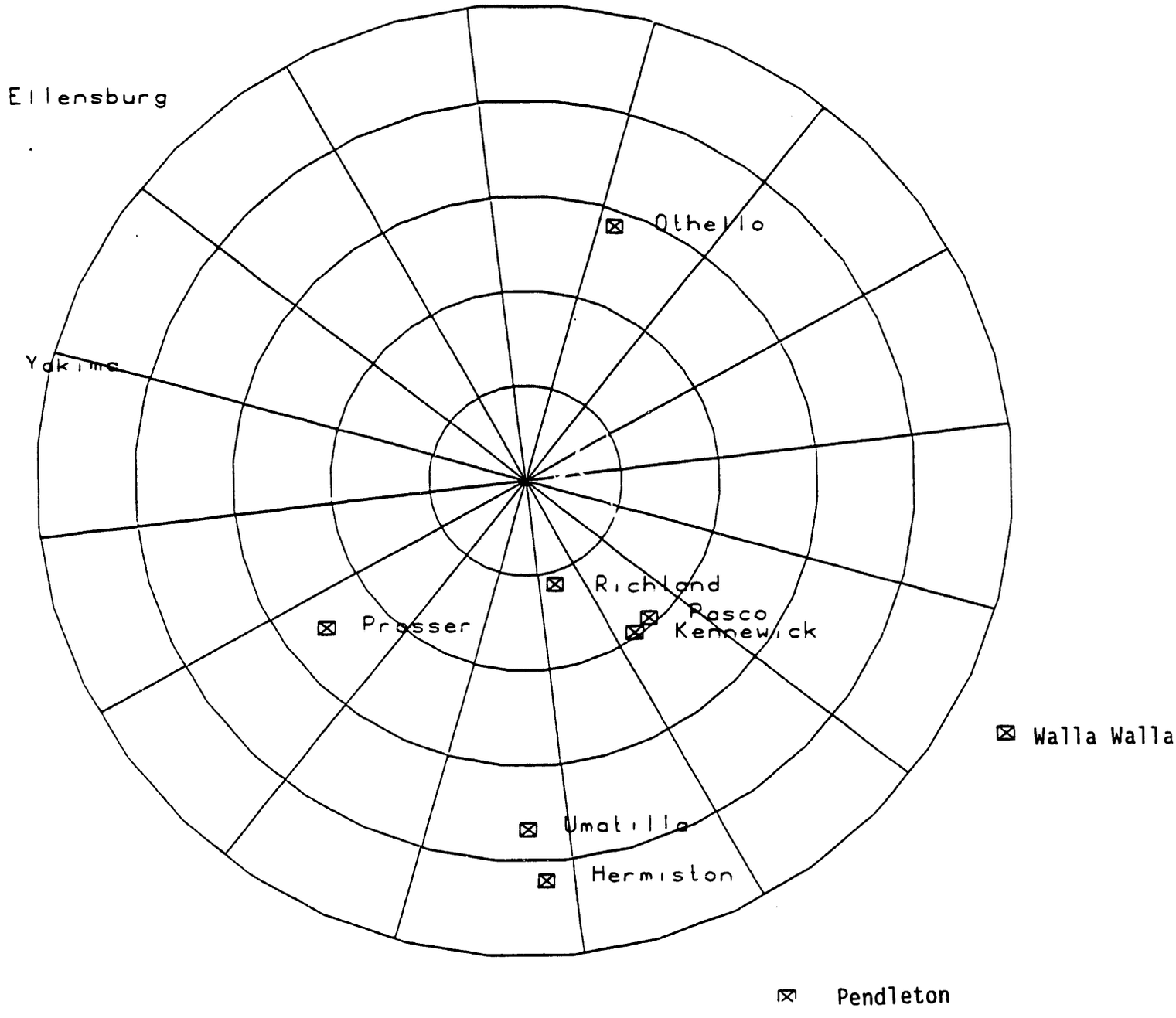


FIGURE C.5. Cities Within 80 Kilometers (50 Miles) of the 400 Area Meteorological Tower

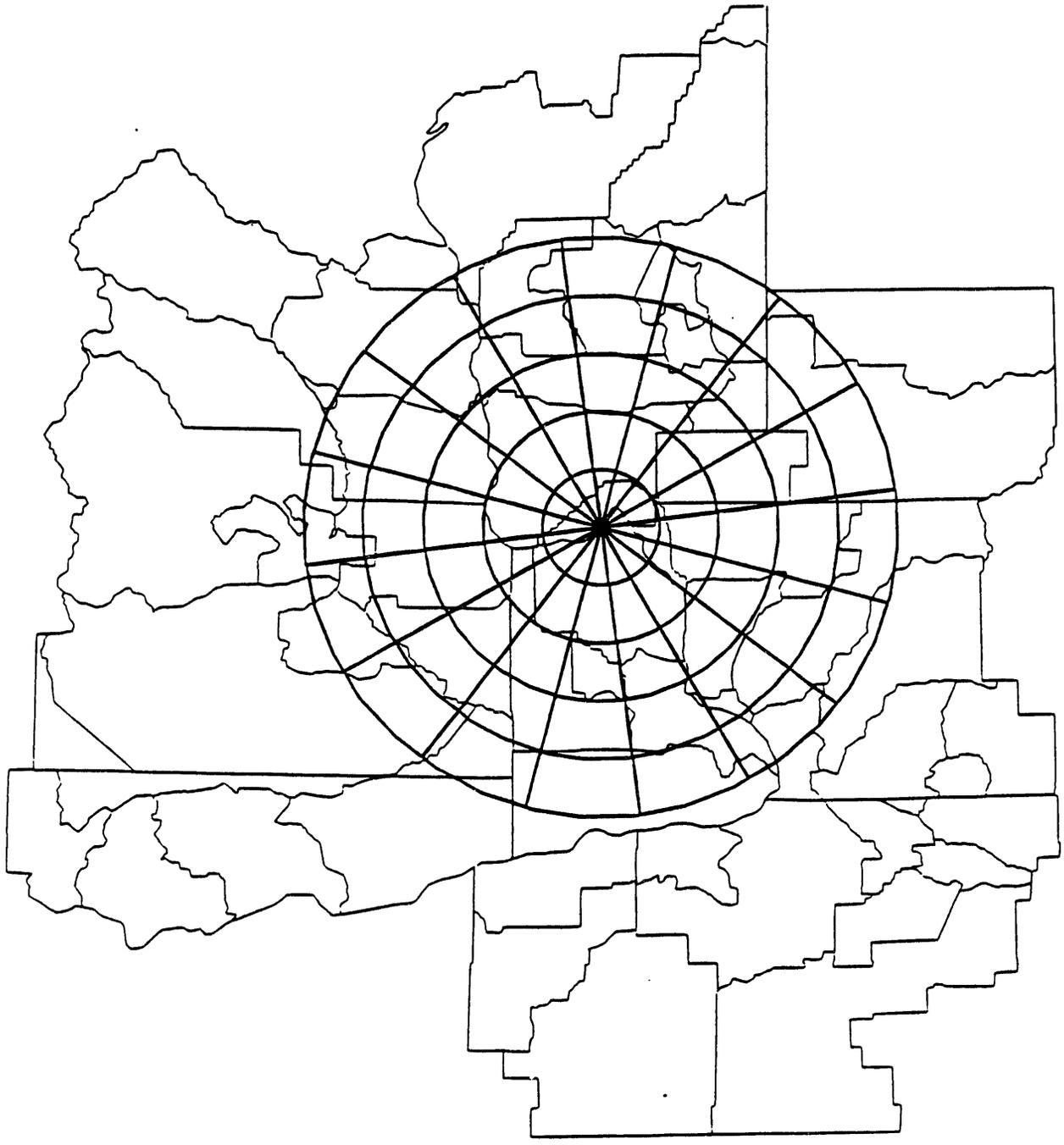


FIGURE C.6. Areas Within 80 Kilometers (50 Miles) of 100-N Meteorological Tower

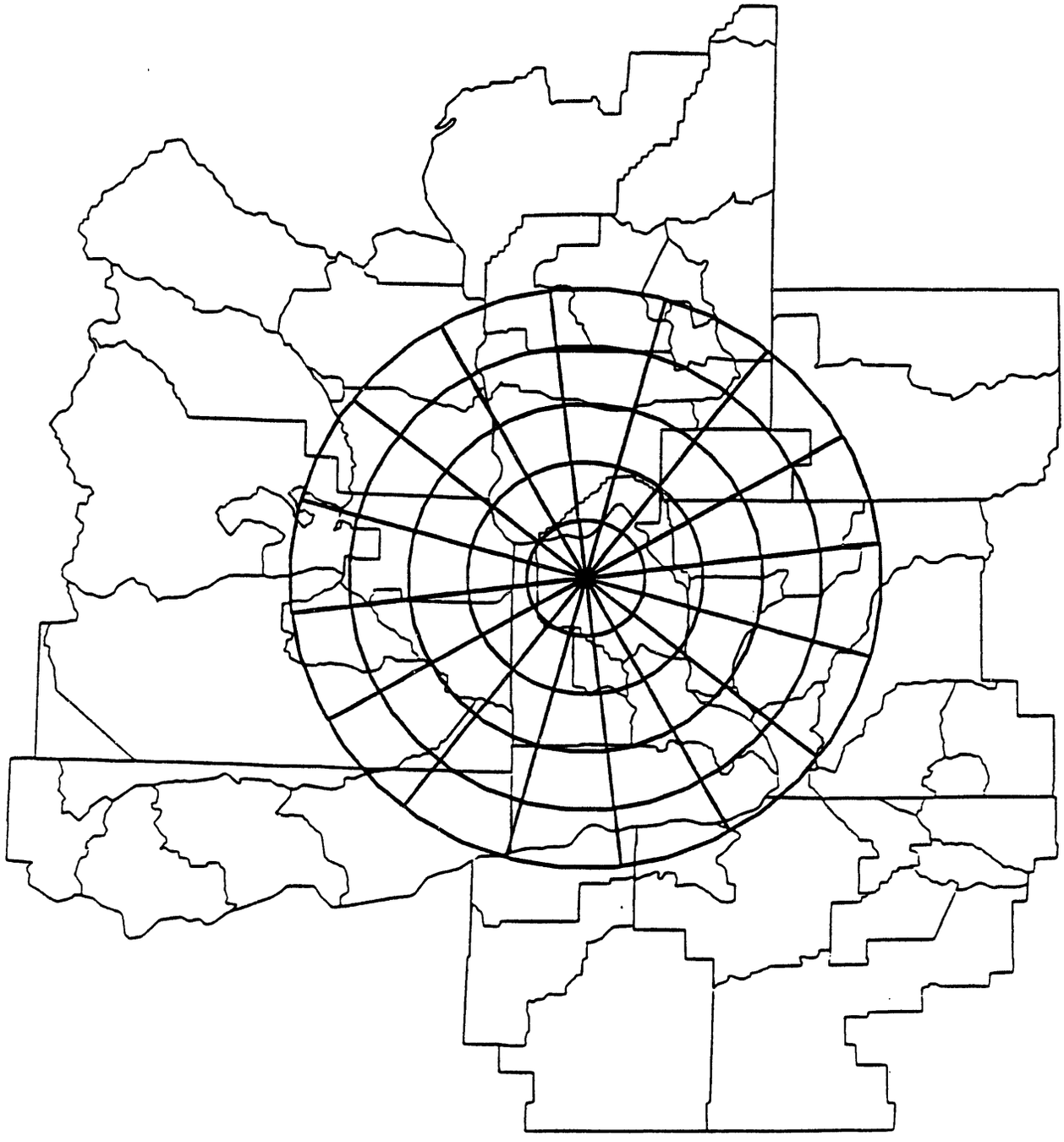


FIGURE C.7. Areas Within 80 Kilometers (50 Miles) of the Hanford Meteorological Station

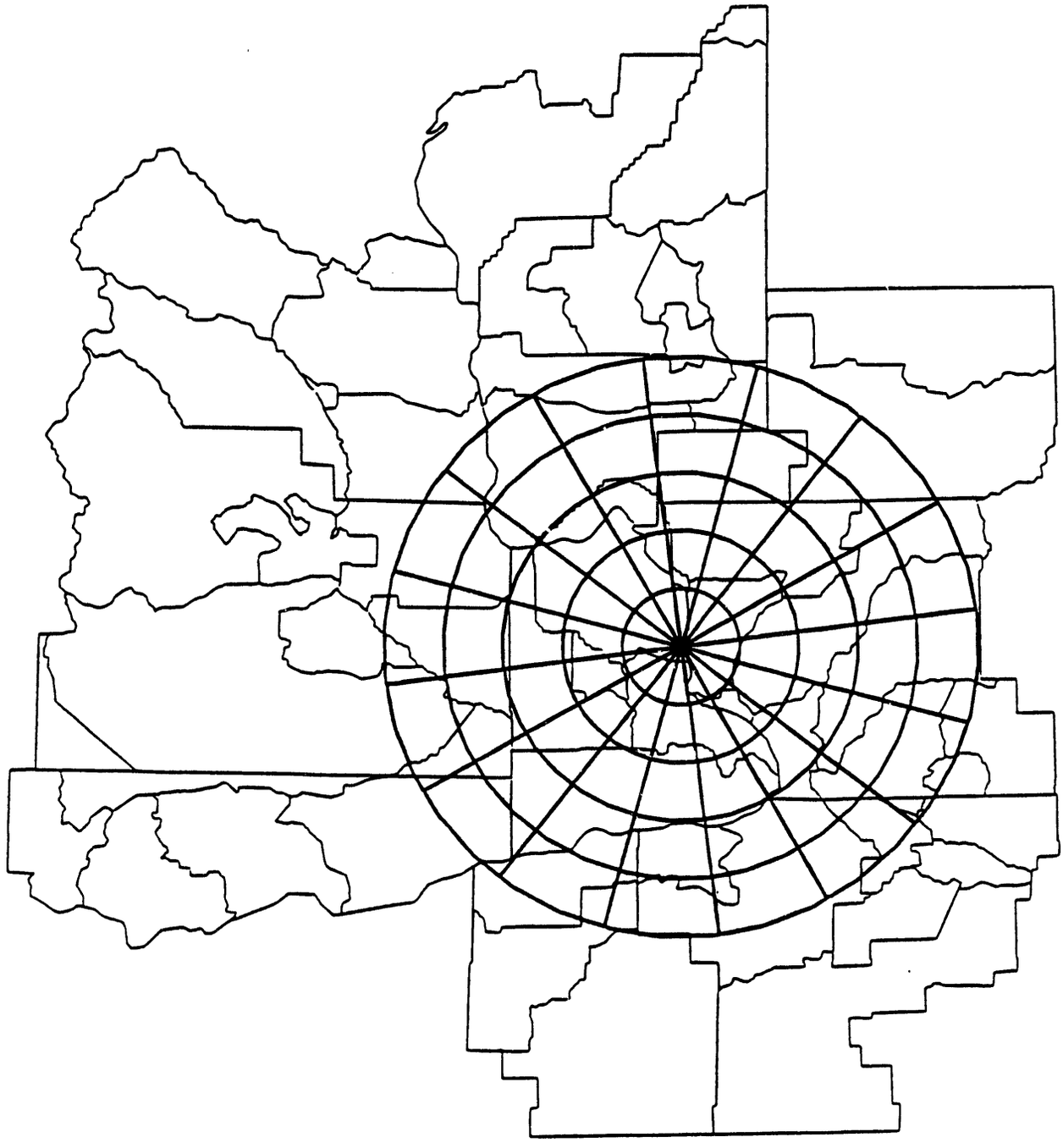


FIGURE C.8. Areas Within 80 Kilometers (50 Miles) of the 300 Area Meteorological Tower

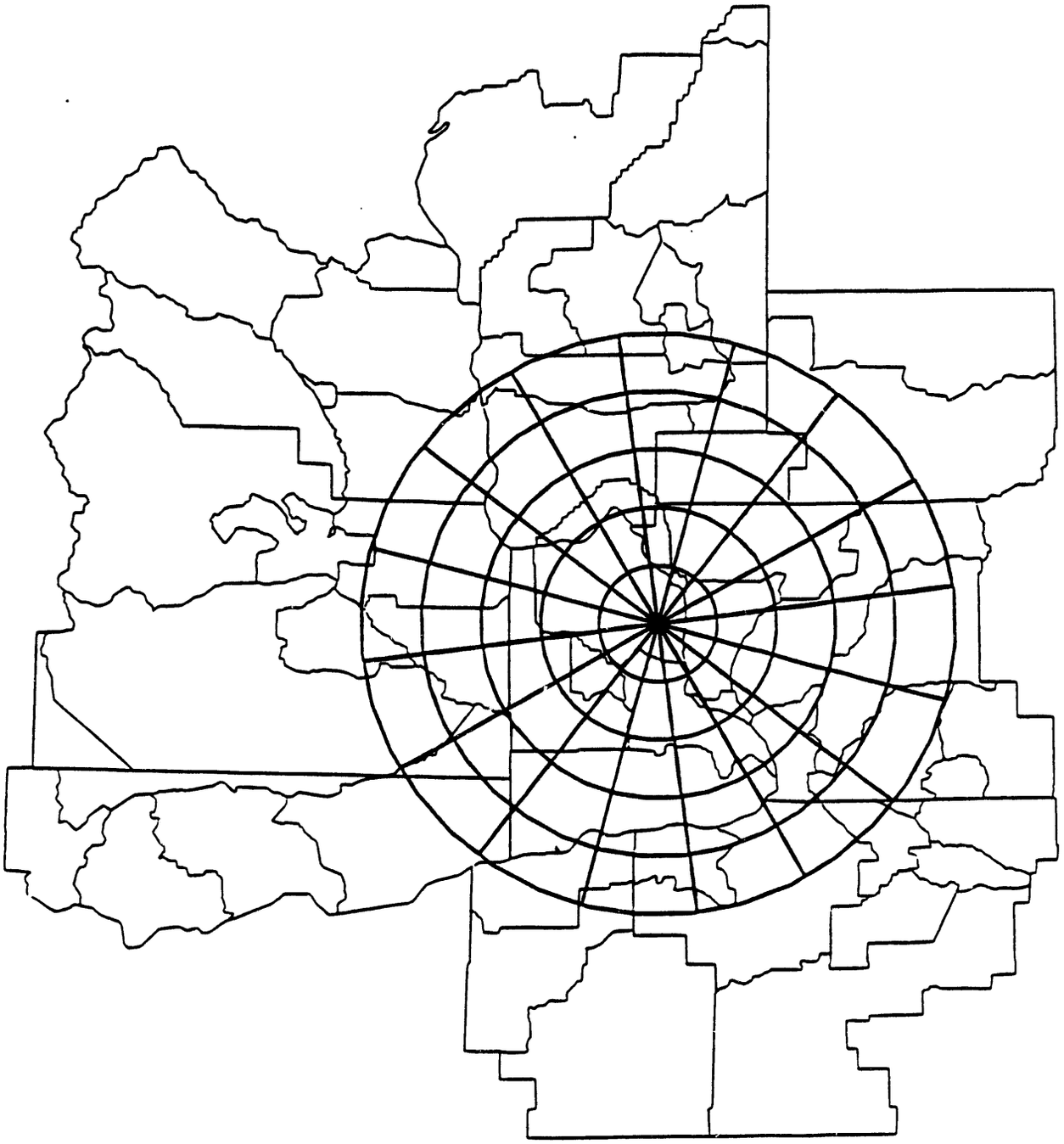


FIGURE C.9. Areas Within 80 Kilometers (50 Miles) of the 400 Area Meteorological Tower

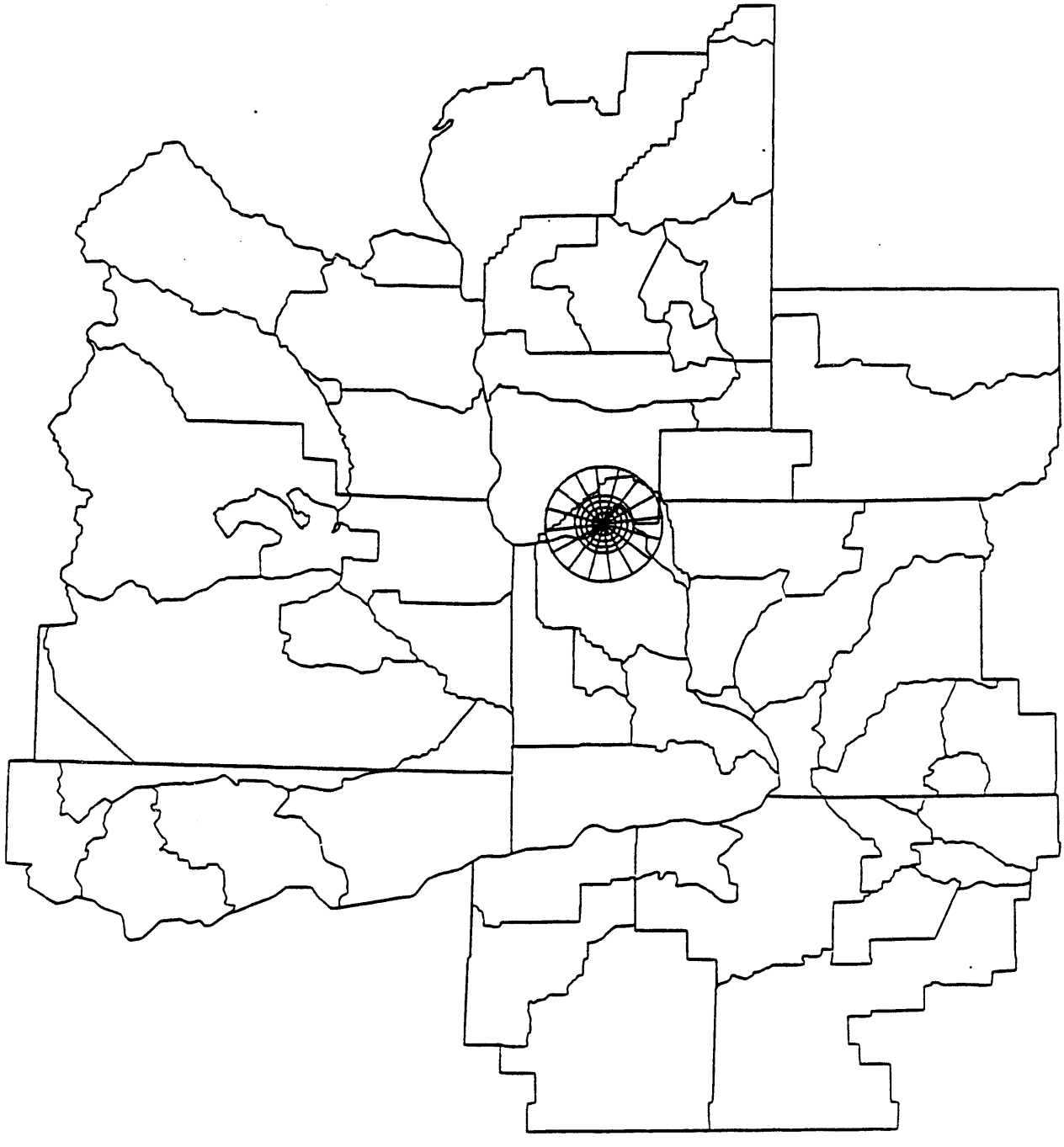


FIGURE C.10. Areas Within 16 Kilometers (10 Miles) of 100-N Meteorological Tower

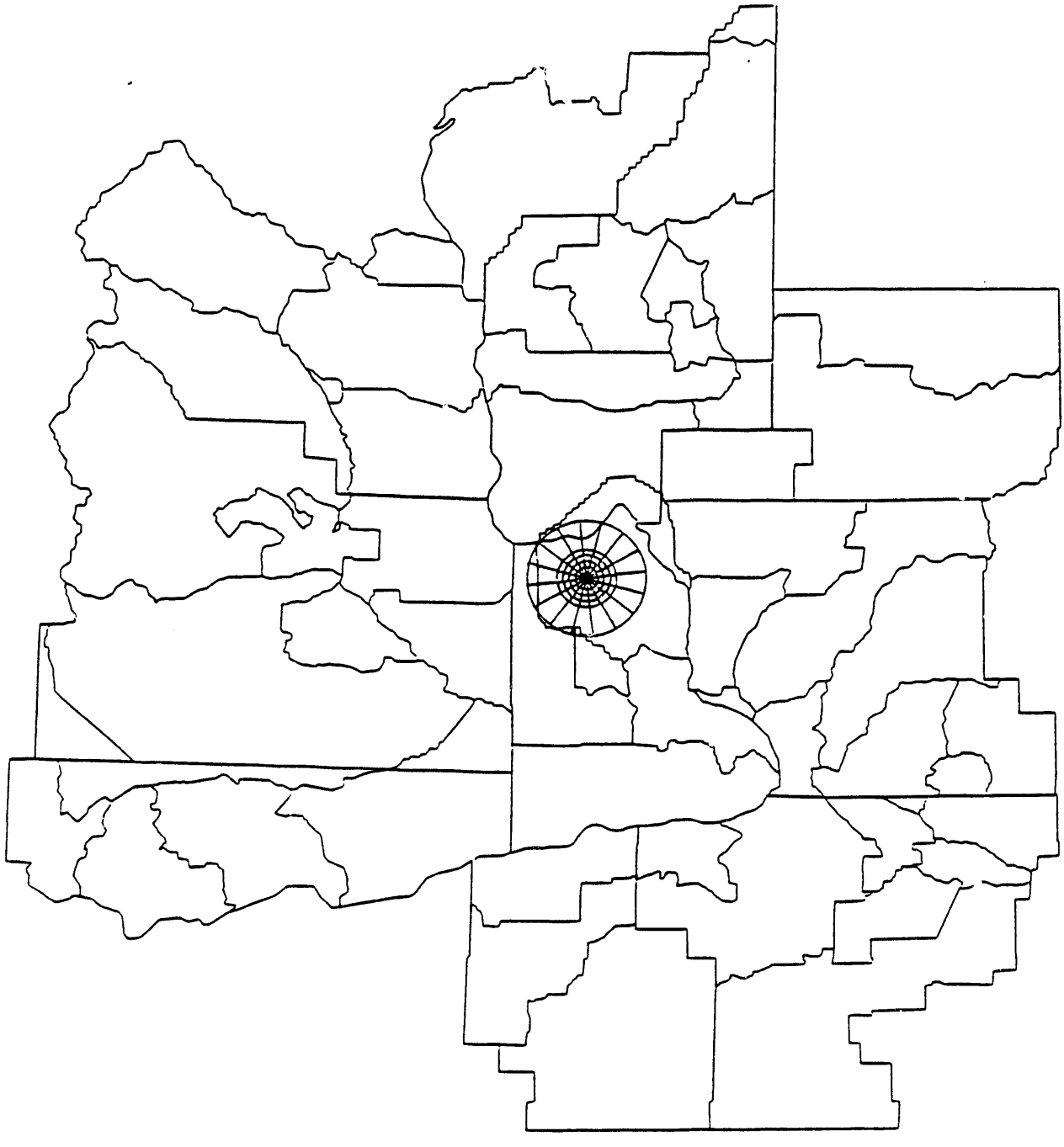


FIGURE C.11. Areas Within 16 Kilometers (10 Miles) of the Hanford Meteorological Station

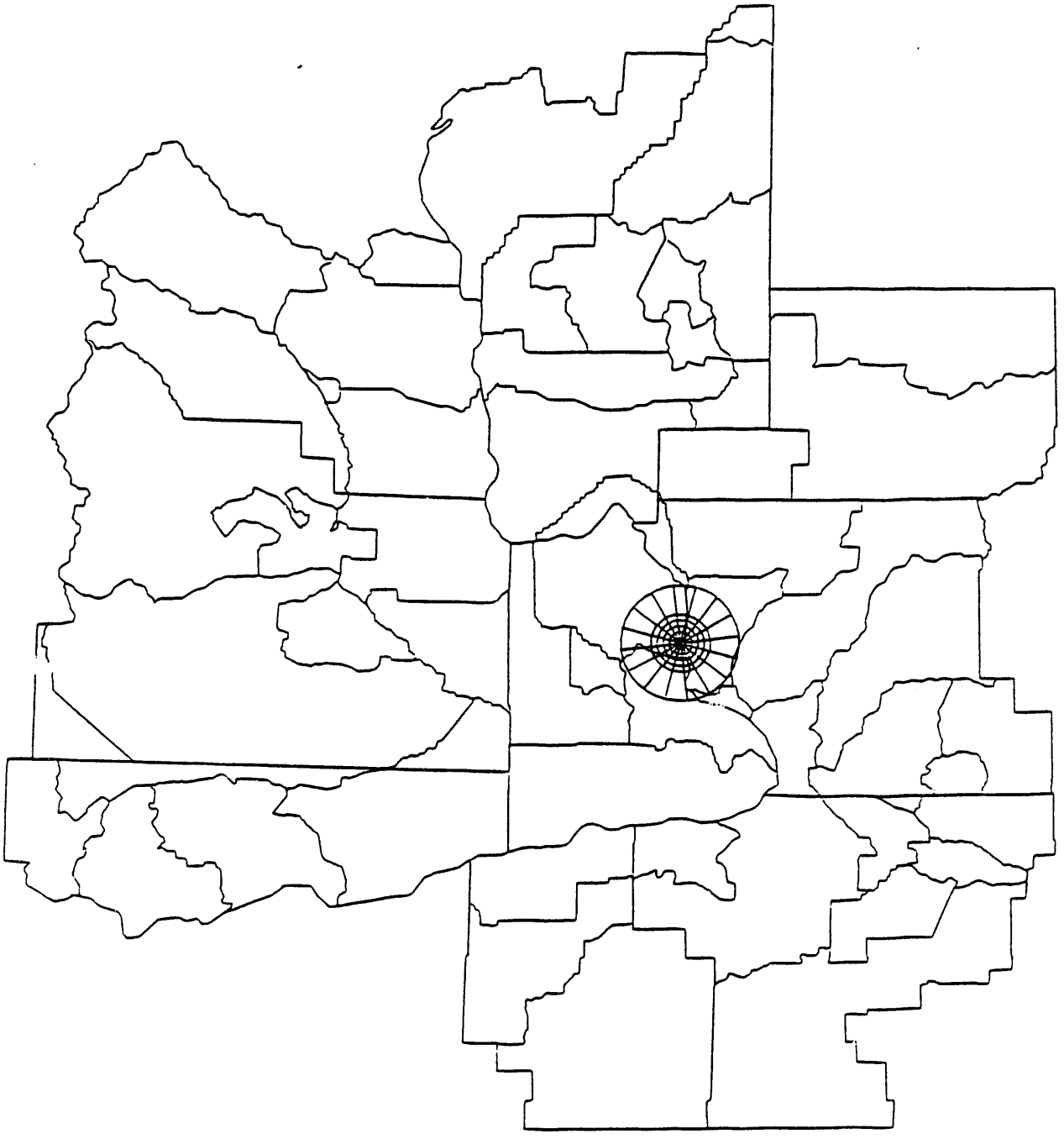


FIGURE C.12. Areas Within 16 Kilometers (10 Miles) of the 300 Area Meteorological Tower

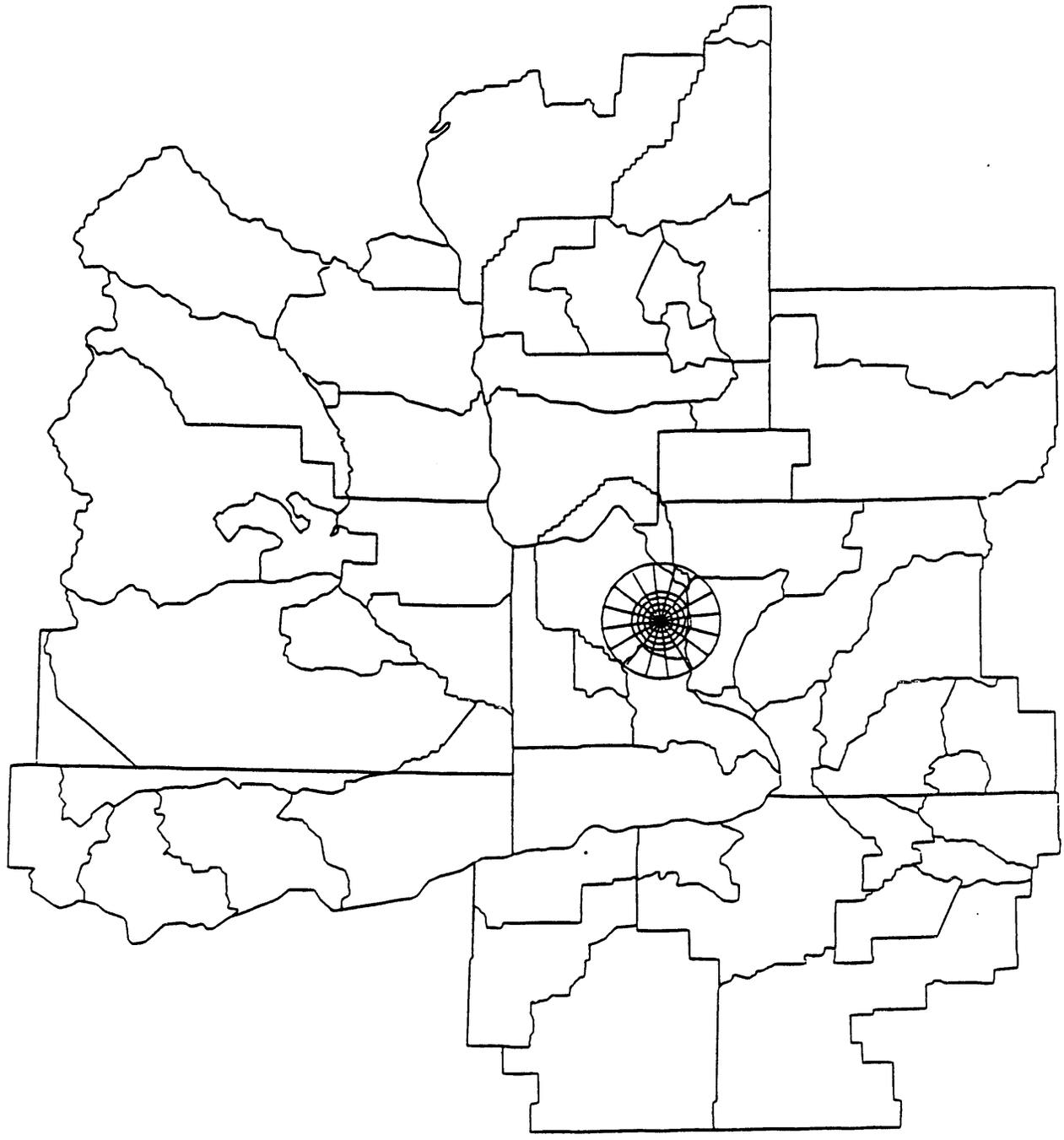
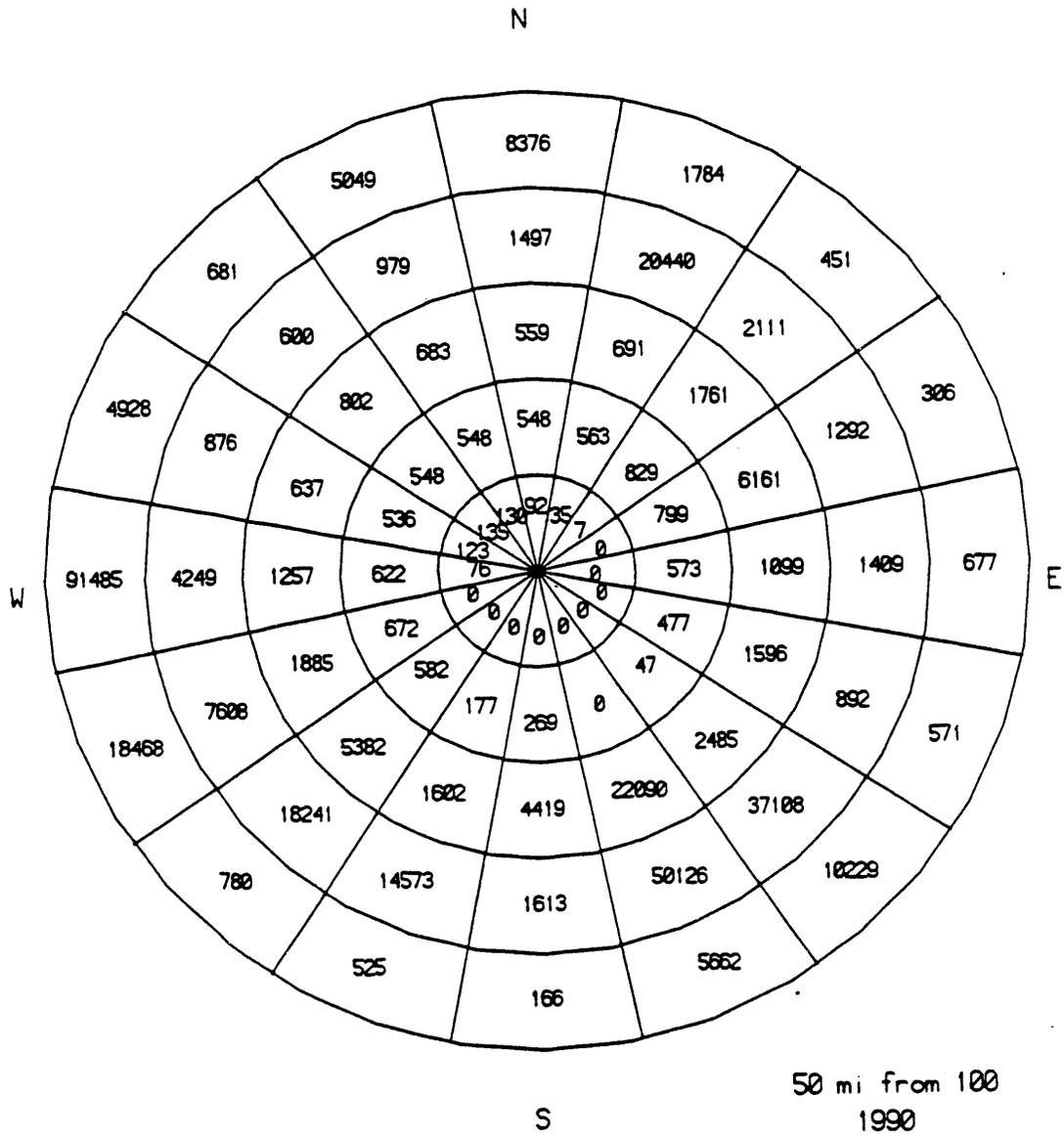


FIGURE C.13. Areas Within 16 Kilometers (10 Miles) of the 400 Area Meteorological Tower


N
E
S
W
8376
1784
451
306
677
571
892
37108
10229
5662
166
1613
50126
22090
4419
269
2485
1596
47
477
0
573
1099
1409
799
6161
1292
2111
20440
1497
559
691
563
829
548
1761
683
979
5049
681
600
802
876
4928
637
548
536
622
1257
4249
91485
672
582
177
1885
7608
18468
5382
1602
18241
780
14573
525
130
92
35
7
135
123
76
0
0
0

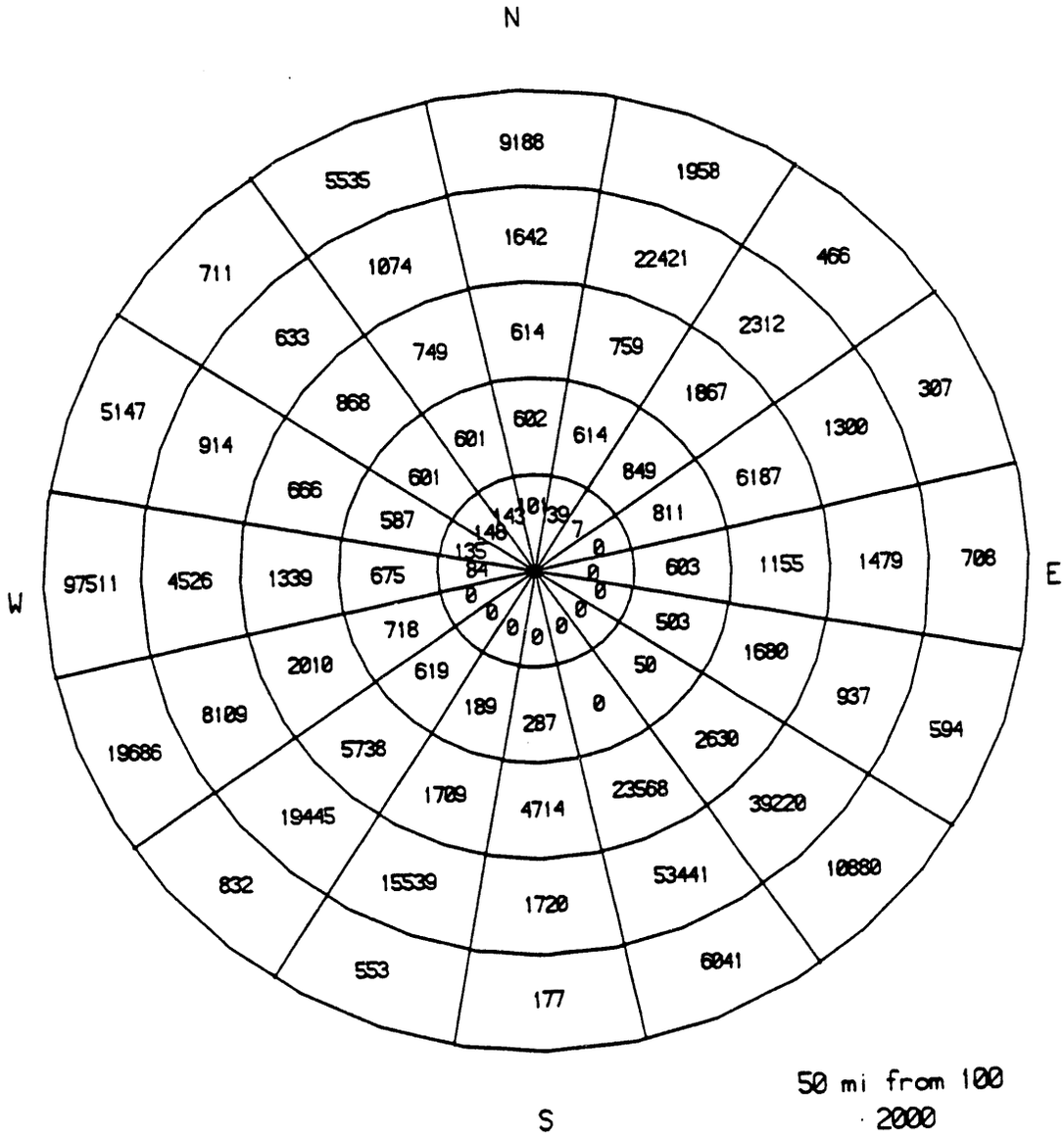


FIGURE C.15. Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the 100-N Meteorological Tower, by Population Grid Sector for 2000

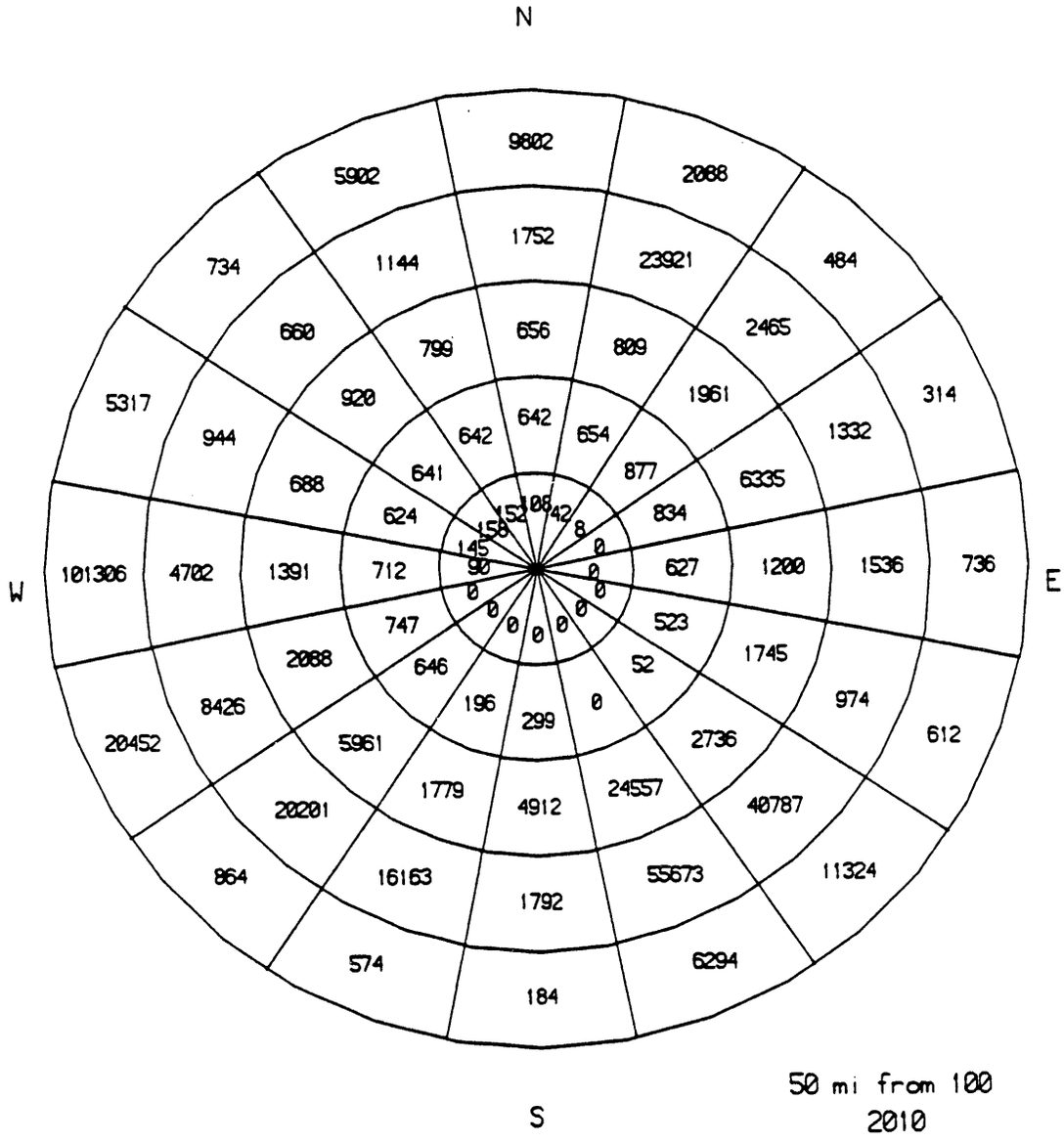


FIGURE C.16. Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the 100-N Meteorological Tower, by Population Grid Sector for 2010

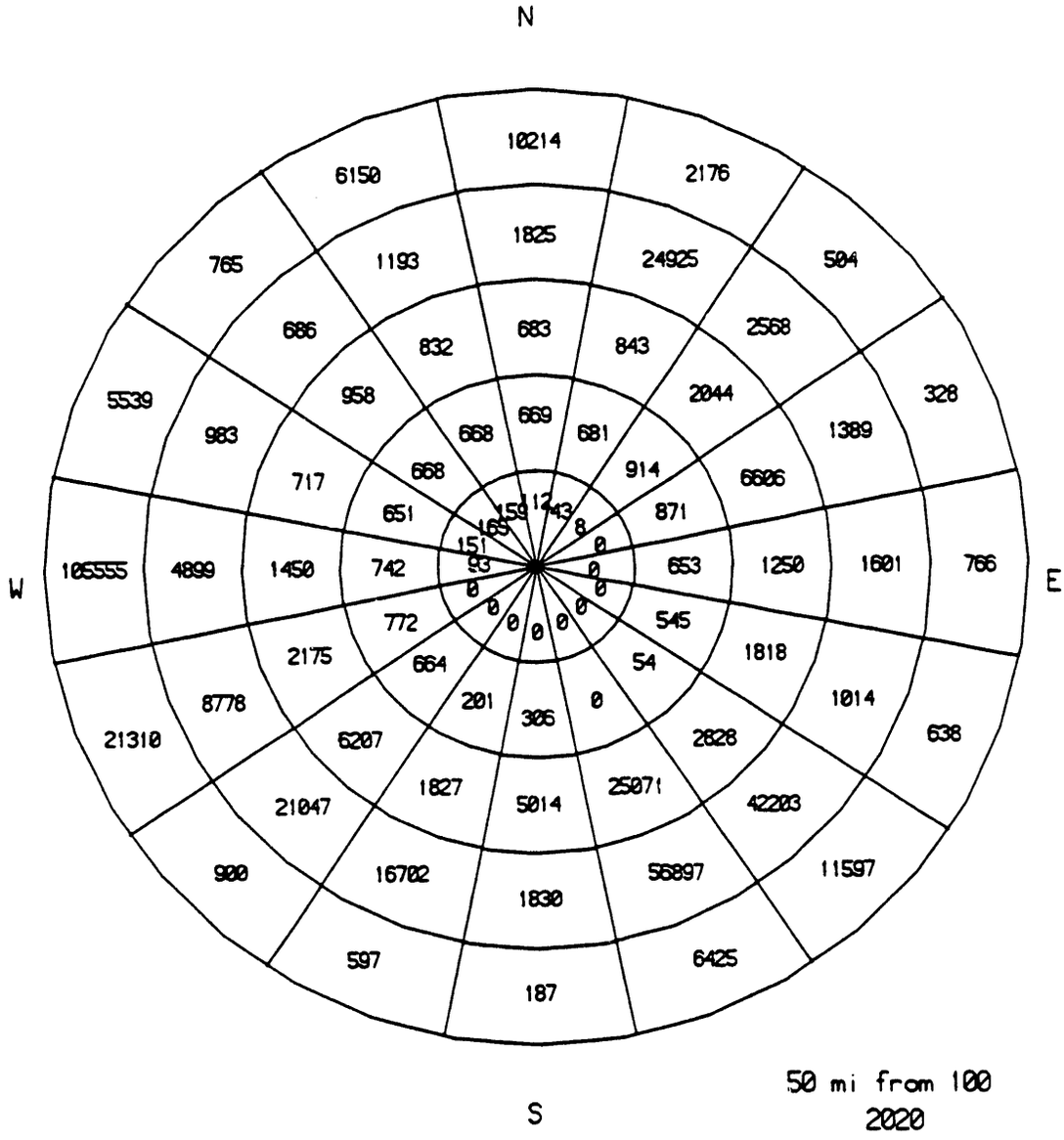
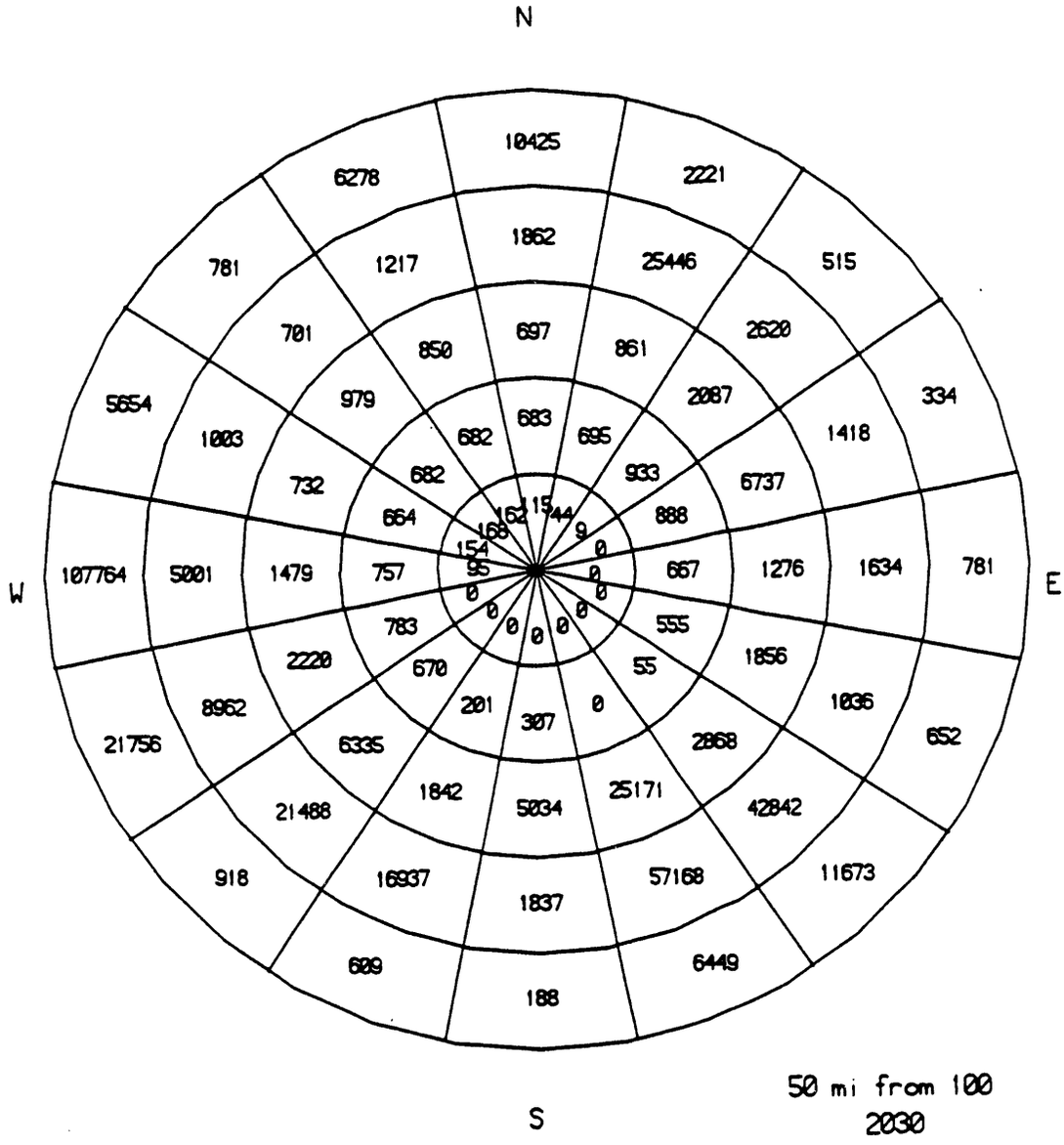
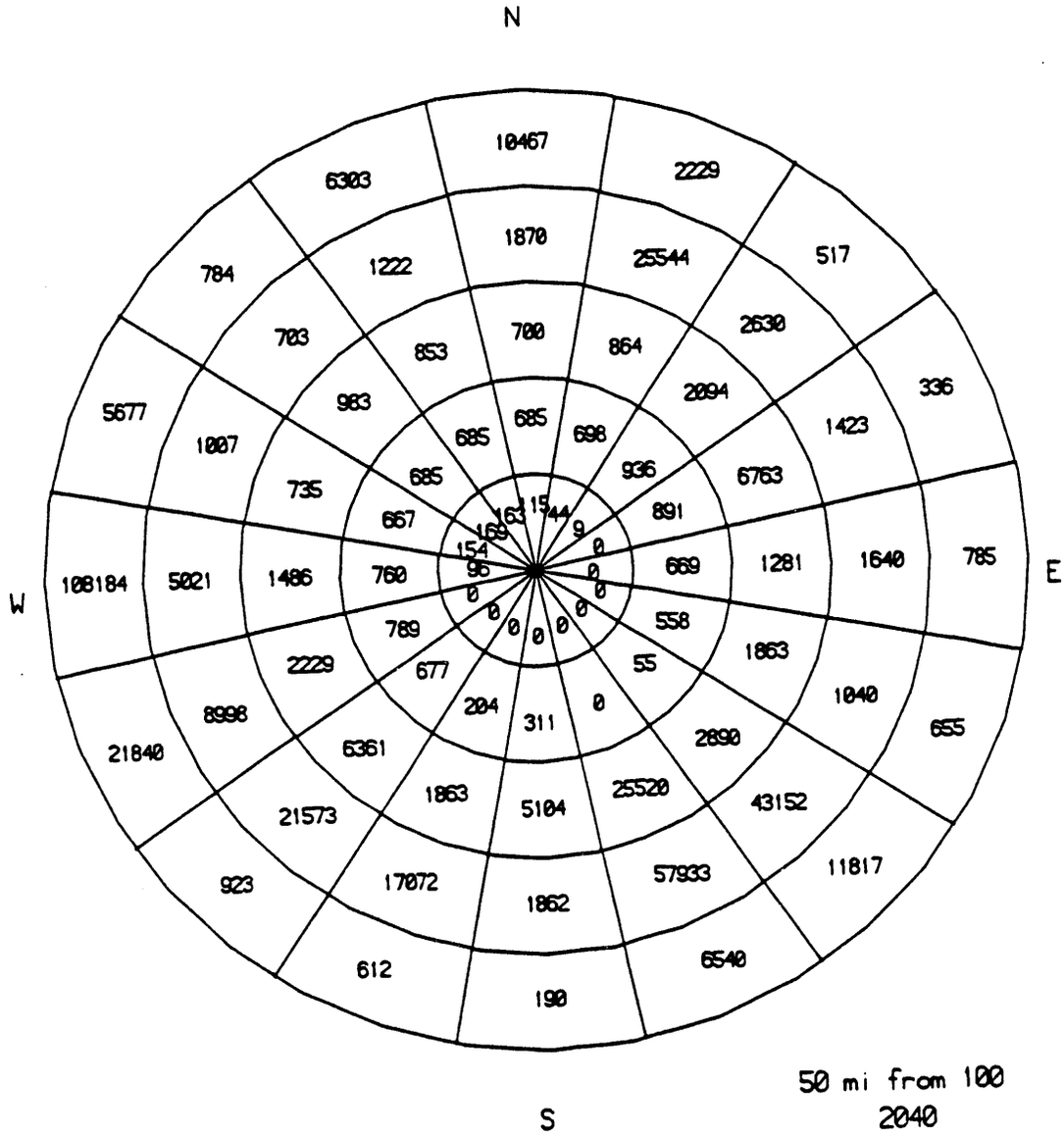
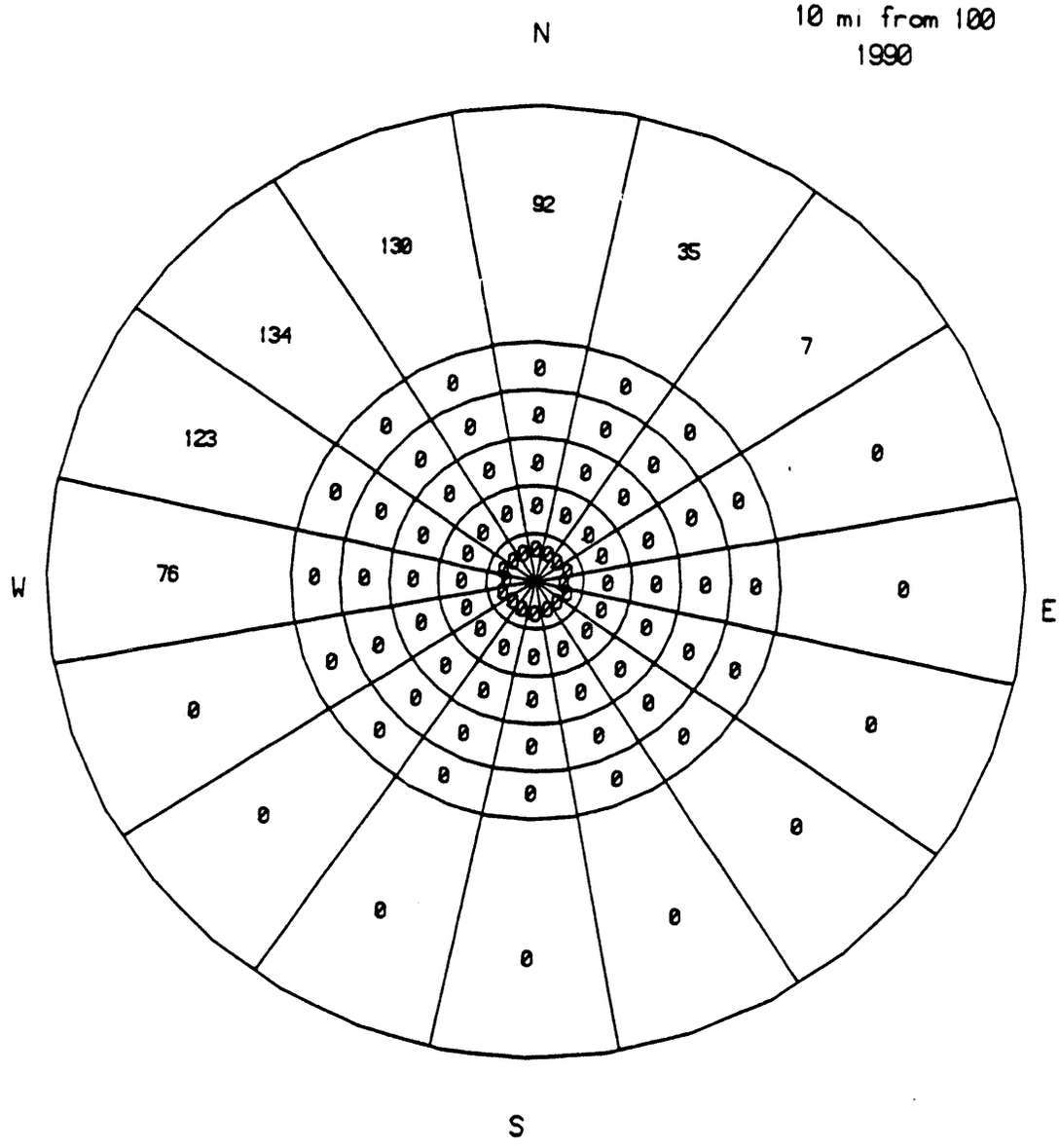


FIGURE C.17. Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the 100-N Meteorological Tower, by Population Grid Sector for 2020


N
E
S
W
10425
2221
25446
515
2620
334
1418
6737
1634
781
1276
667
1856
555
1036
55
652
2868
42842
25171
11673
57168
6449
5034
1837
188
307
201
1842
16937
609
918
21488
6335
670
8962
2220
21756
783
757
107764
5001
1479
664
1003
732
5654
682
979
701
781
682
850
1217
6278
1862
697
683
115
44
9
0
0
0


N
E
S
W
10467
2229
517
336
785
655
11817
6540
190
612
923
17072
1862
57933
43152
25520
5104
1863
21573
6361
2890
21840
8998
1040
1863
2229
558
55
0
789
677
204
311
0
0
0


10 mi from 100
1990
N
92
35
7
0
0
0

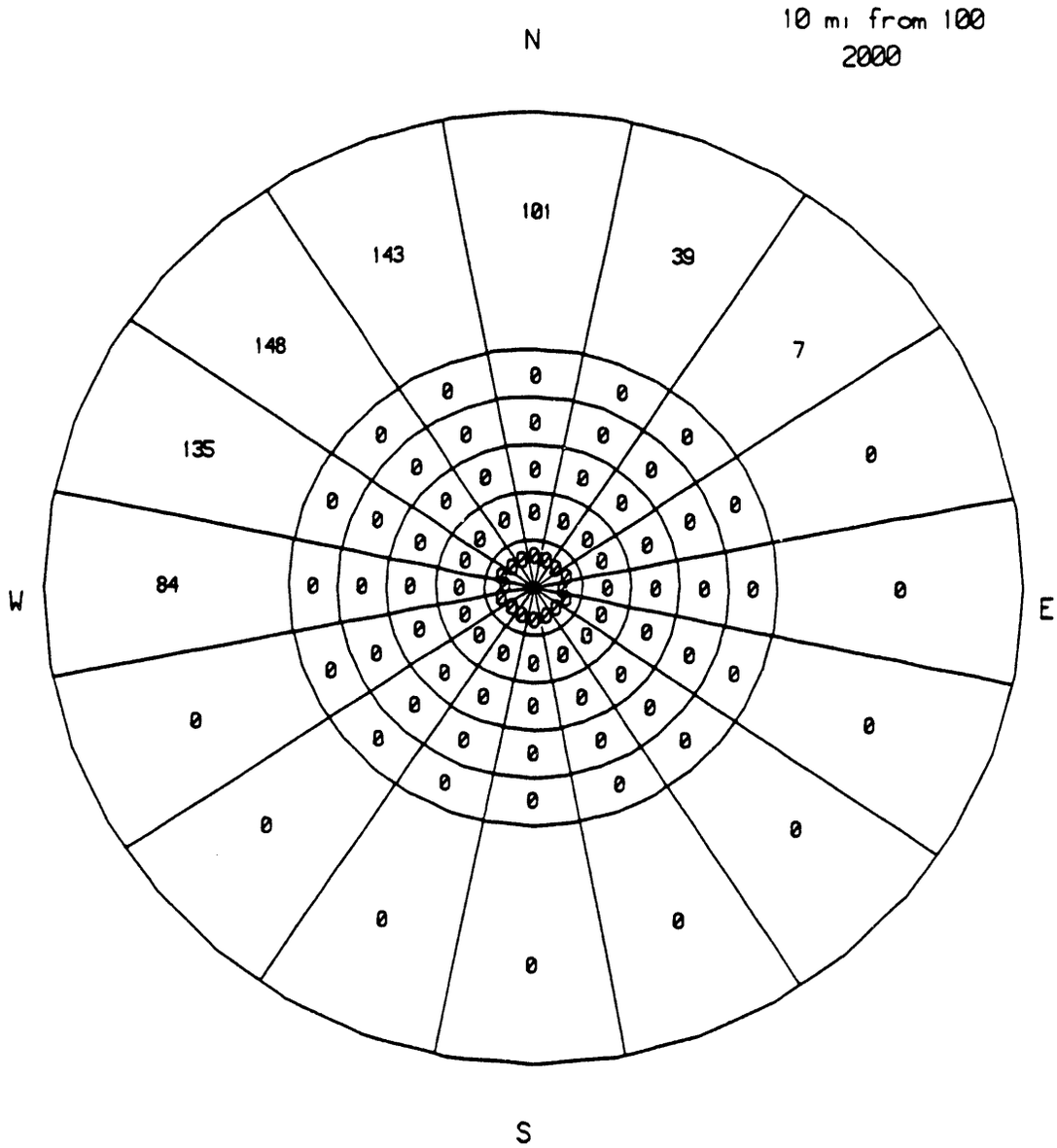


FIGURE C.21. Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 100-N Meteorological Tower, by Population Grid Sector for 2000

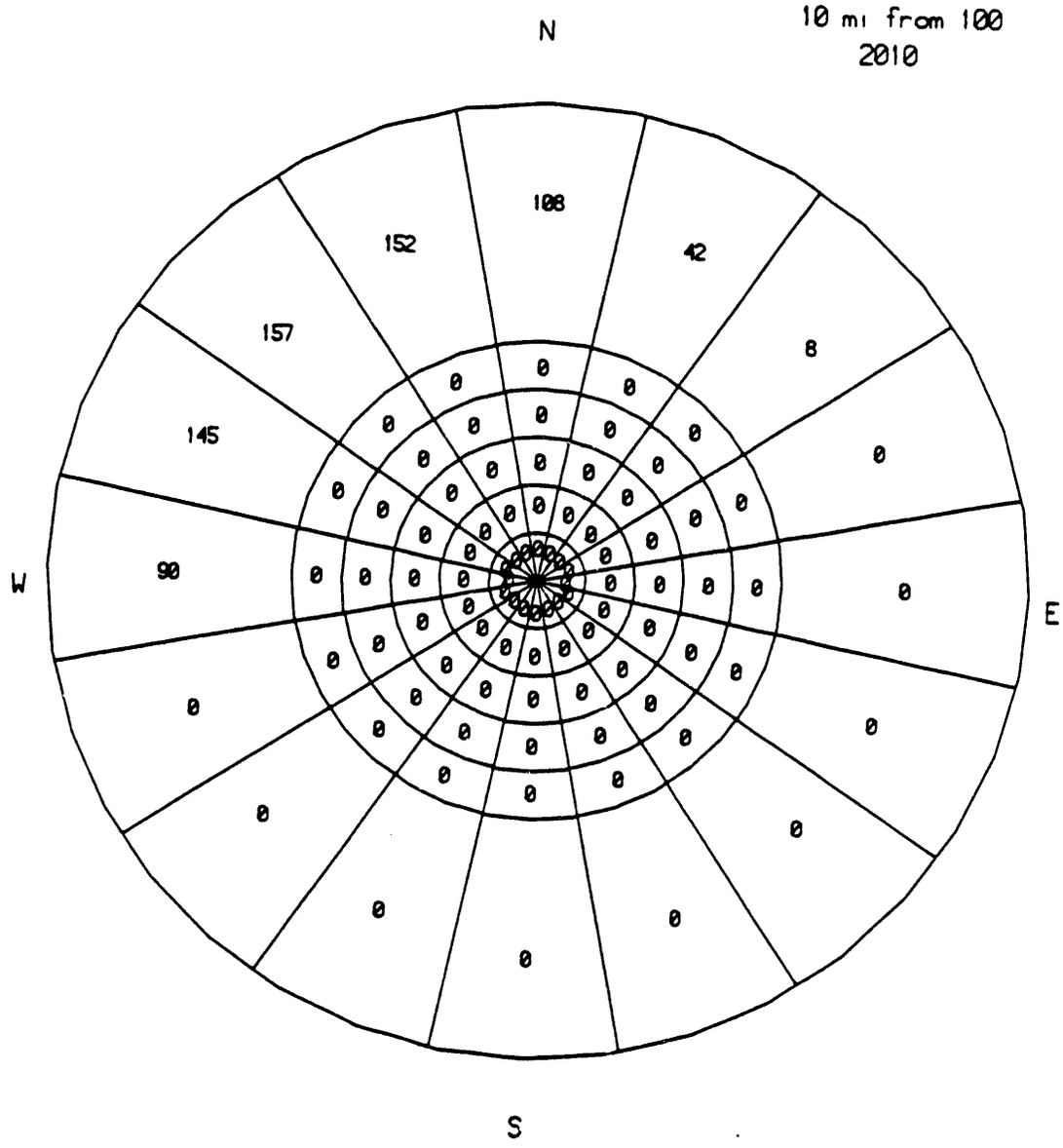


FIGURE C.22. Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 100-N Meteorological Tower, by Population Grid Sector for 2010

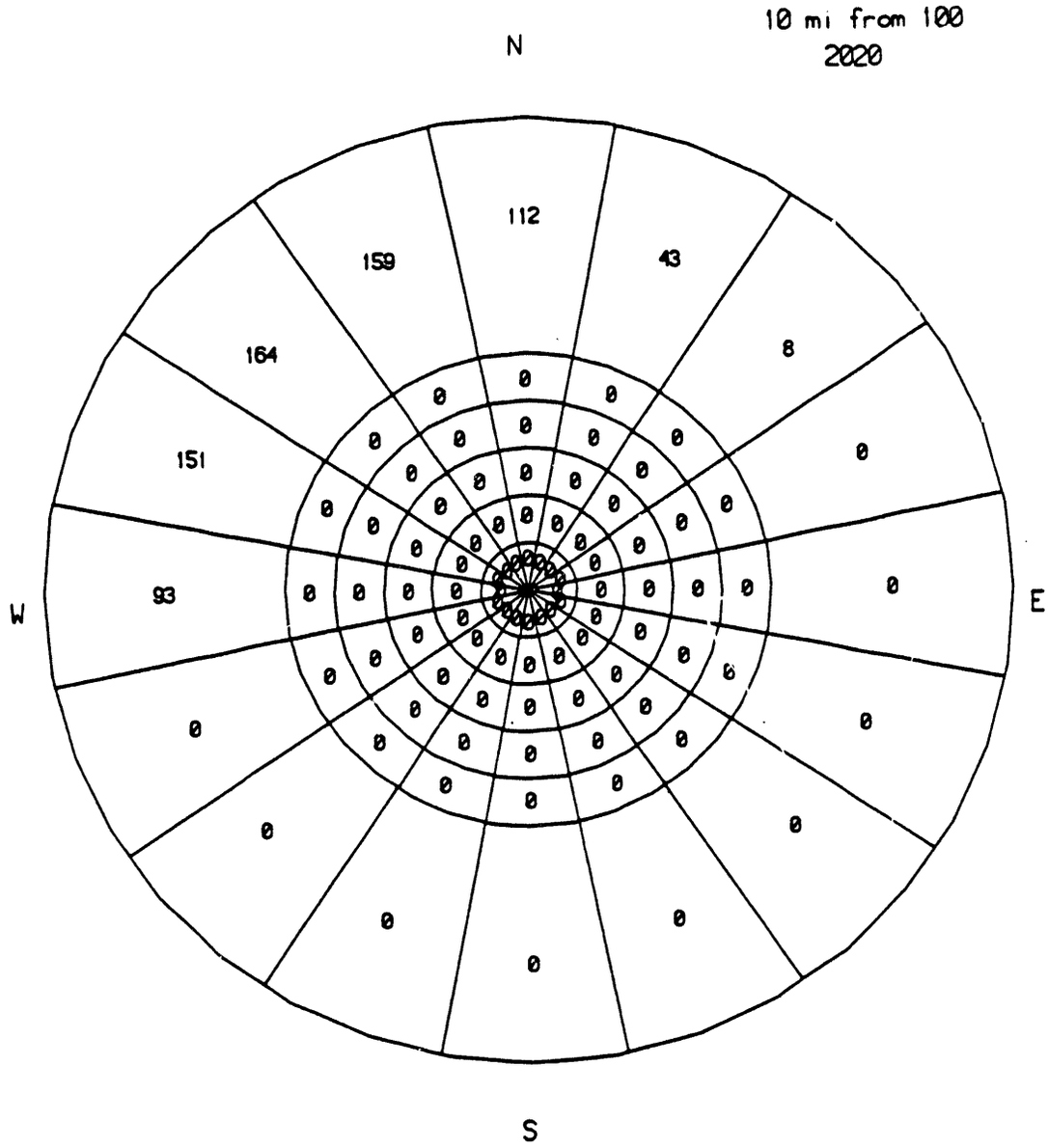


FIGURE C.23. Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 100-N Meteorological Tower, by Population Grid Sector for 2020

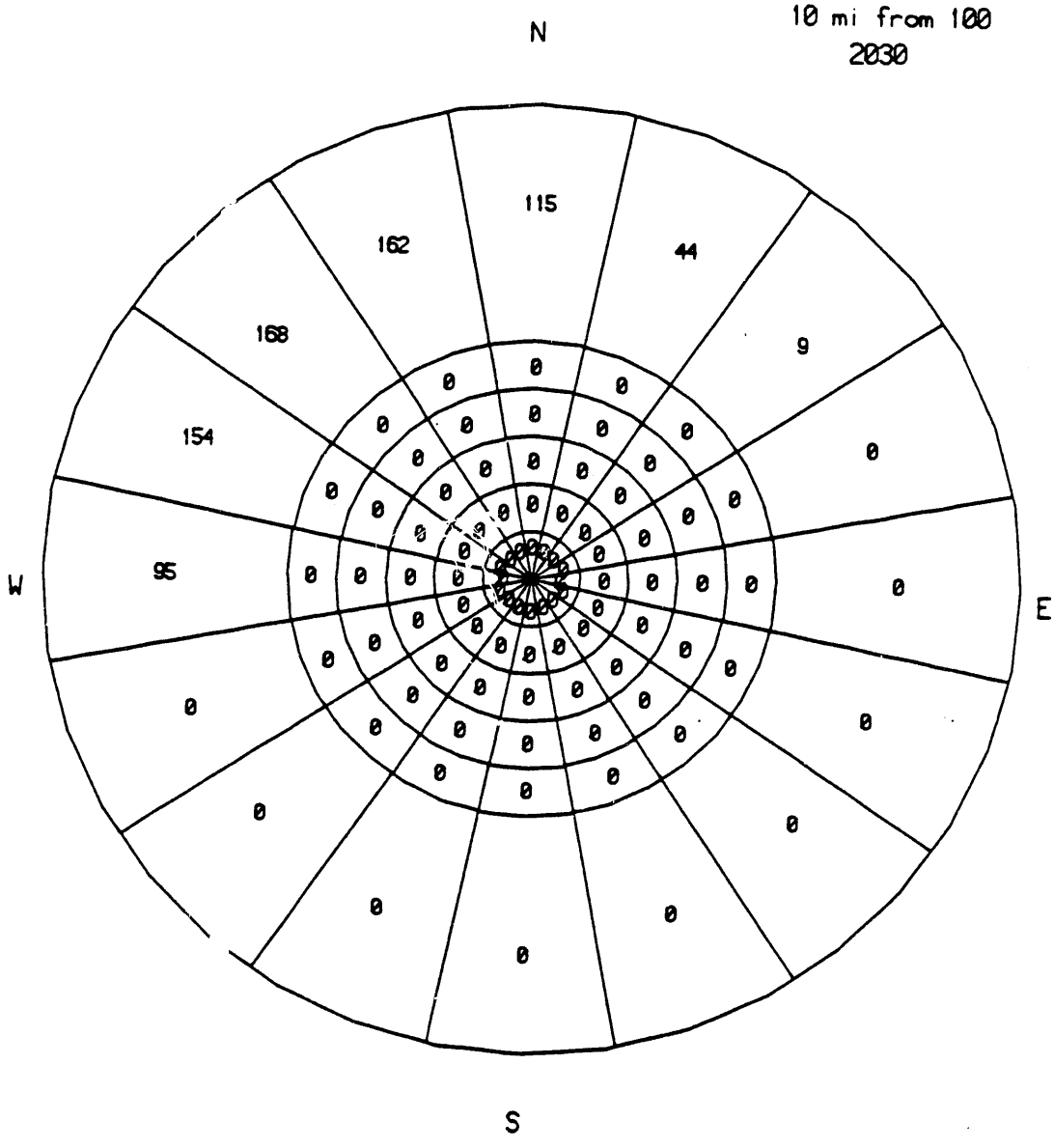


FIGURE C.24. Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 100-N Meteorological Tower, by Population Grid Sector for 2030

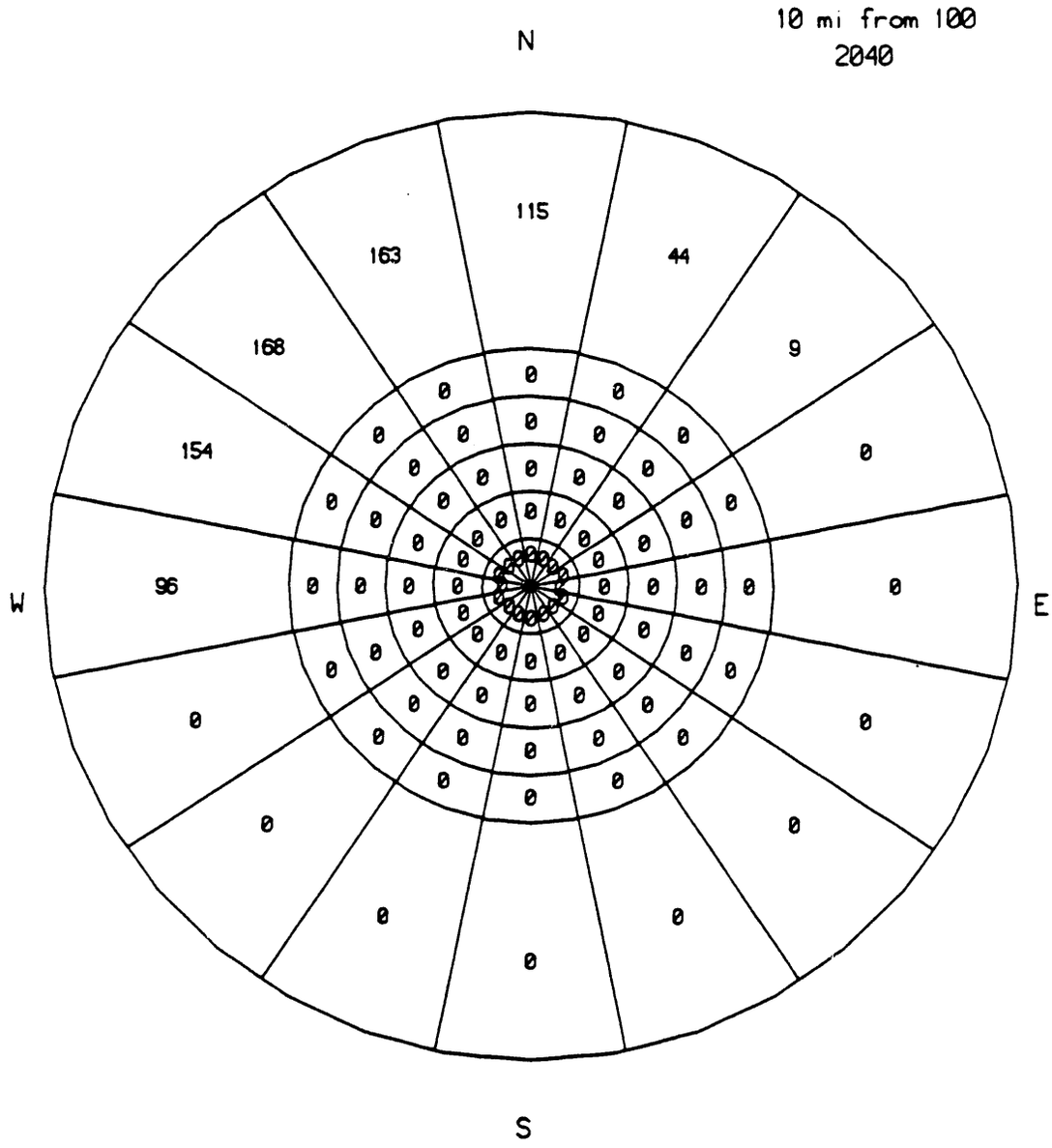


FIGURE C.25. Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 100-N Meteorological Tower, by Population Grid Sector for 2040

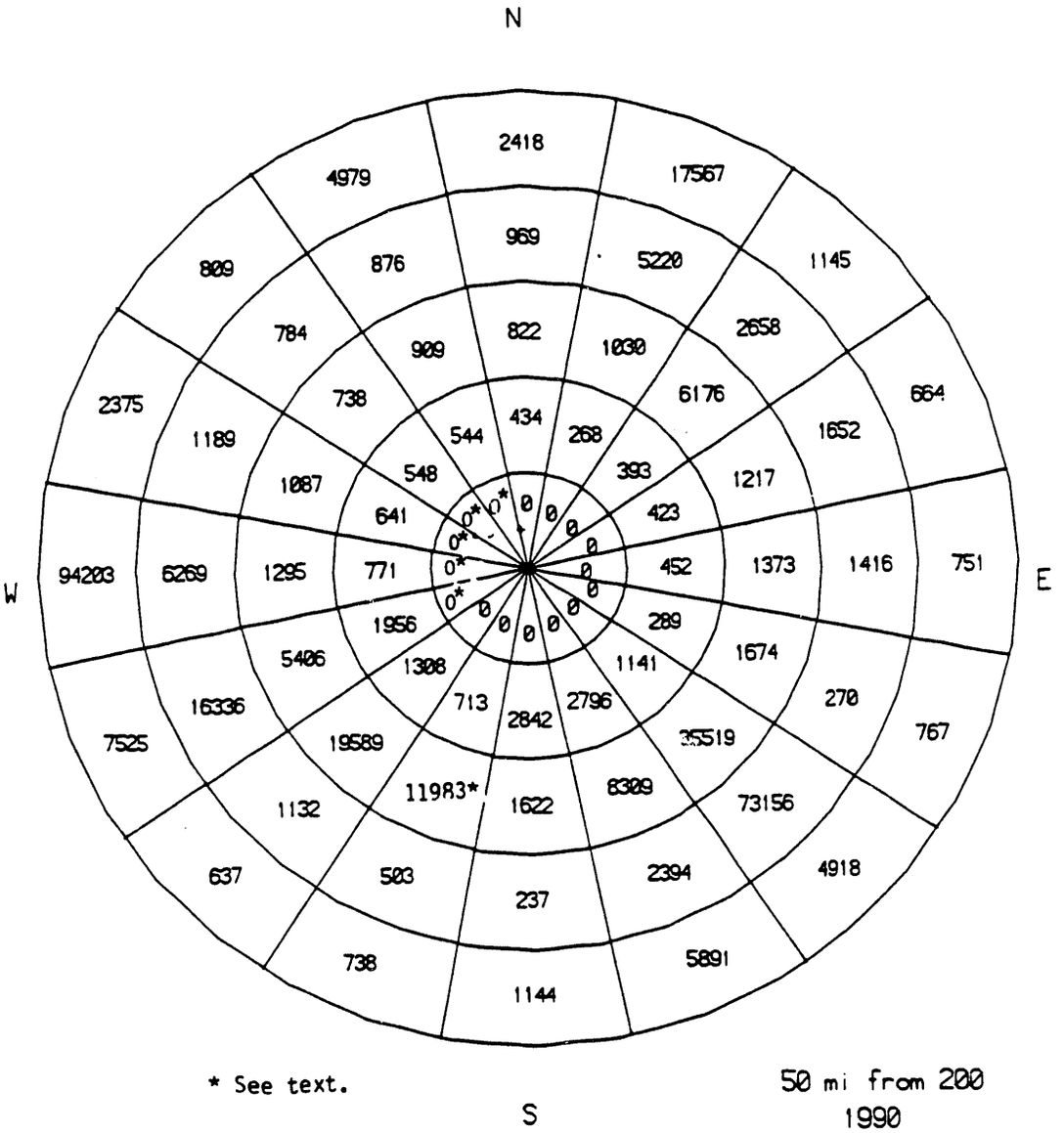


FIGURE C.26. Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the Hanford Meteorological Station, by Population Grid Sector for 1990

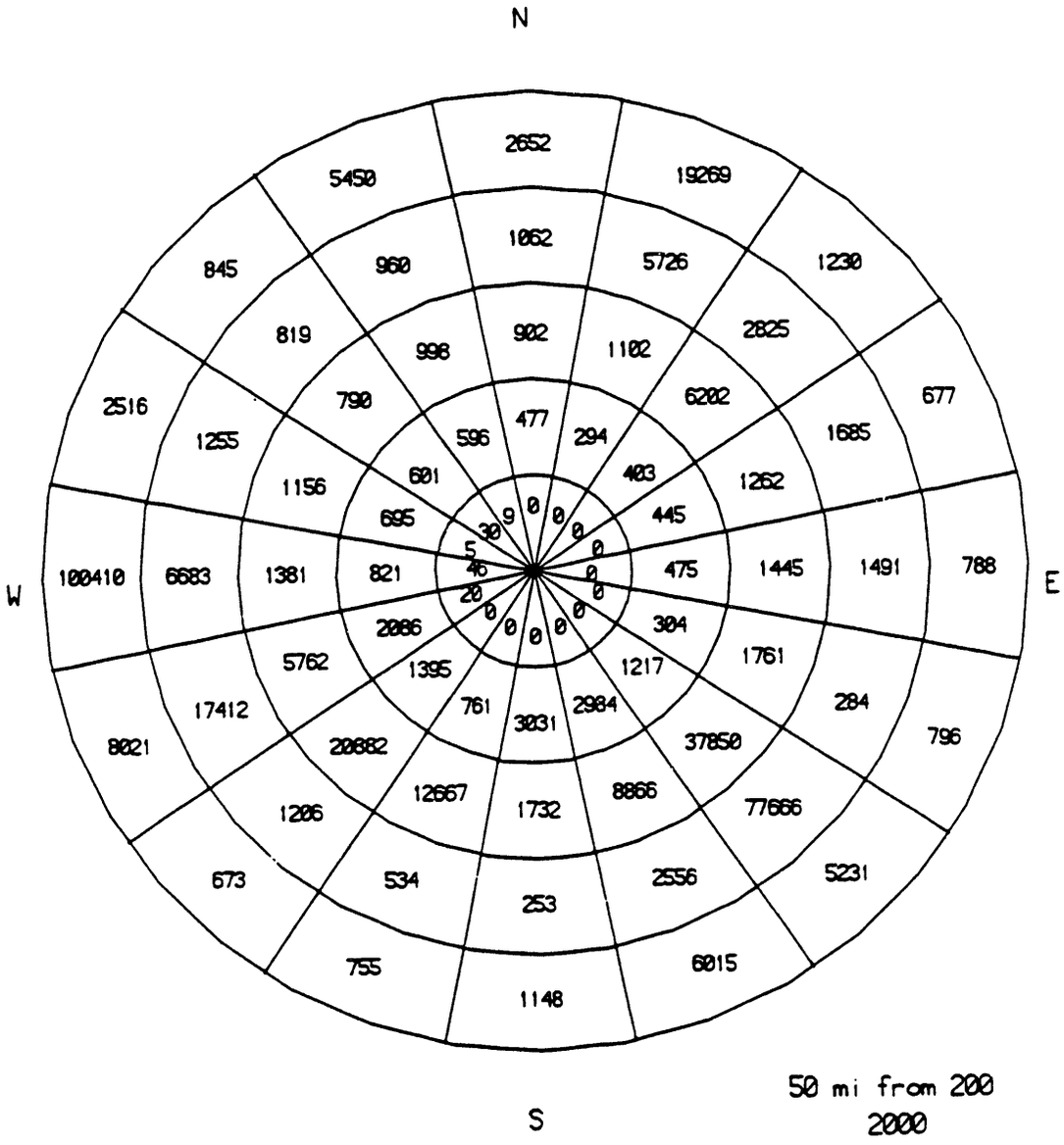


FIGURE C.27. Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the Hanford Meteorological Station, by Population Grid Sector for 2000

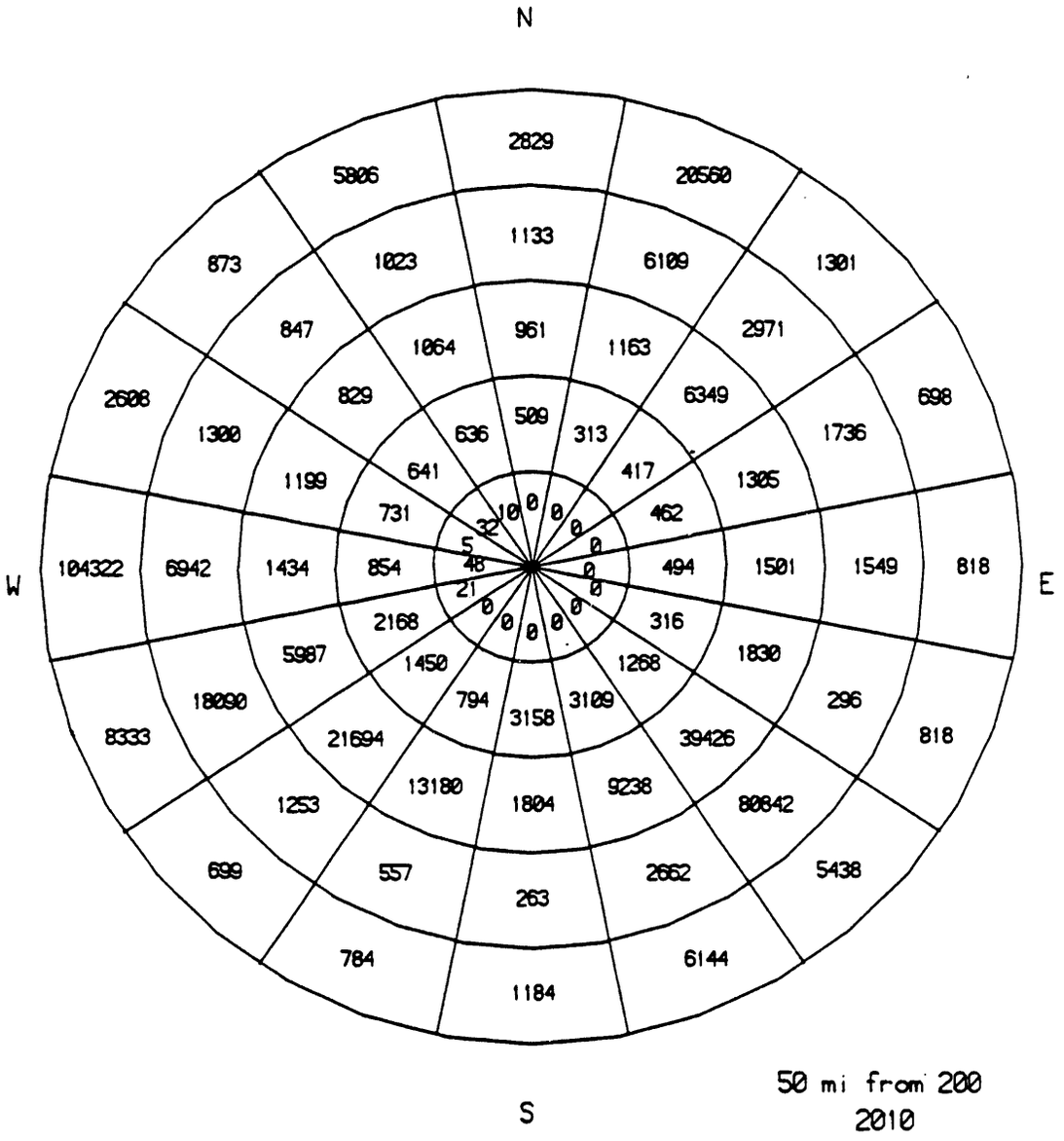
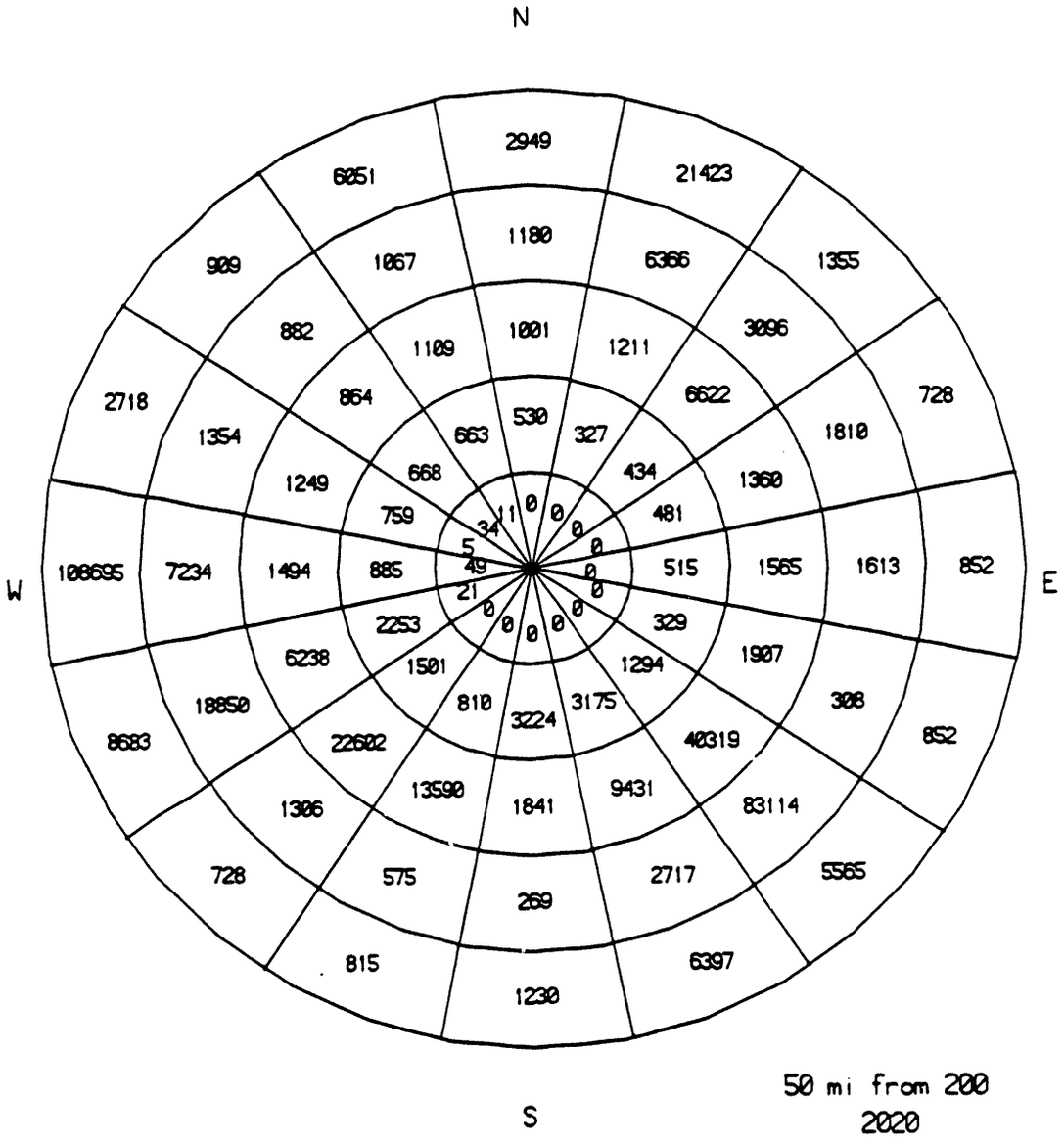
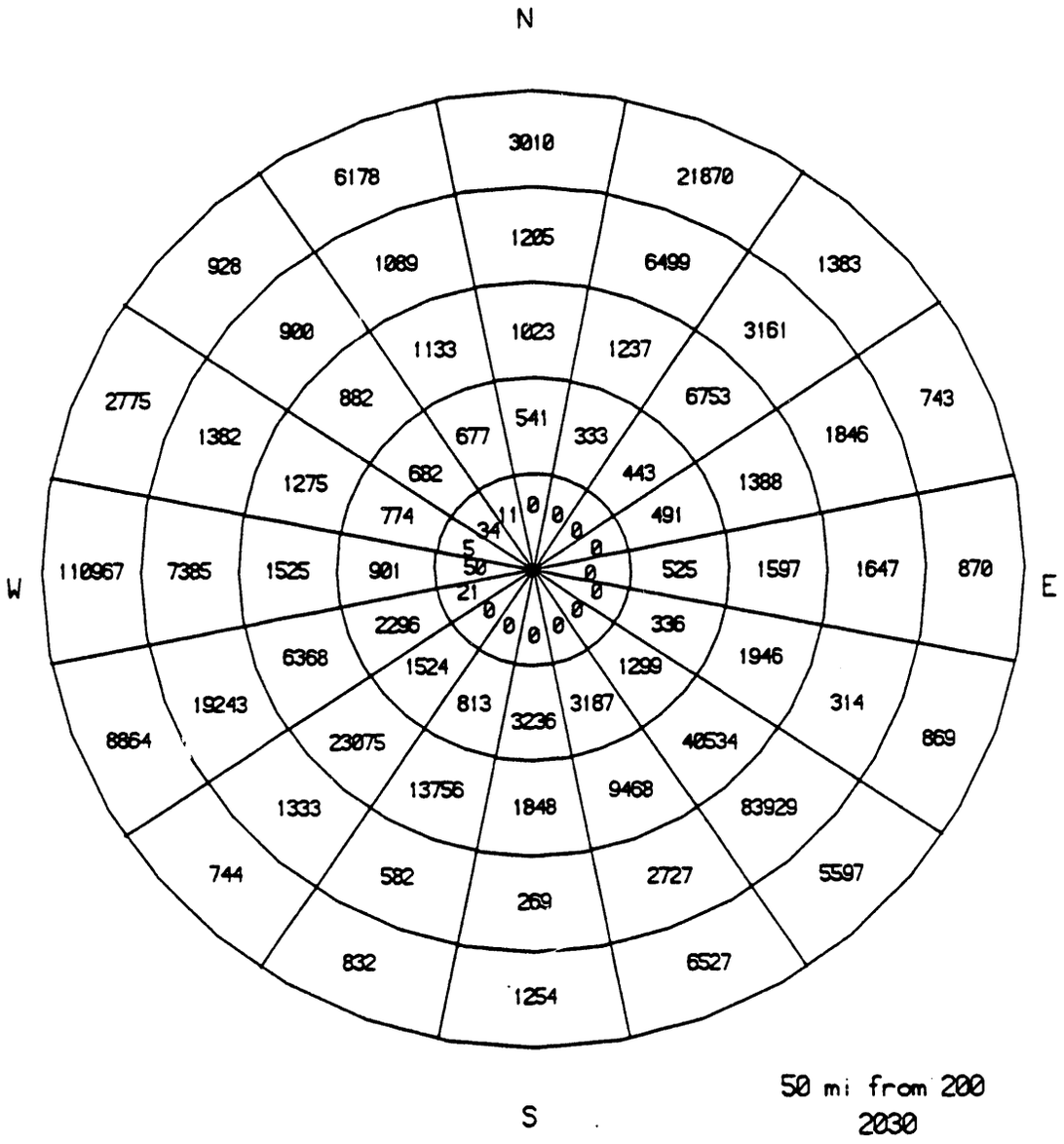


FIGURE C.28. Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the Hanford Meteorological Station, by Population Grid Sector for 2010


N
E
S
W
2949
21423
6051
1180
6366
1355
909
1067
1001
1211
3096
882
1109
530
6622
728
2718
864
663
327
1810
1354
668
434
1360
1249
759
481
11
0
0
0
34
5
0
49
0
0
21
0
0
0


N
E
S
W
3010
21870
1205
6499
1383
1023
1237
3161
541
333
6753
743
1846
1388
491
525
1597
1647
870
314
869
1946
1299
336
3187
40534
9468
83929
5597
2727
1848
3236
813
1524
2296
13756
23075
1333
582
269
1254
6527
832
744
19243
8864
6368
901
774
682
1275
882
1382
2775
7385
110967
1525
1133
900
928
1089
6178
0
0
0

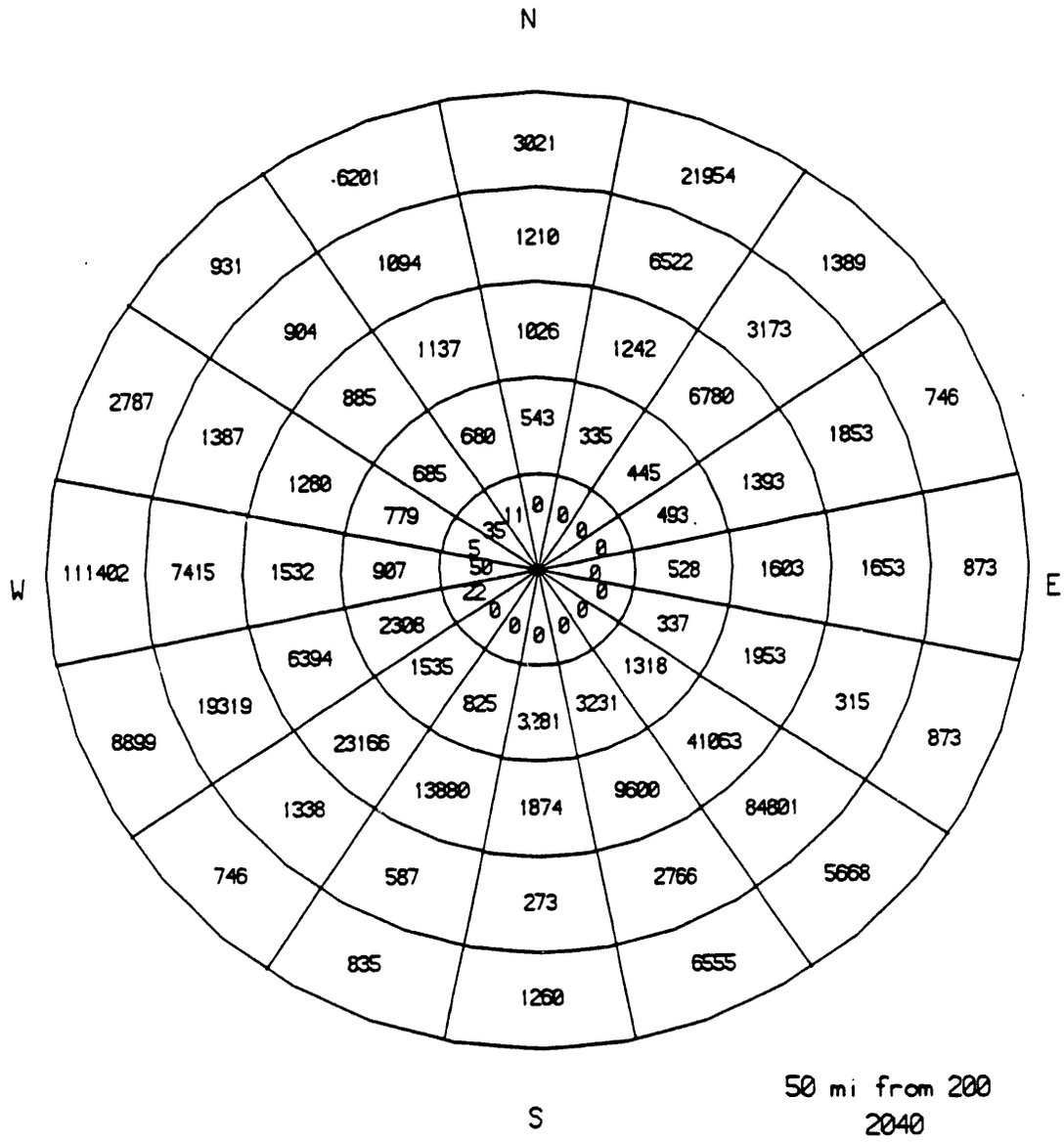


FIGURE C.31. Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the Hanford Meteorological Station, by Population Grid Sector for 2040

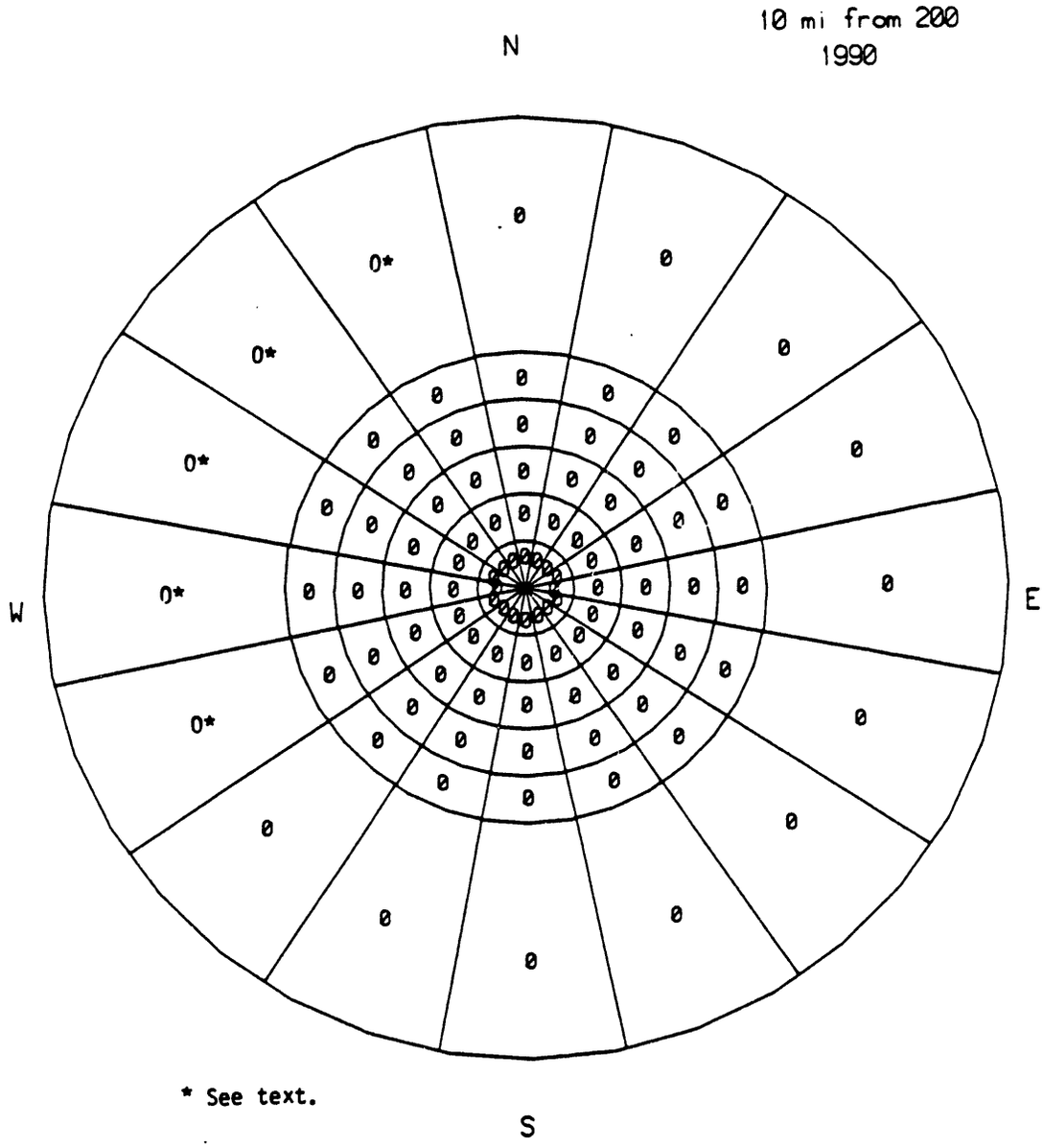


FIGURE C.32. Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the Hanford Meteorological Station, by Population Grid Sector for 1990

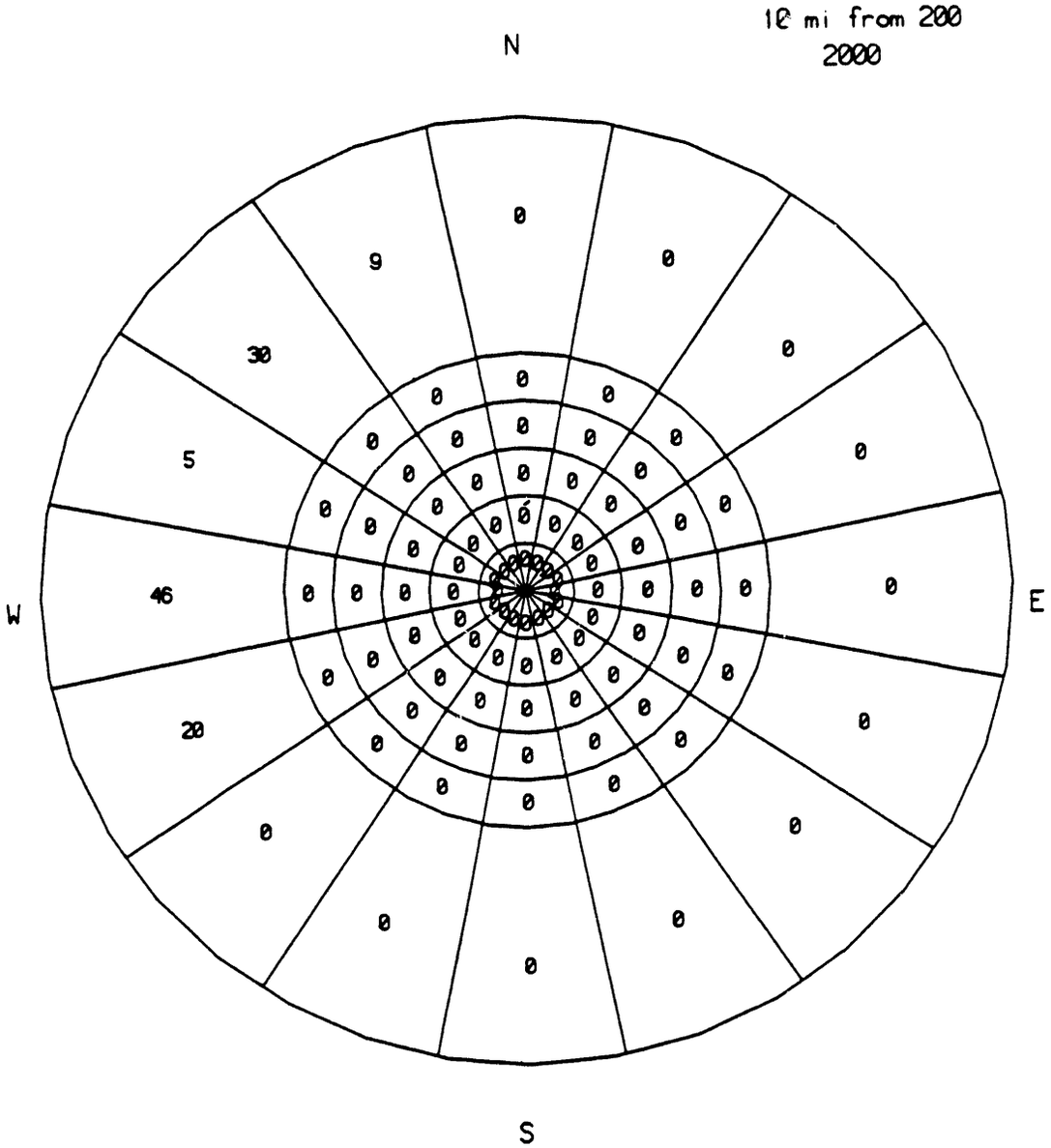


FIGURE C.33. Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the Hanford Meteorological Station, by Population Grid Sector for 2000

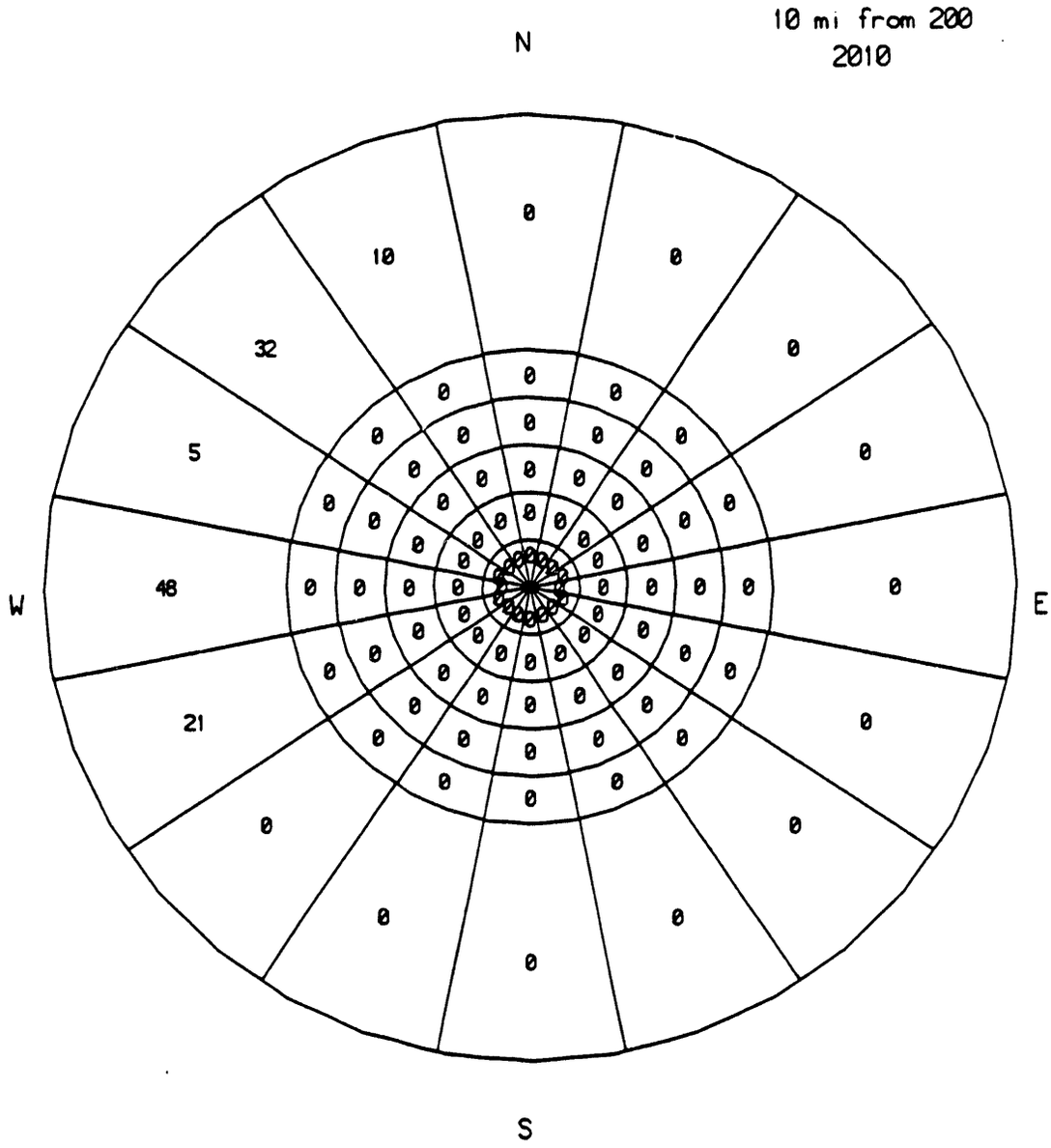


FIGURE C.34. Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the Hanford Meteorological Station, by Population Grid Sector for 2010

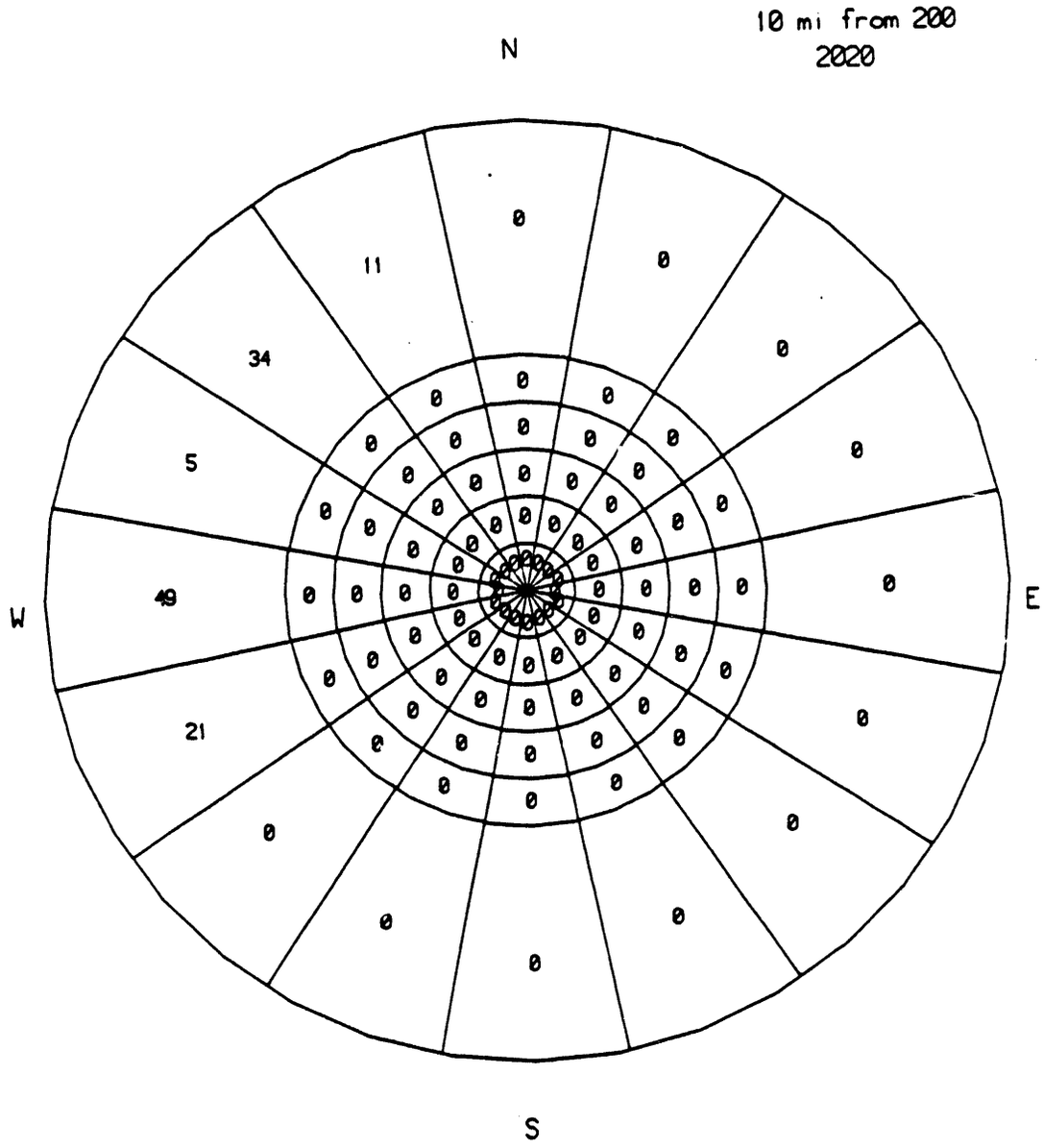


FIGURE C.35. Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the Hanford Meteorological Station, by Population Grid Sector for 2020

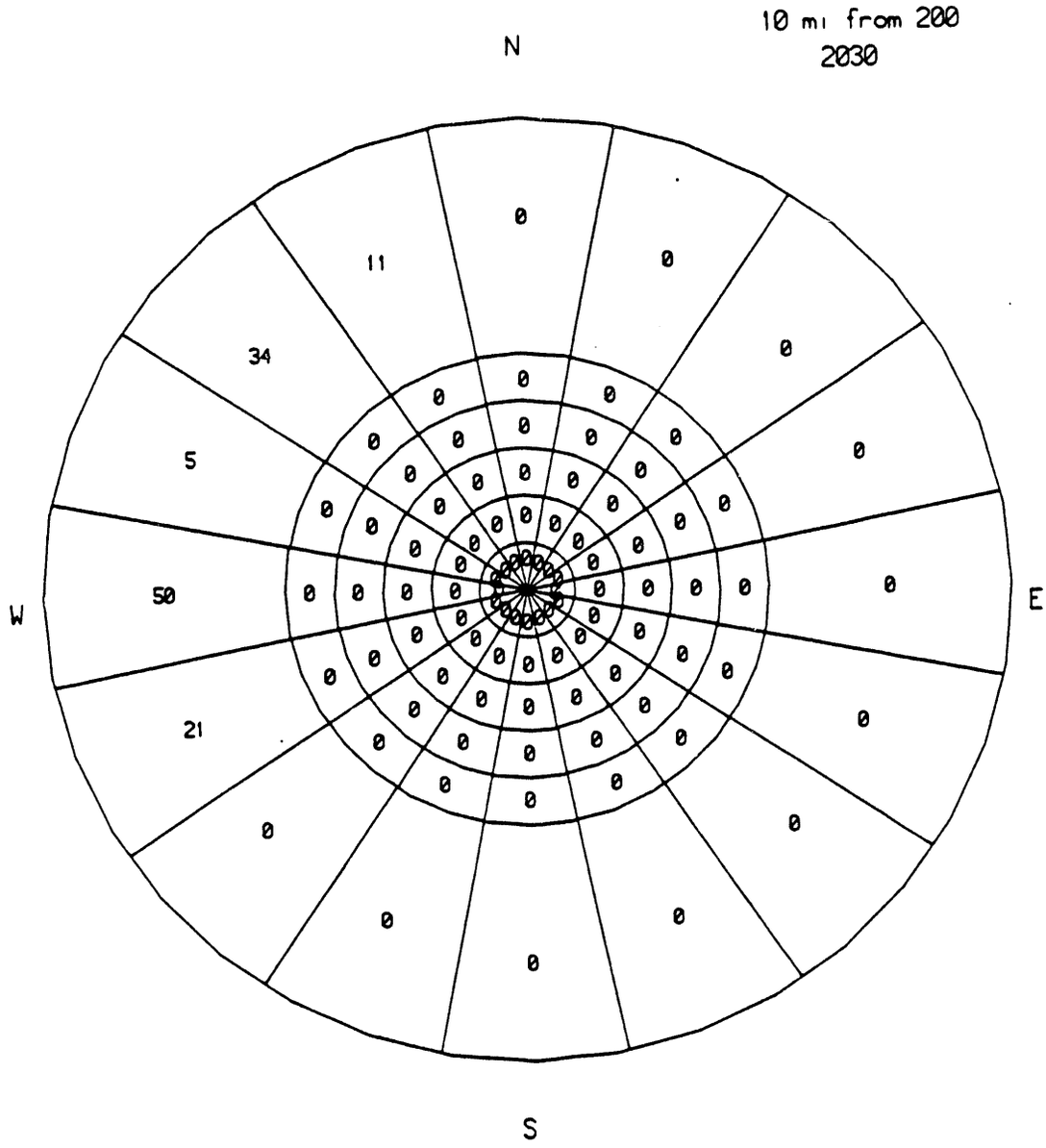


FIGURE C.36. Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the Hanford Meteorological Station, by Population Grid Sector for 2030

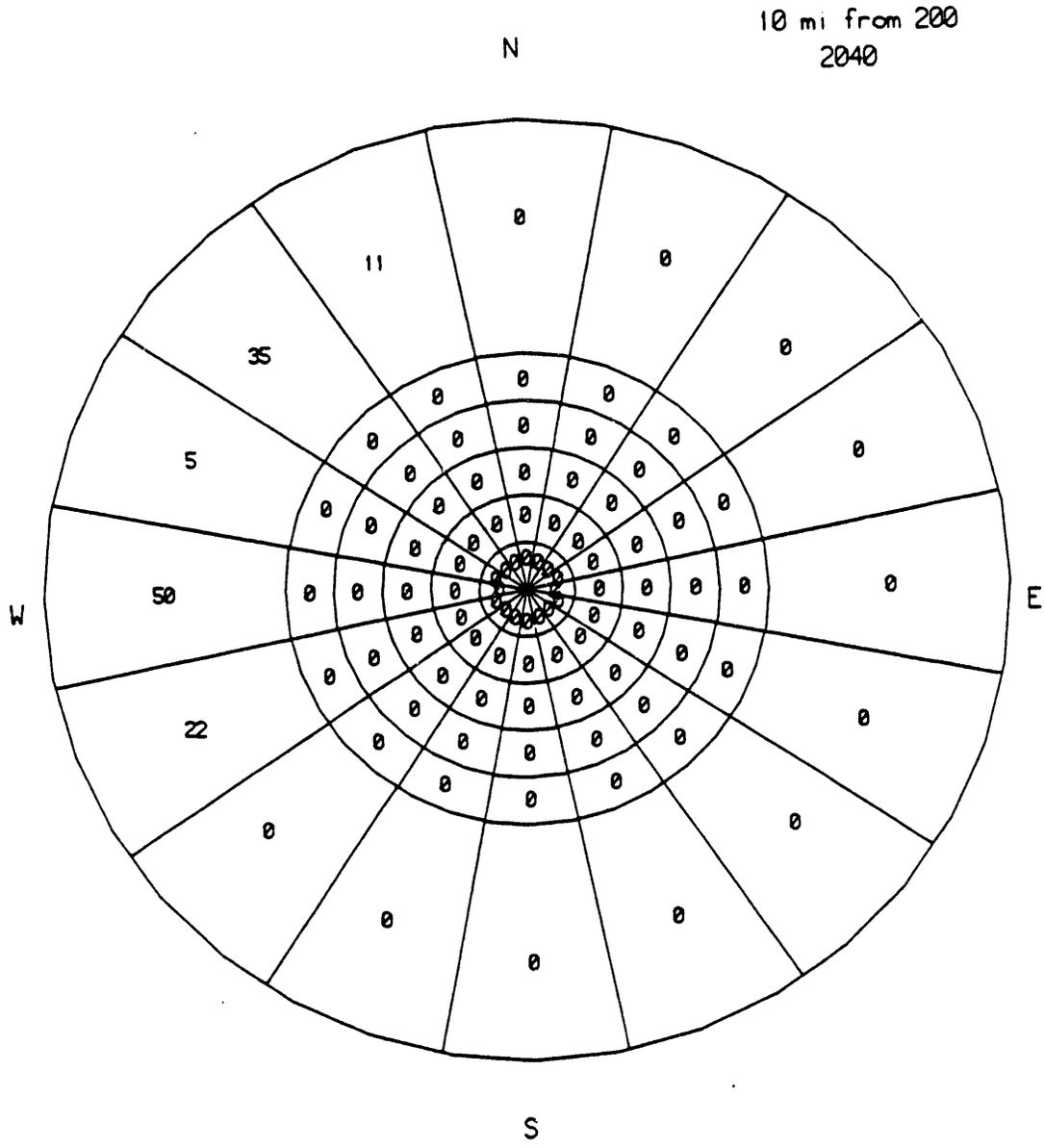


FIGURE C.37. Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the Hanford Meteorological Station, by Population Grid Sector for 2040

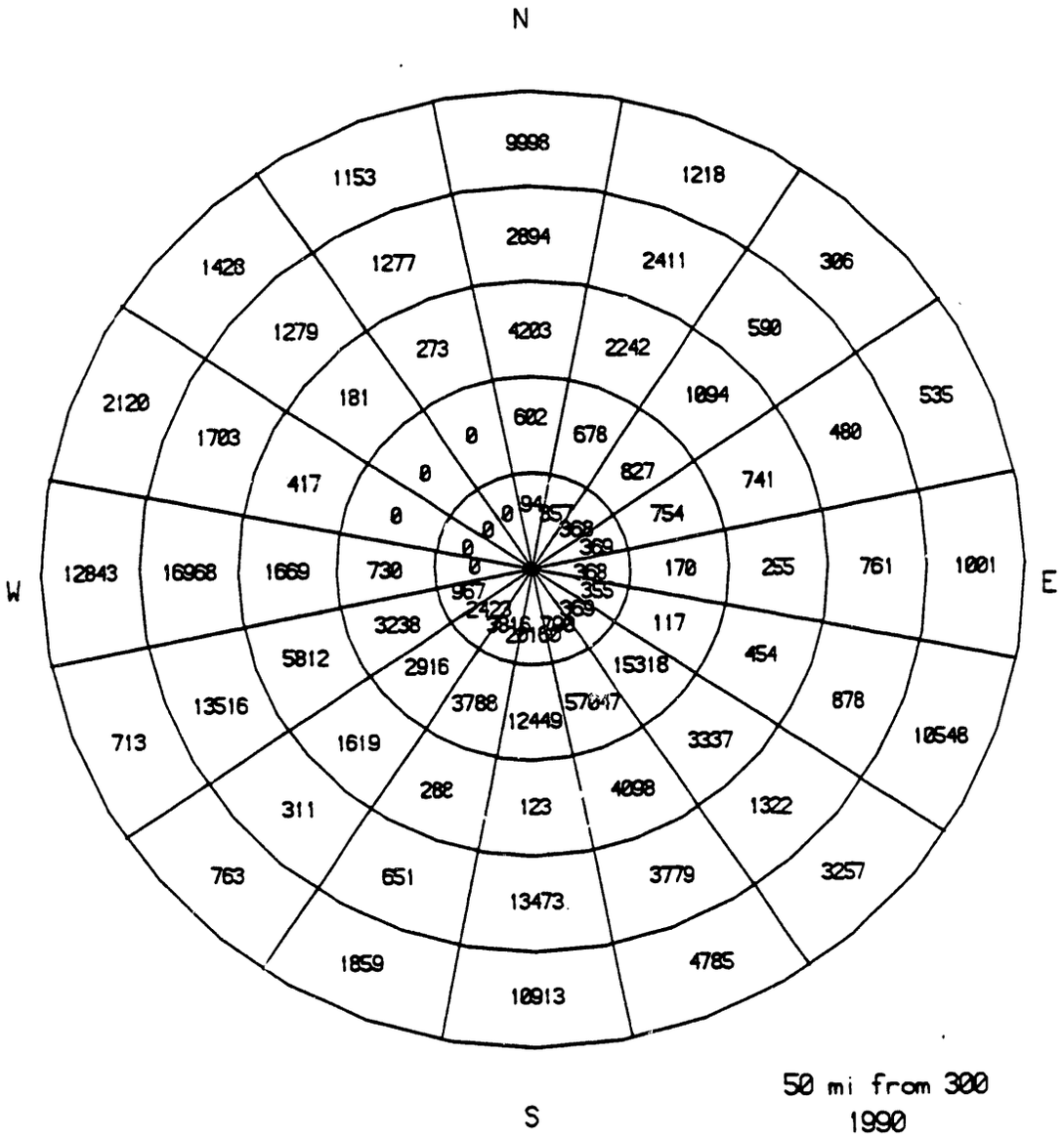


FIGURE C.38. Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the 300 Area Meteorological Tower, by Population Grid Sector for 1990

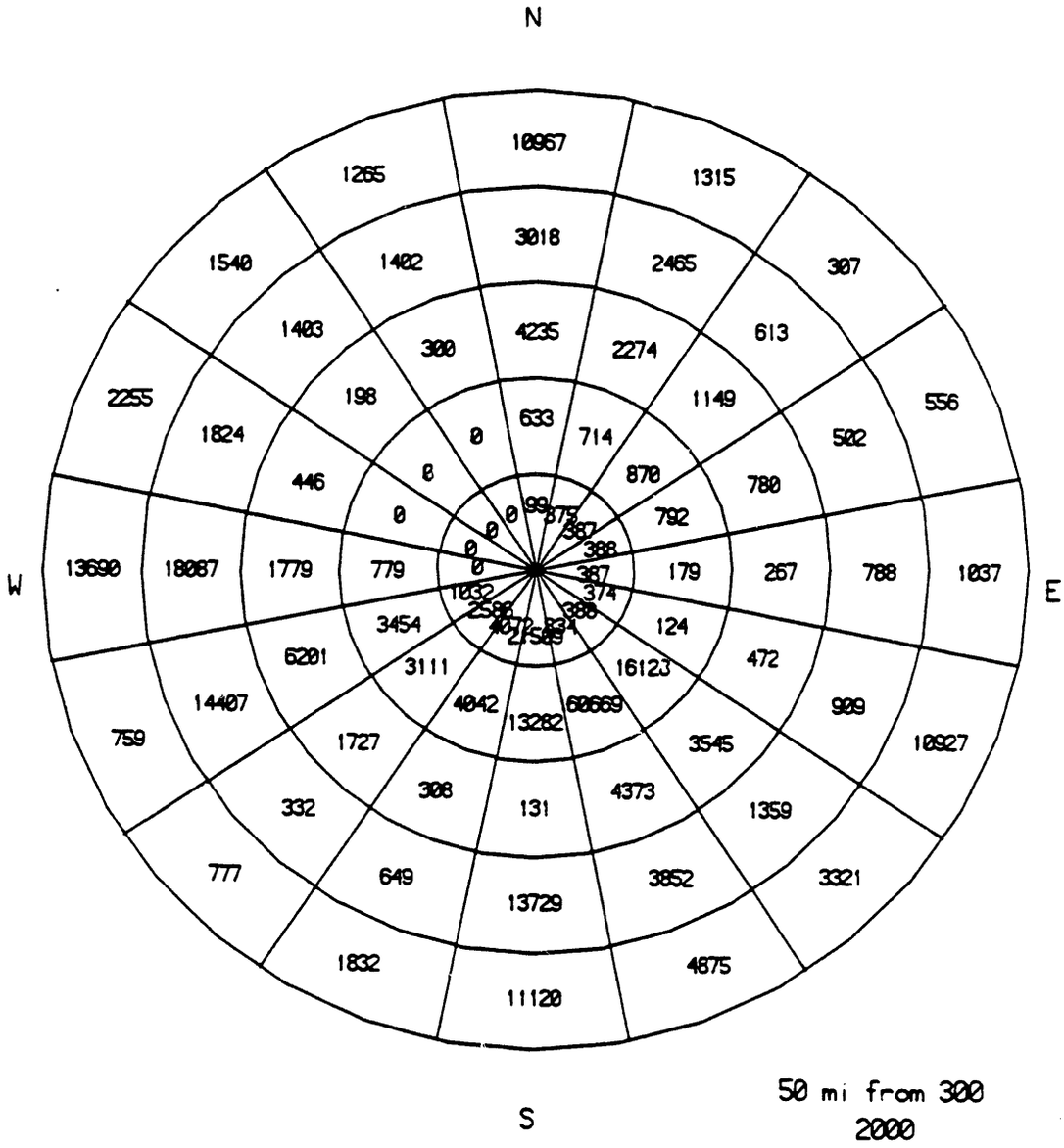


FIGURE C.39. Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the 300 Area Meteorological Tower, by Population Grid Sector for 2000

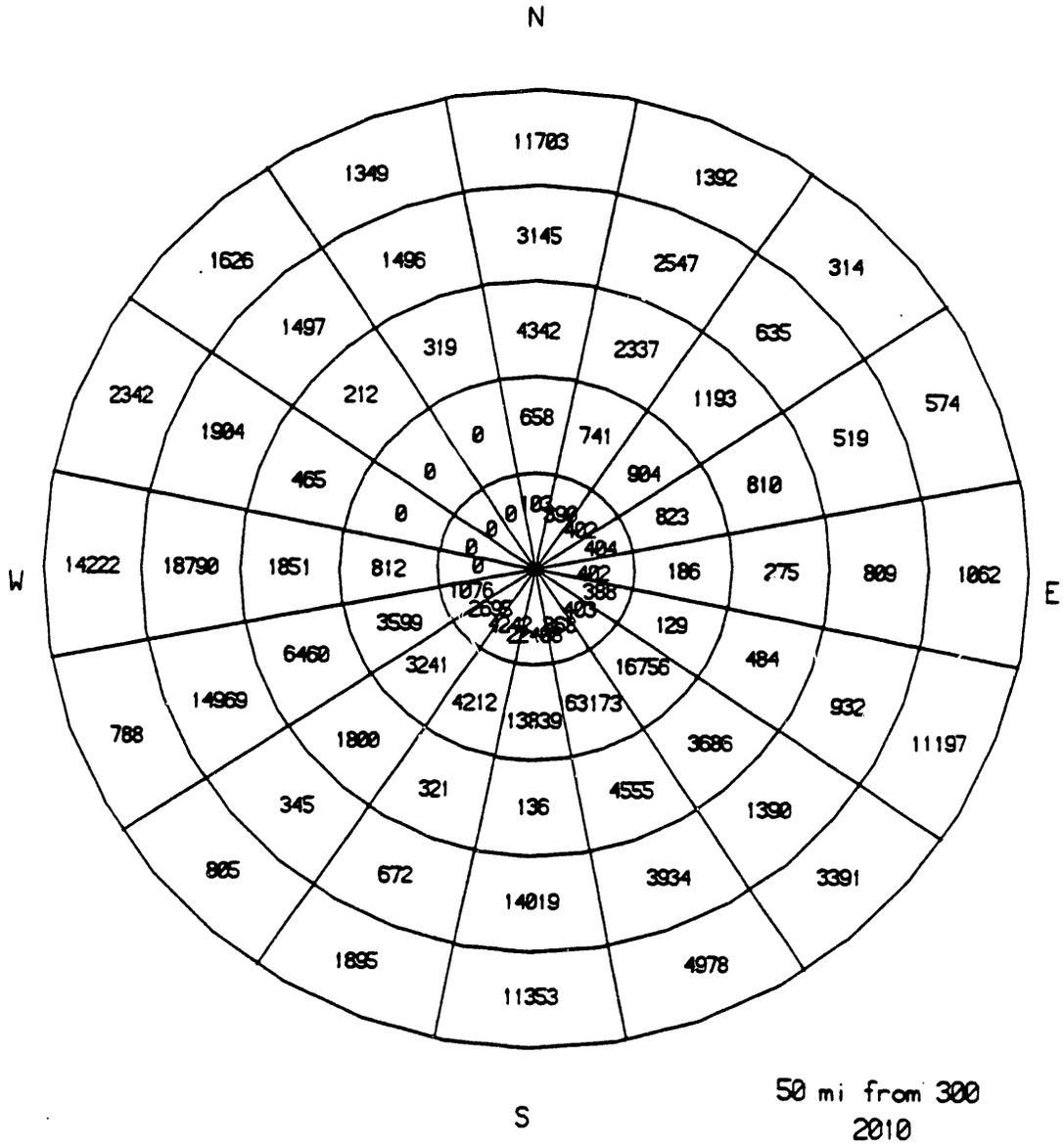
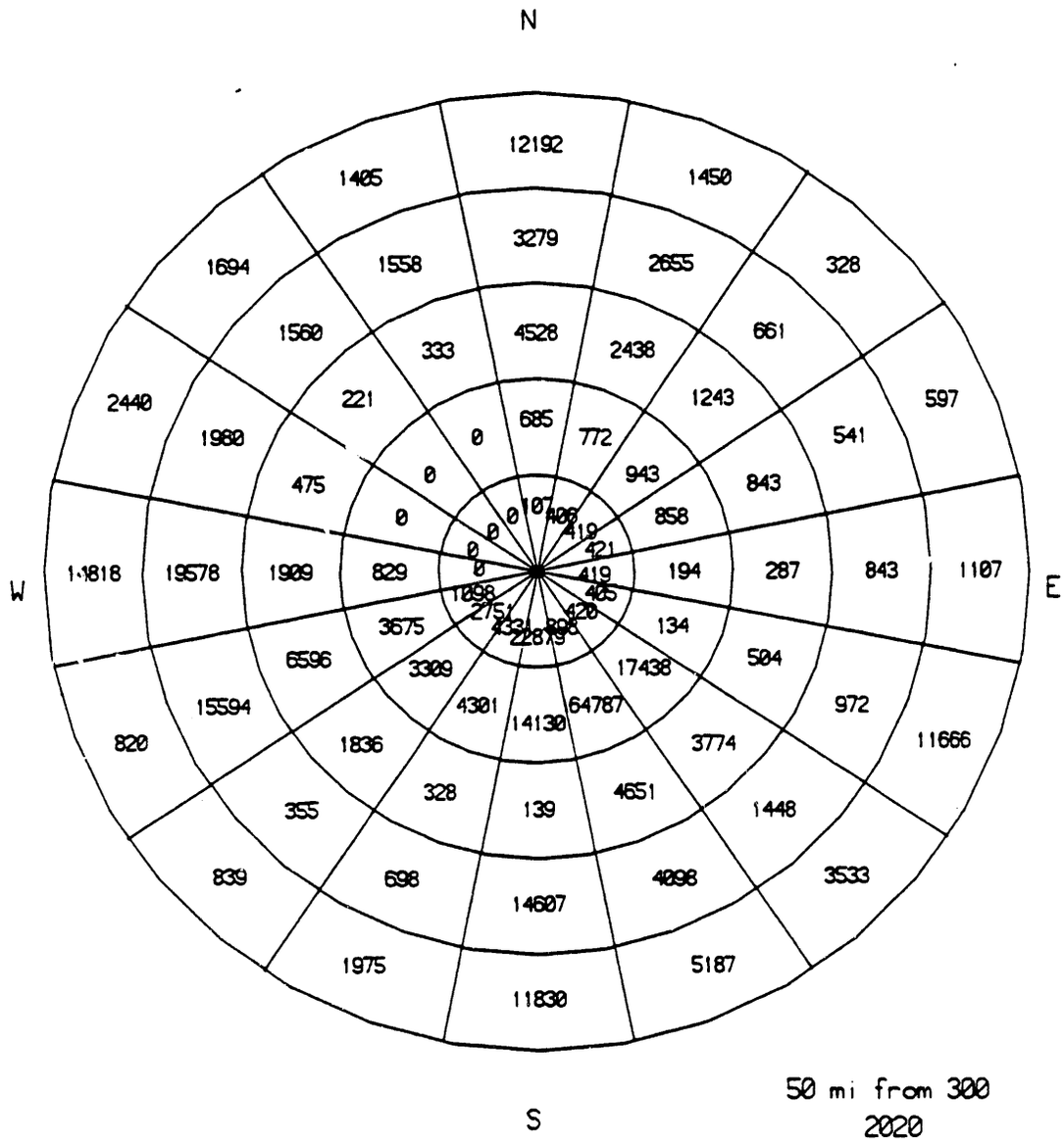


FIGURE C.40. Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the 300 Area Meteorological Tower, by Population Grid Sector for 2010


N
S
E
W
12192
1450
328
597
1107
843
287
194
134
504
972
11666
3533
5187
11830
1975
839
355
820
15594
6596
1818
19578
1909
2440
1694
1405
3279
2655
2438
1243
943
858
843
541
661
4528
333
221
475
829
3675
3309
1836
698
1448
3774
4651
4098
14607
139
328
4301
14130
64787
17438
1560
1558
1980
0
0
0

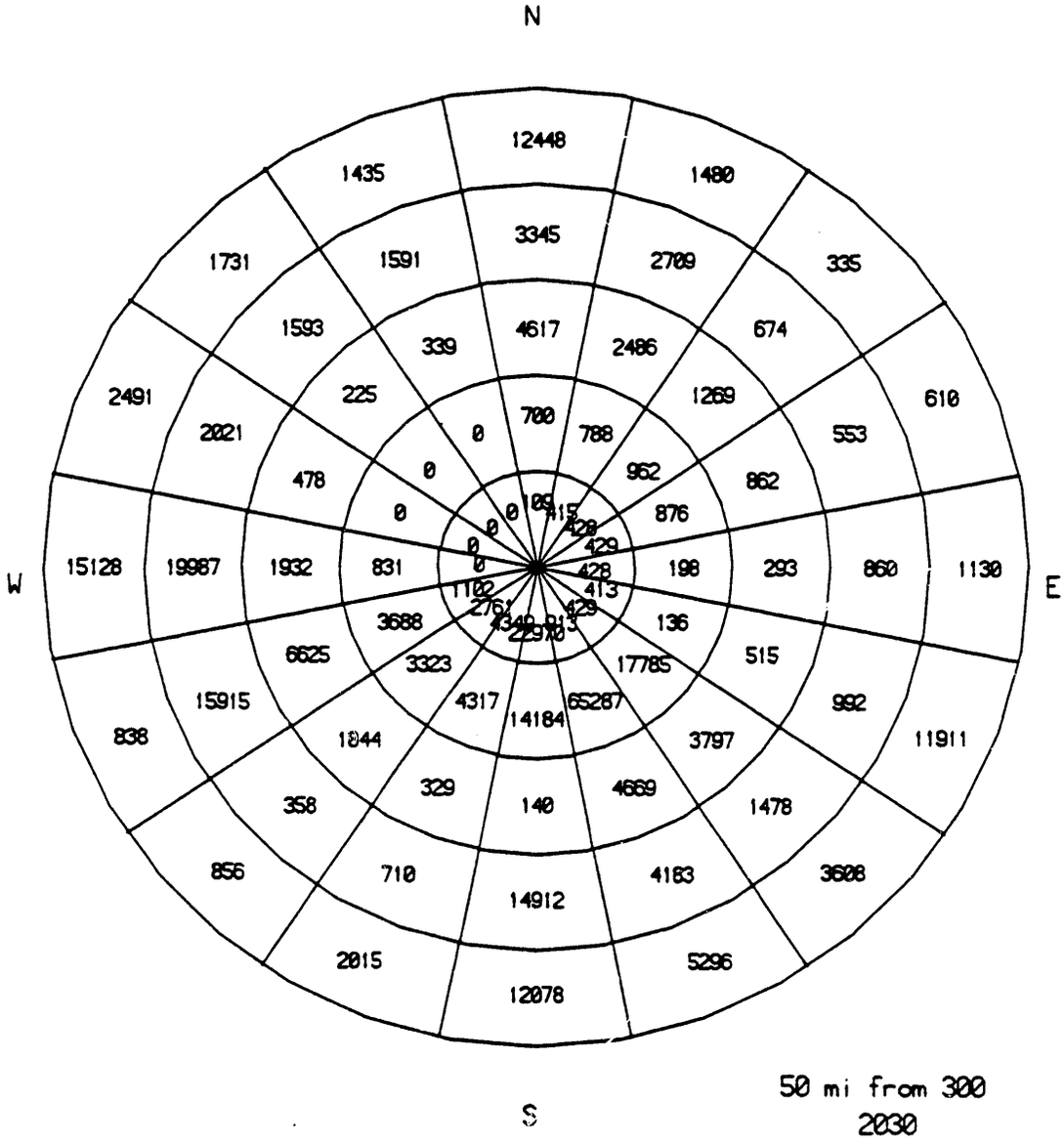
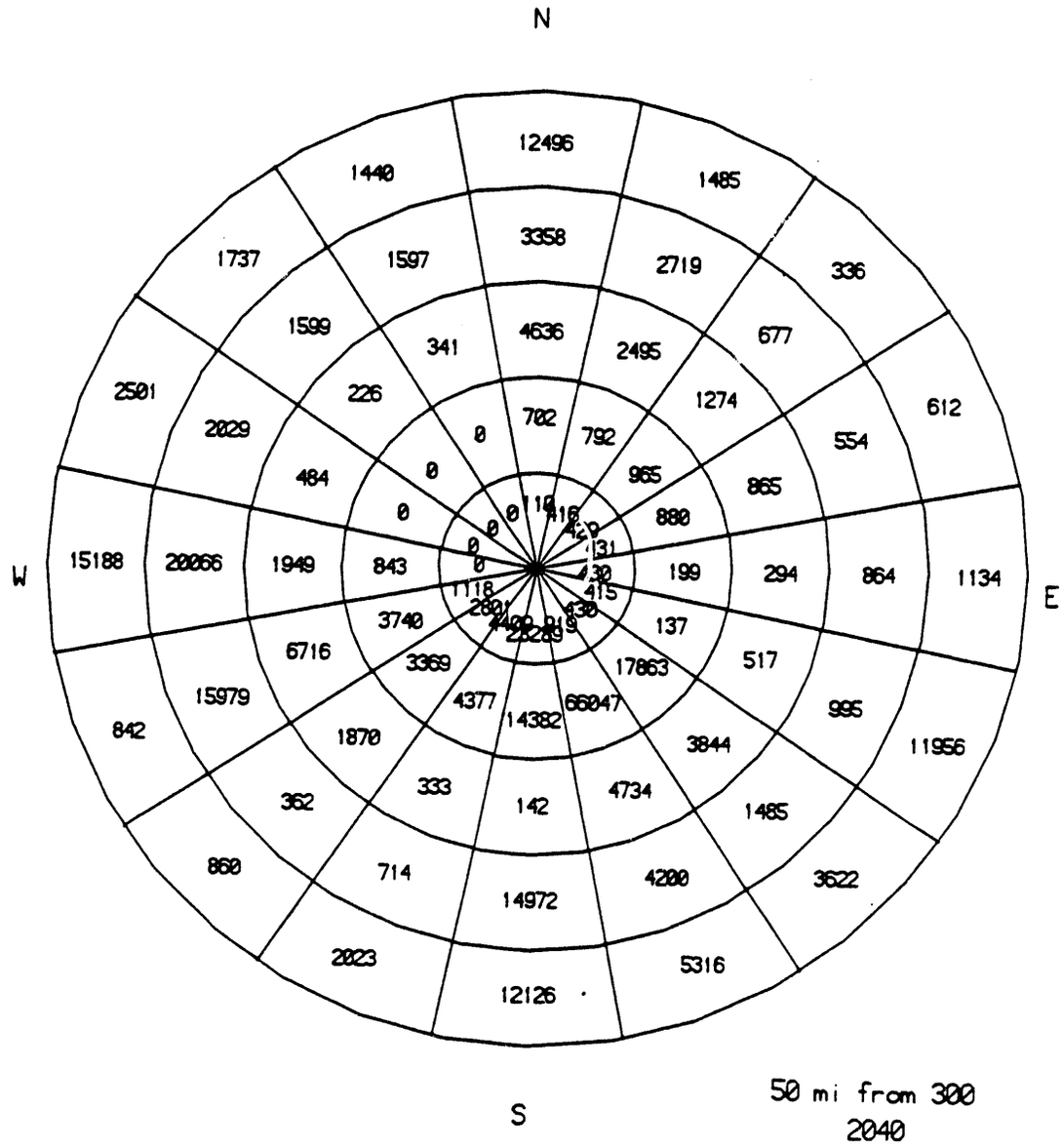
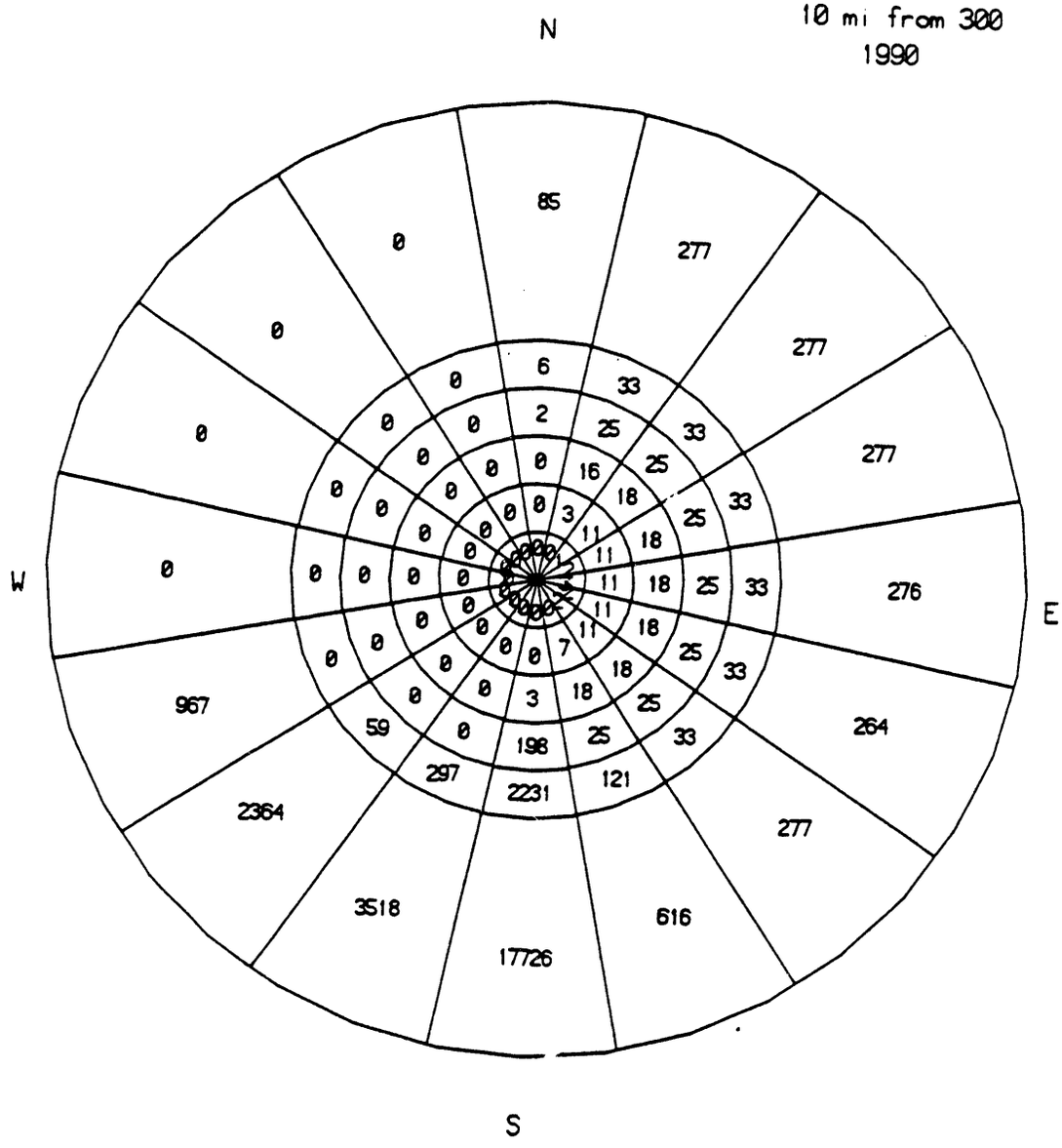


FIGURE C.42. Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the 300 Area Meteorological Tower, by Population Grid Sector for 2030


N
E
S
W
12496
1440
1485
3358
1597
1737
2719
336
4636
1599
341
2495
677
2501
226
1274
612
702
2029
0
792
554
484
0
965
865
0
880
0
0
0


10 mi from 300
1990
N
E
S
W
85
277
277
277
276
264
277
616
17726
3518
2364
967
0
0
0

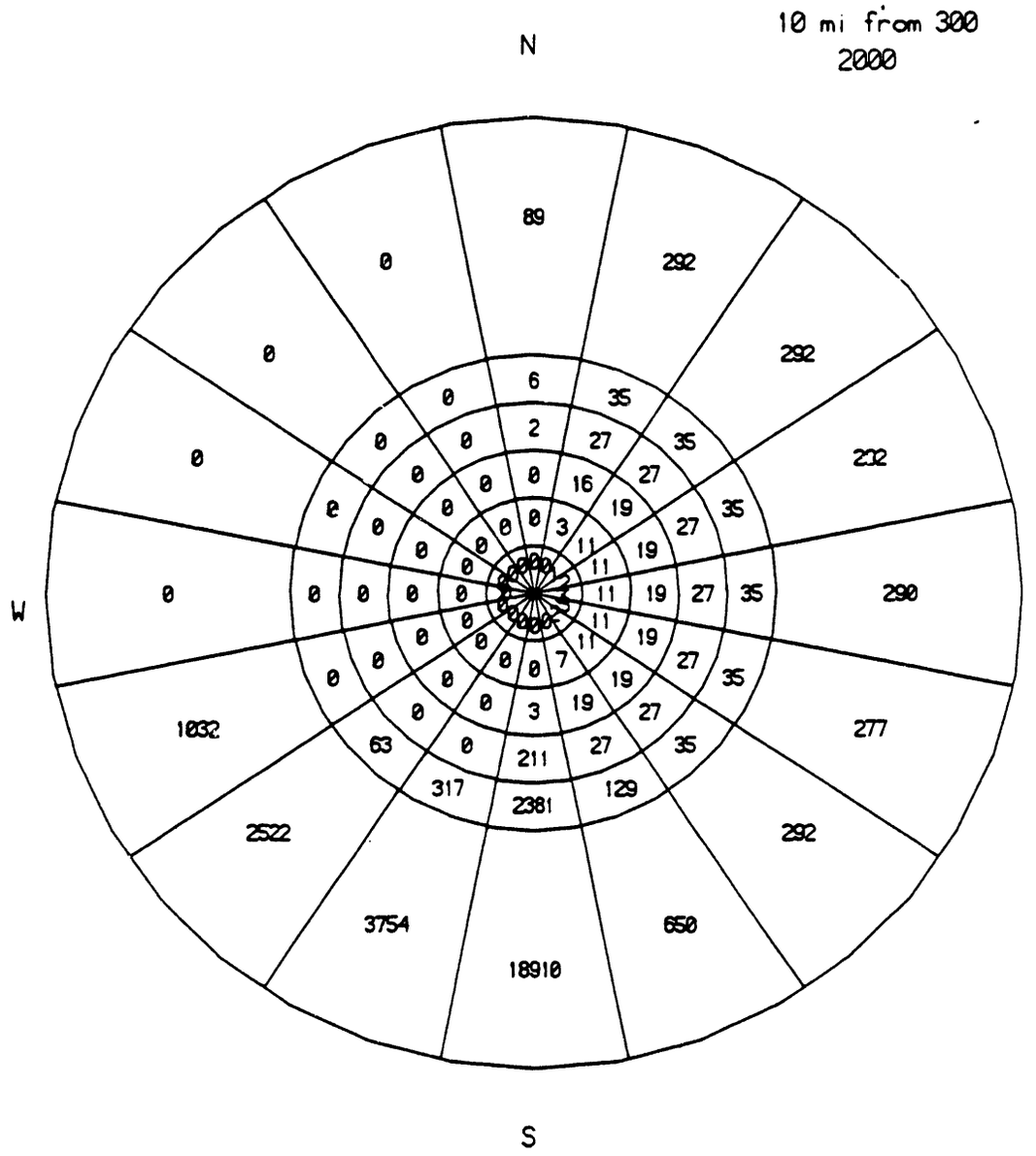


FIGURE C.45. Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 300 Area Meteorological Tower, by Population Grid Sector for 2000

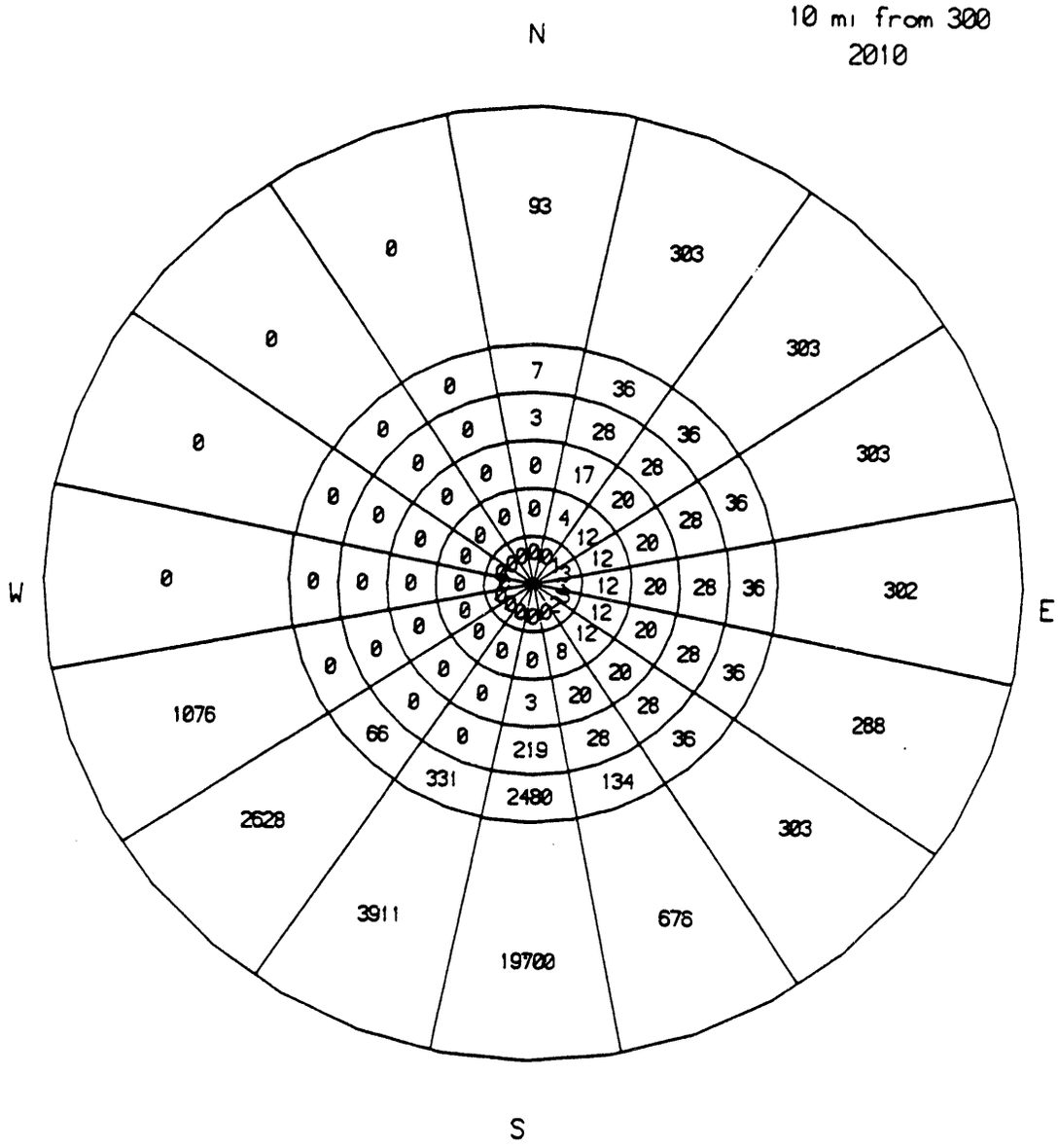


FIGURE C.46. Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 300 Area Meteorological Tower, by Population Grid Sector for 2010

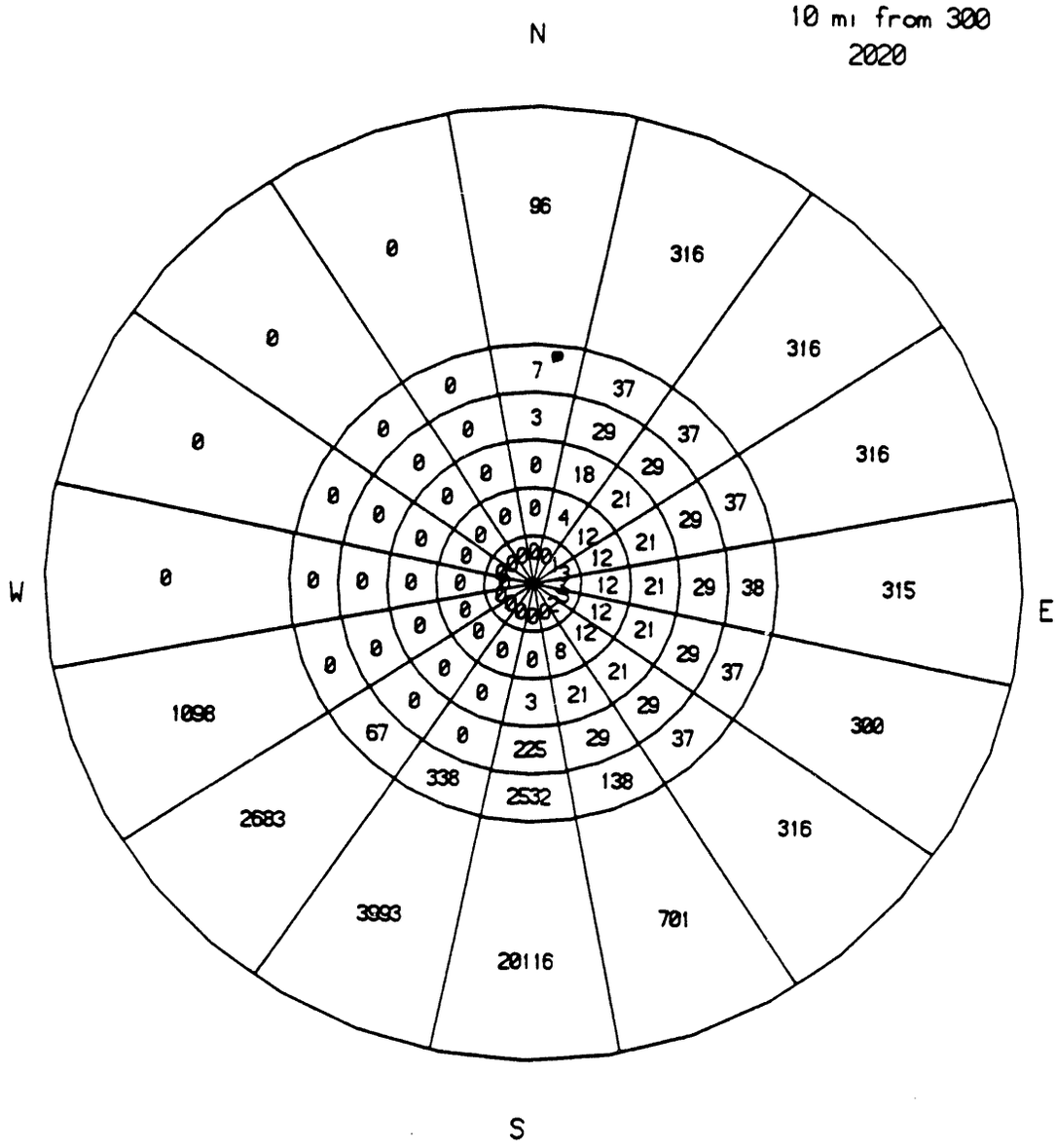


FIGURE C.47. Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 300 Area Meteorological Tower, by Population Grid Sector for 2020

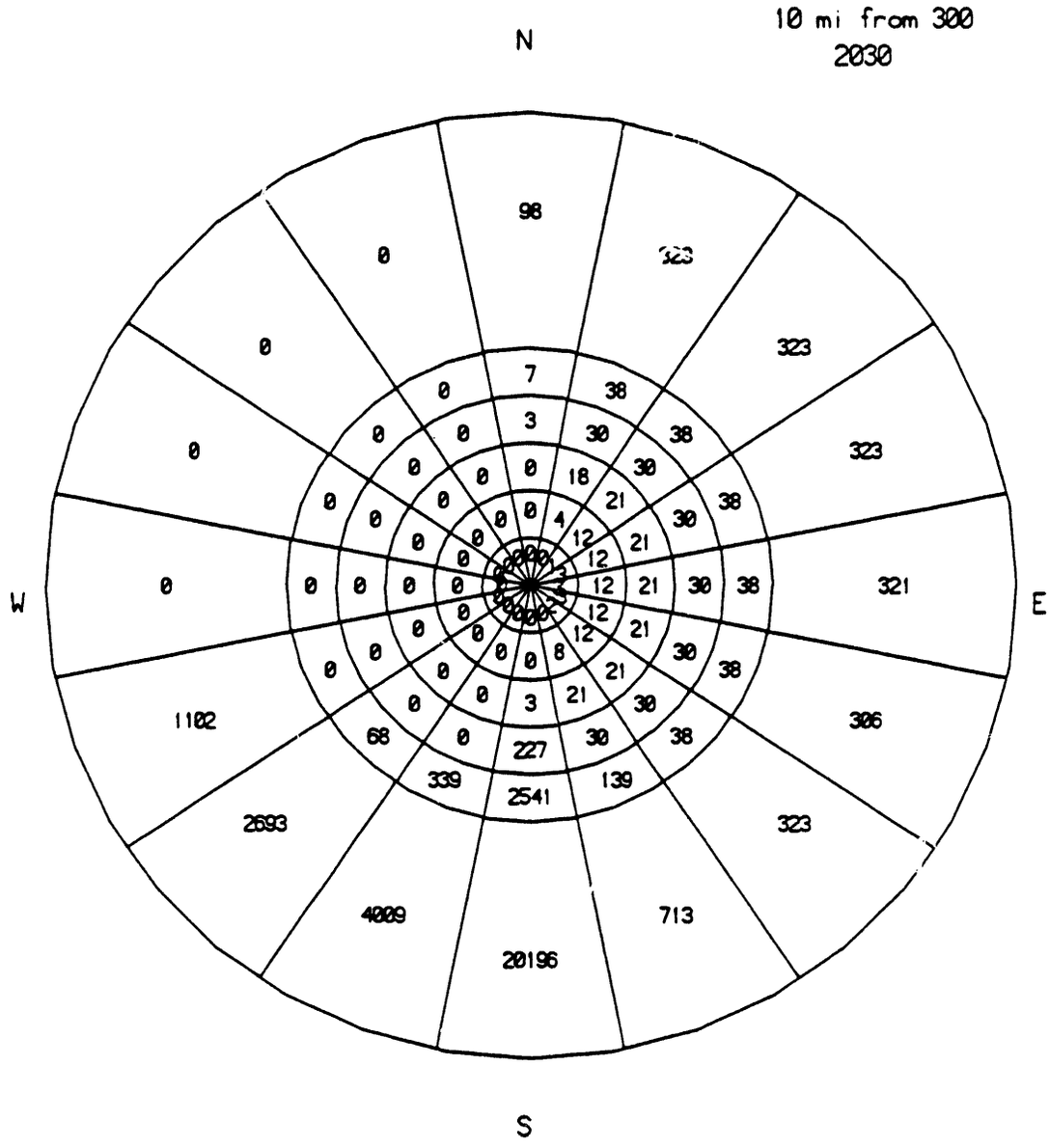


FIGURE C.48. Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 300 Area Meteorological Tower, by Population Grid Sector for 2030

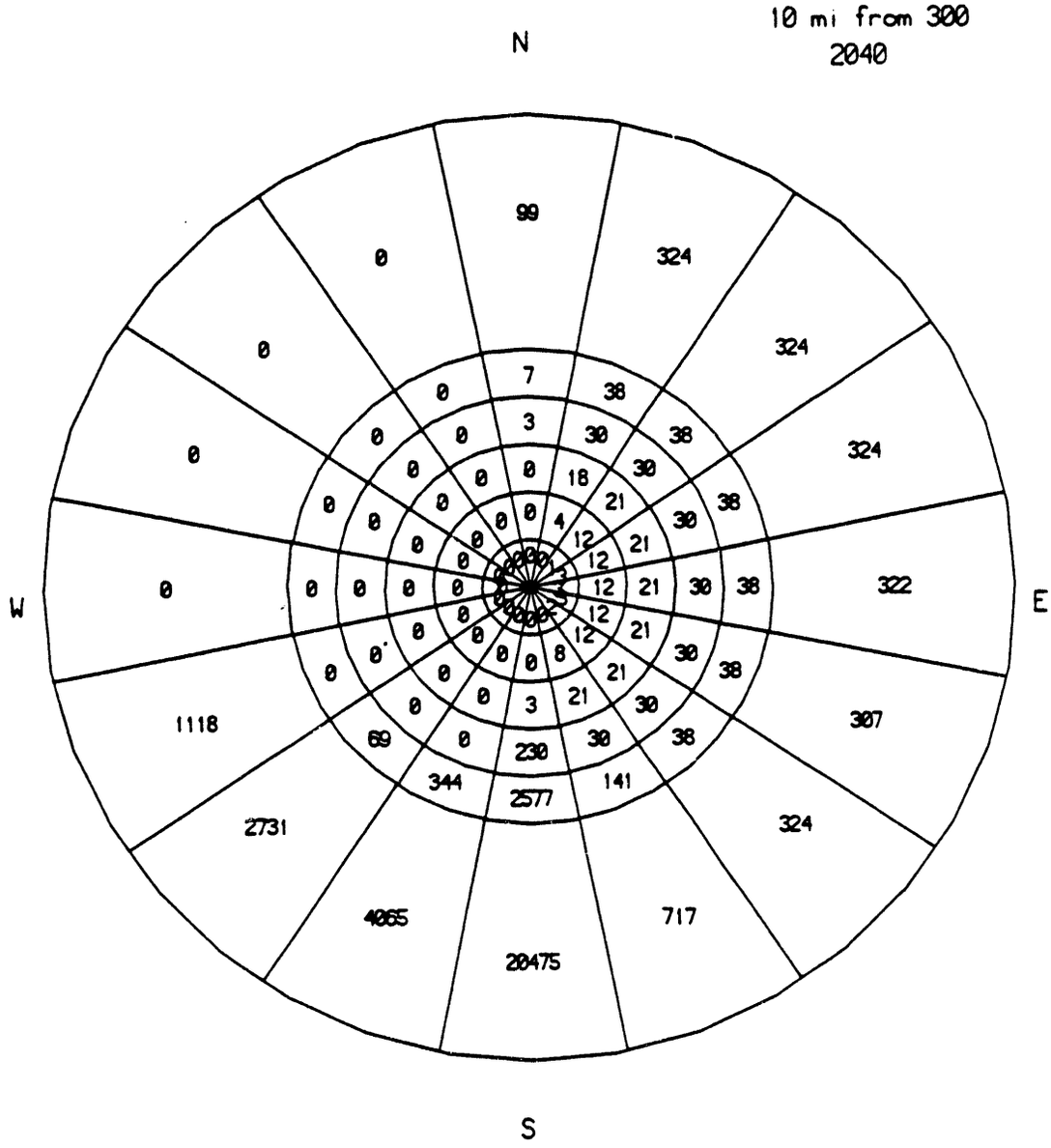


FIGURE C.49. Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 300 Area Meteorological Tower, by Population Grid Sector for 2040

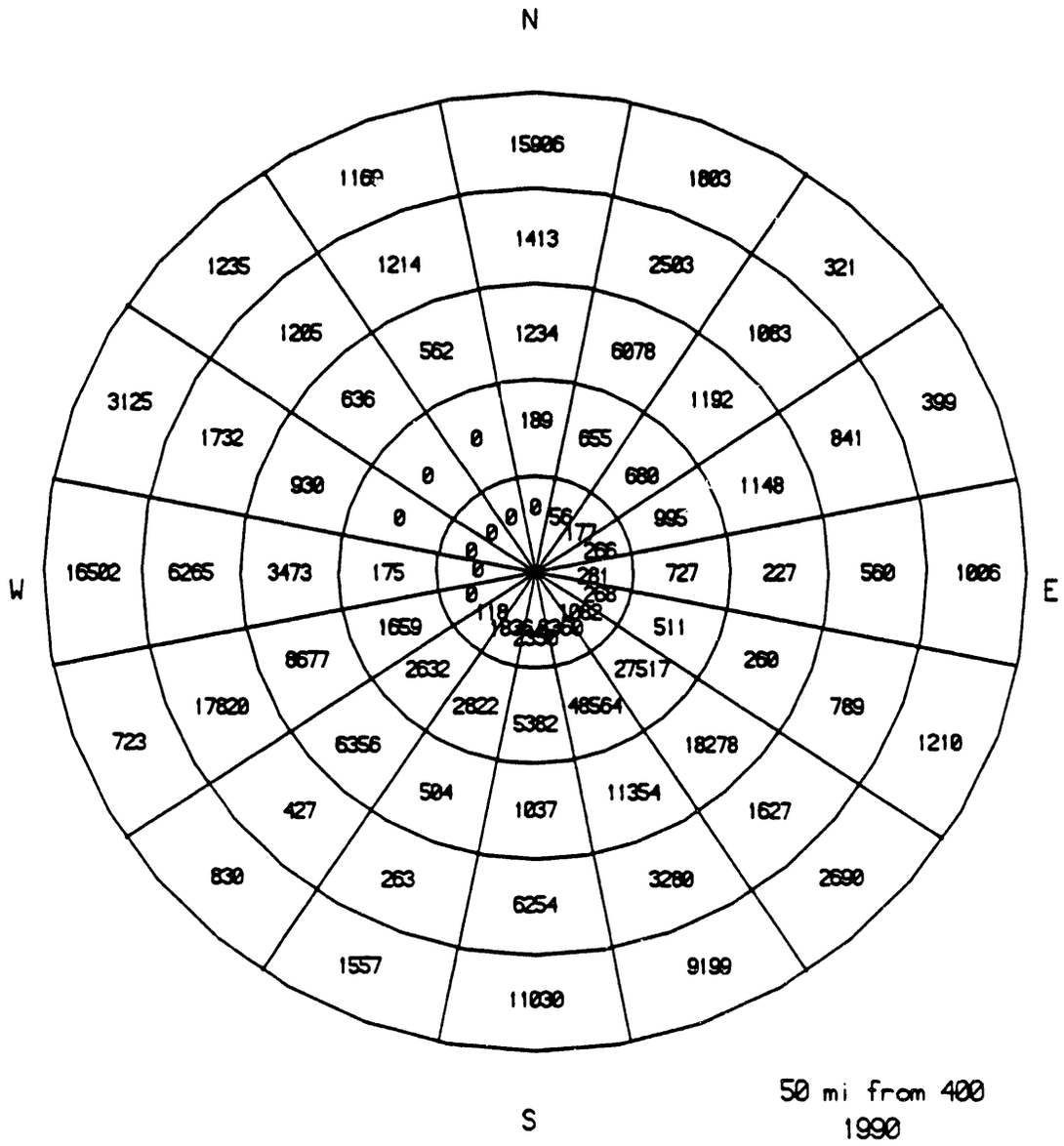
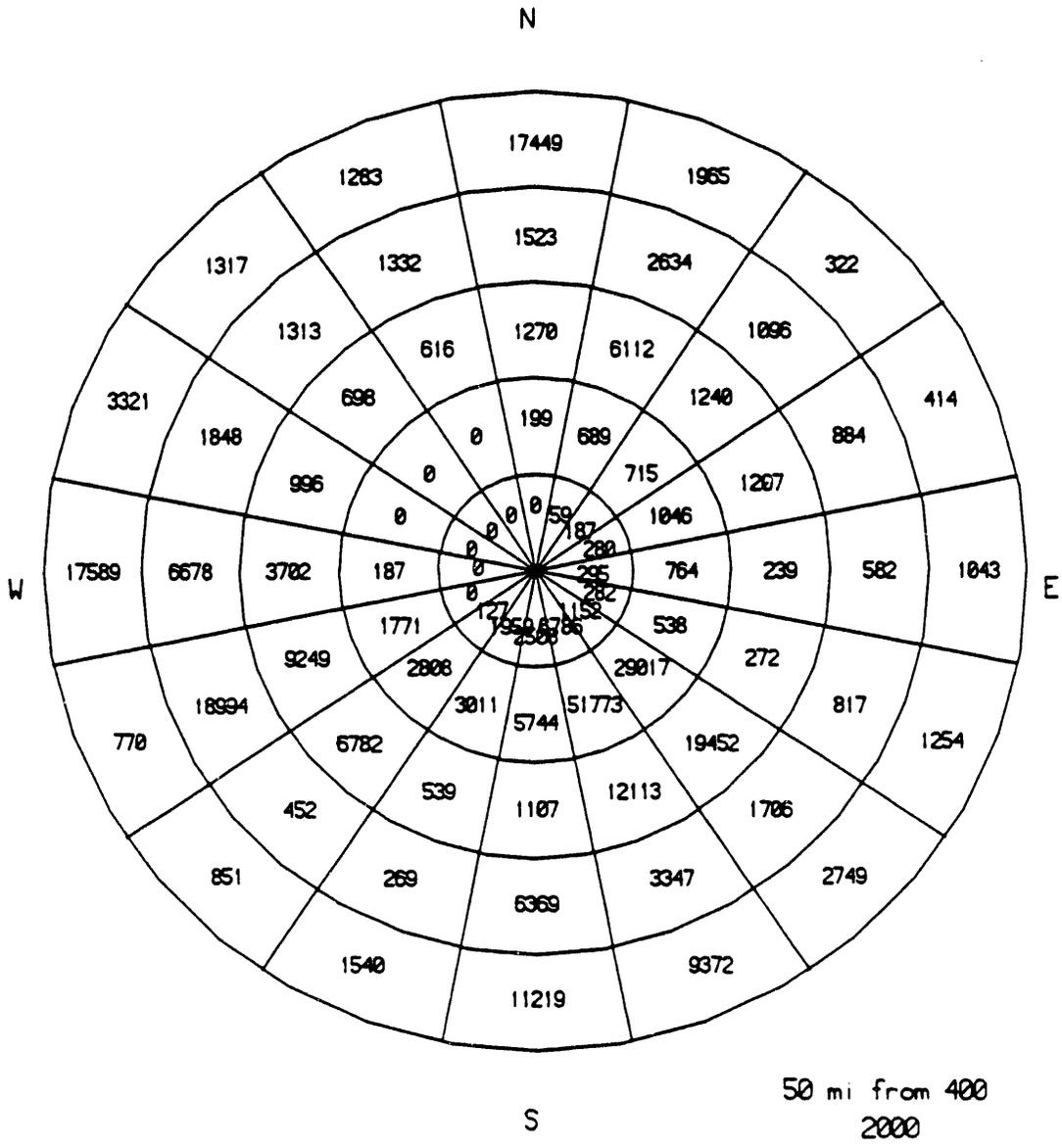
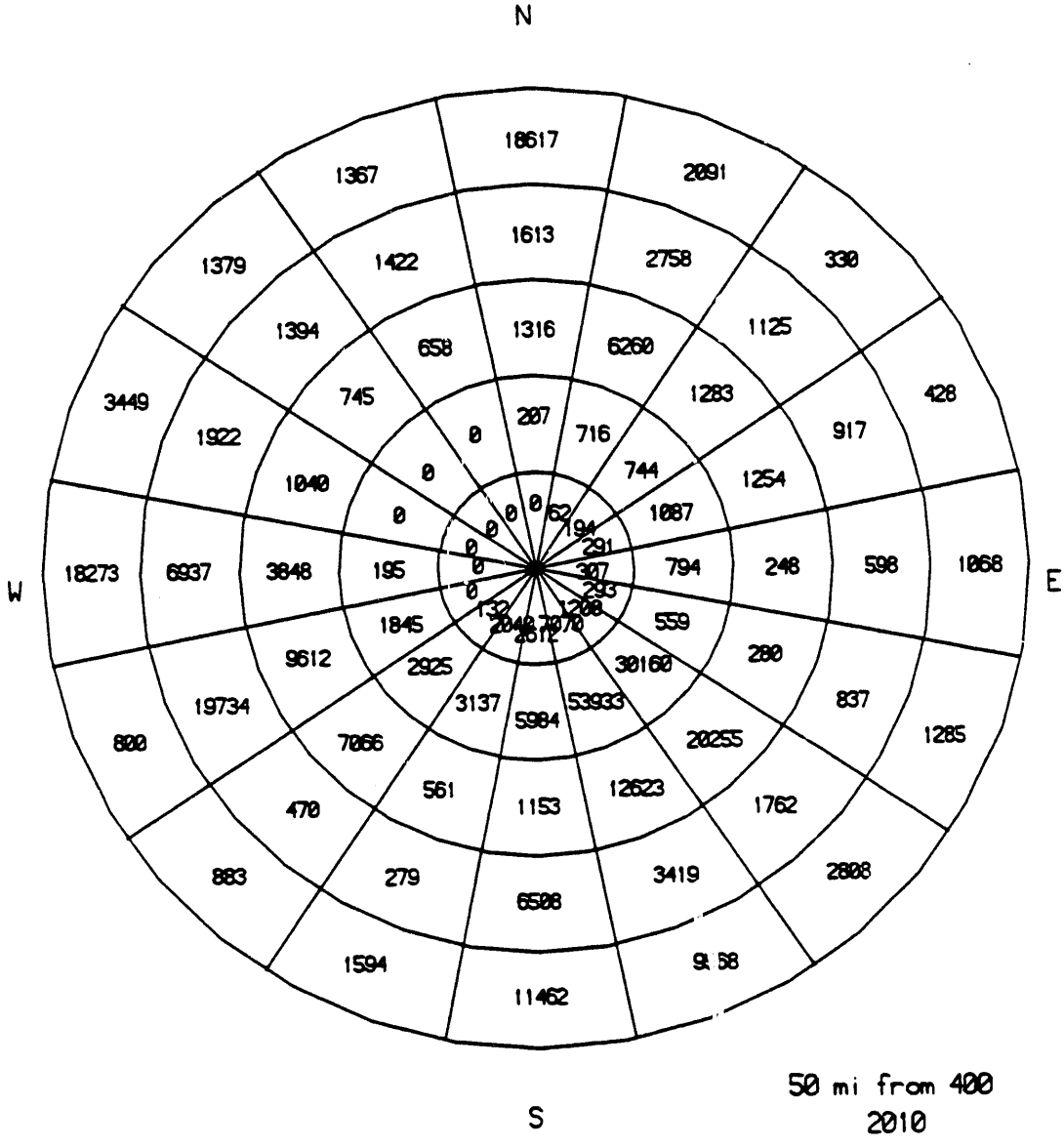
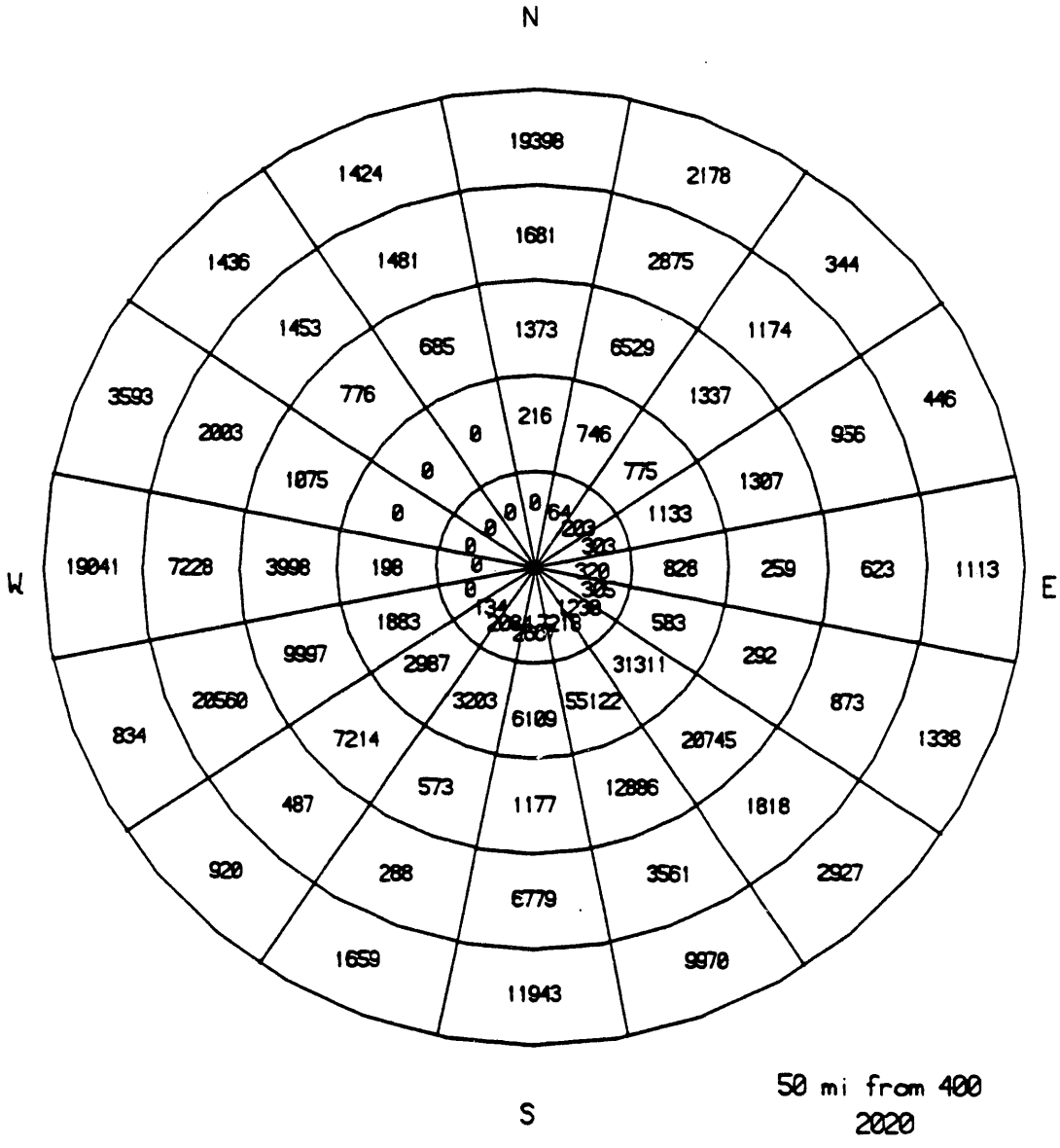


FIGURE C.50. Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the 400 Area Meteorological Tower, by Population Grid Sector for 1990


N
E
S
W
17449
1965
322
414
1043
582
239
764
1046
1207
884
1096
2634
1523
1332
1283
1317
1313
3321
1848
996
3702
6678
17589
770
18994
9249
1771
187
698
616
1270
6112
1240
715
689
199
0
0
0


N
E
S
W
18617
2091
330
428
1068
598
248
794
280
837
1285
1762
2808
9158
11462
1594
883
470
19734
9612
1845
195
3848
6937
18273
3449
1367
1379
1422
1394
1922
1040
658
745
1316
1613
2758
6260
1125
1283
917
1254
1087
207
716
744
0
0
0


N
W
E
S
19398
2178
1681
2875
344
1424
1481
1373
6529
1174
1436
1453
685
216
746
1337
446
3593
776
0
775
956
2003
1075
0
1133
1307
0
0
0

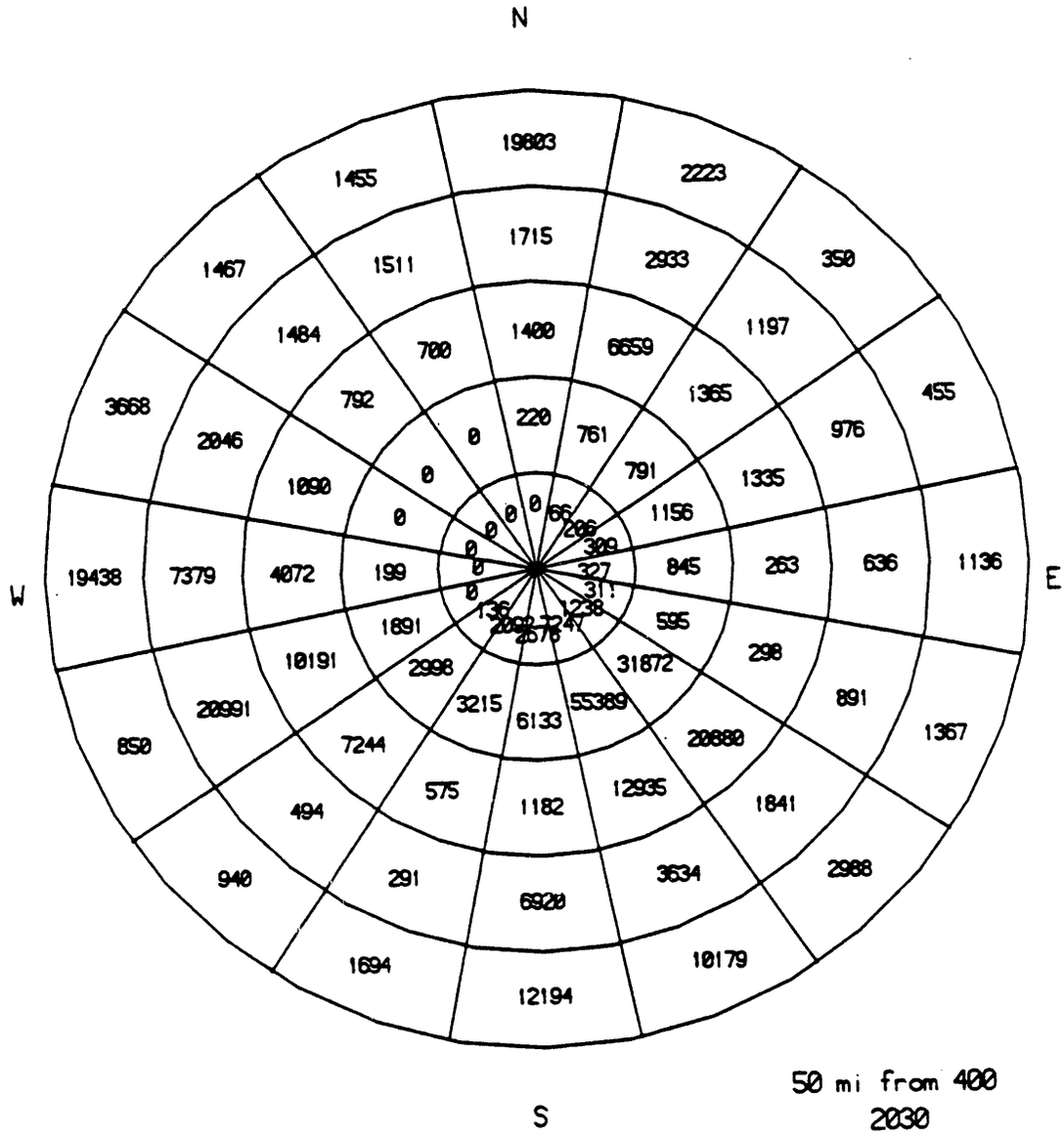


FIGURE C.54. Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the 400 Area Meteorological Tower, by Population Grid Sector for 2030

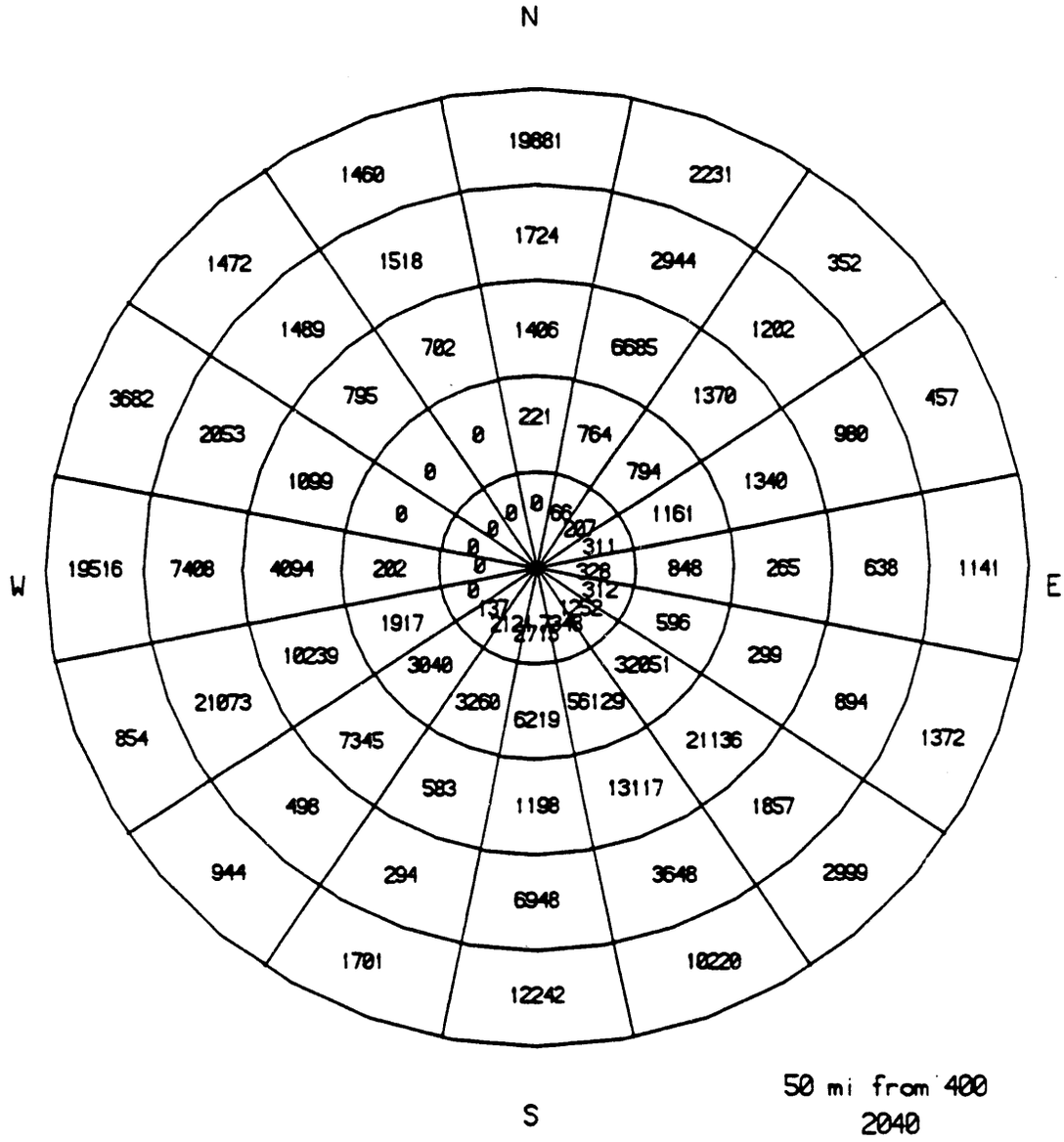


FIGURE C.55. Distribution of Residential Population in an 80-Kilometer (50-Mile) Radius of the 400 Area Meteorological Tower, by Population Grid Sector for 2040

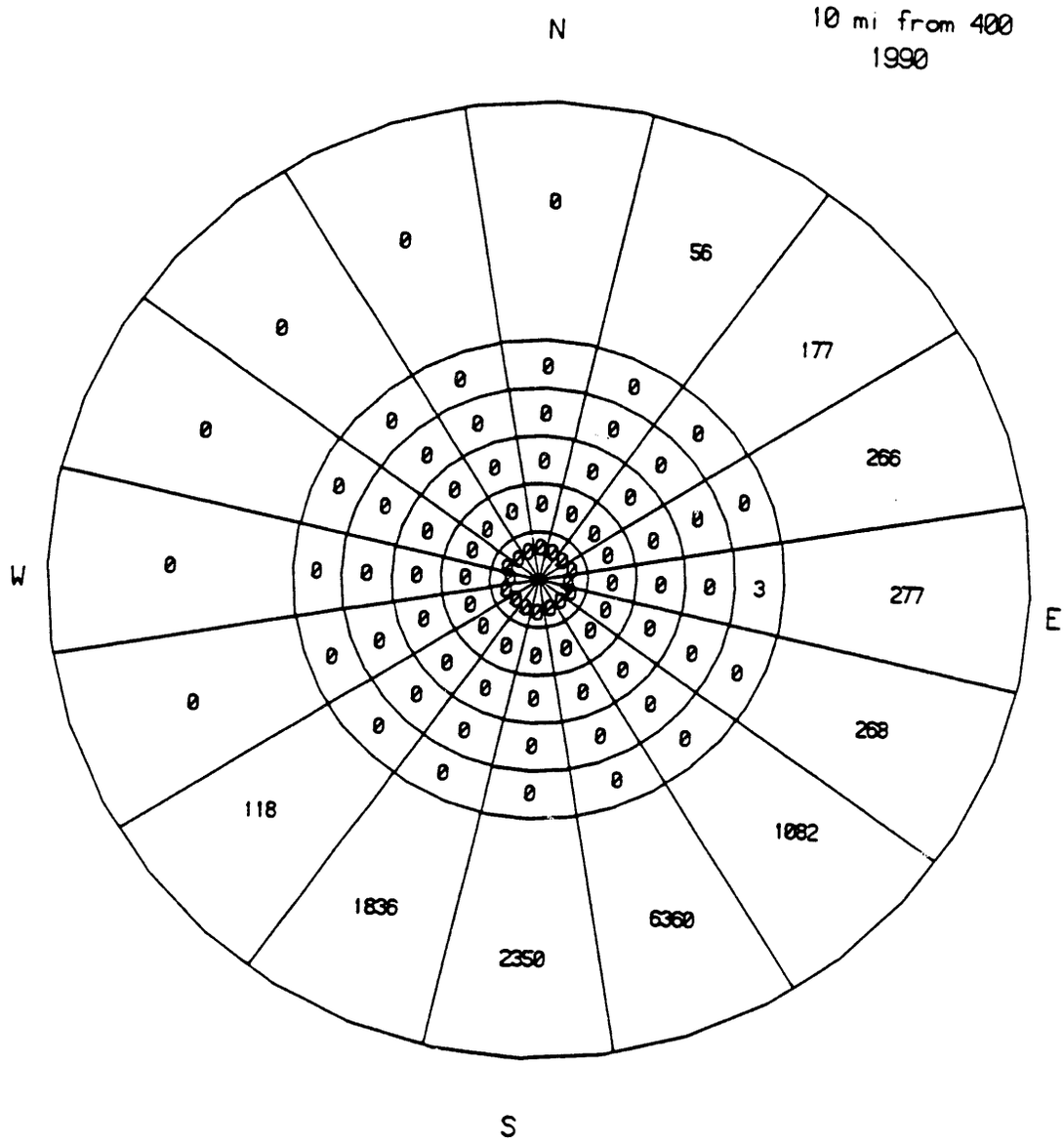


FIGURE C.56. Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 400 Area Meteorological Tower, by Population Grid Sector for 1990

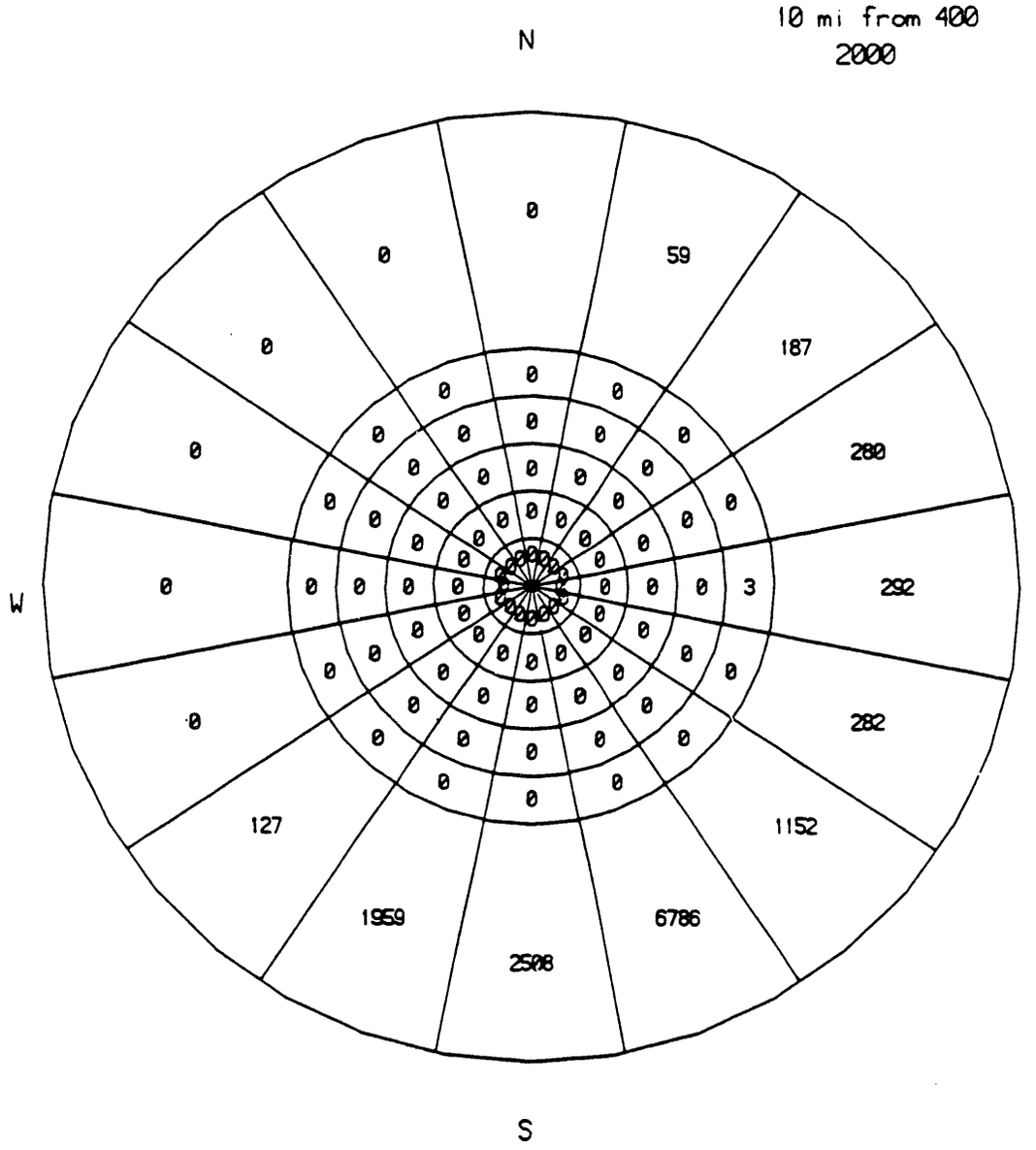


FIGURE C.57. Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 400 Area Meteorological Tower, by Population Grid Sector for 2000

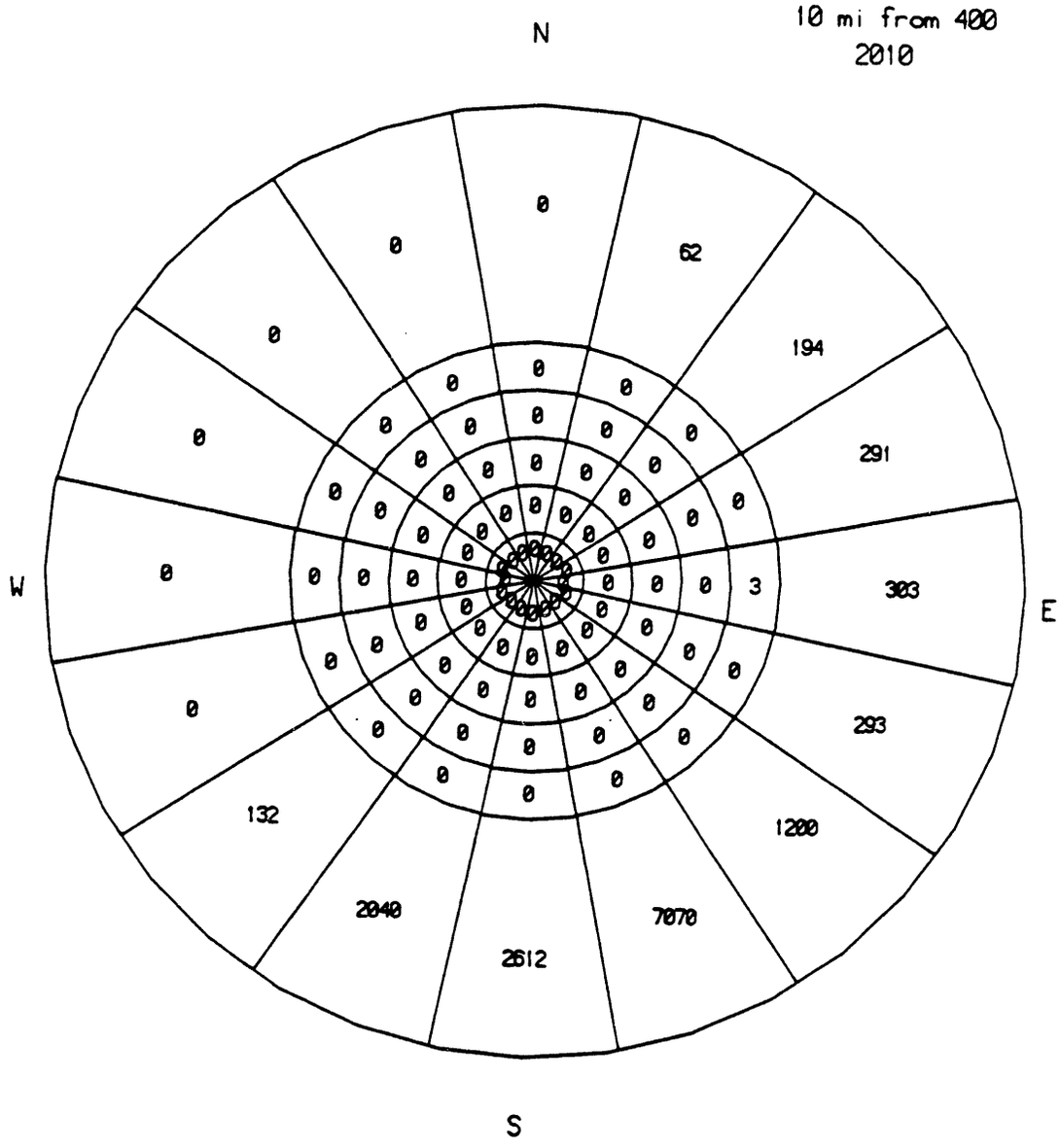


FIGURE C.58. Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 400 Area Meteorological Tower, by Population Grid Sector for 2010

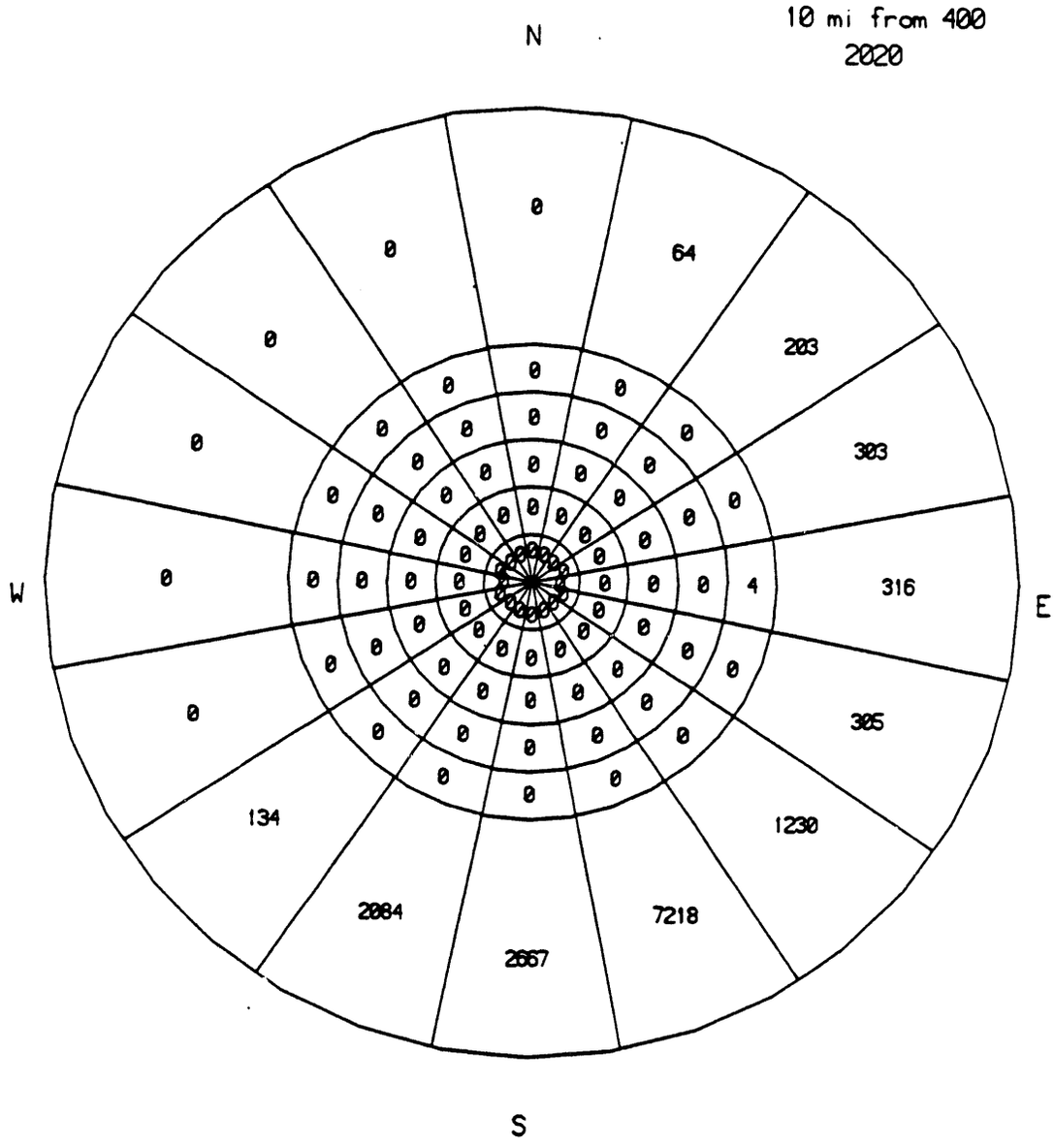


FIGURE C.59. Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 400 Area Meteorological Tower, by Population Grid Sector for 2020

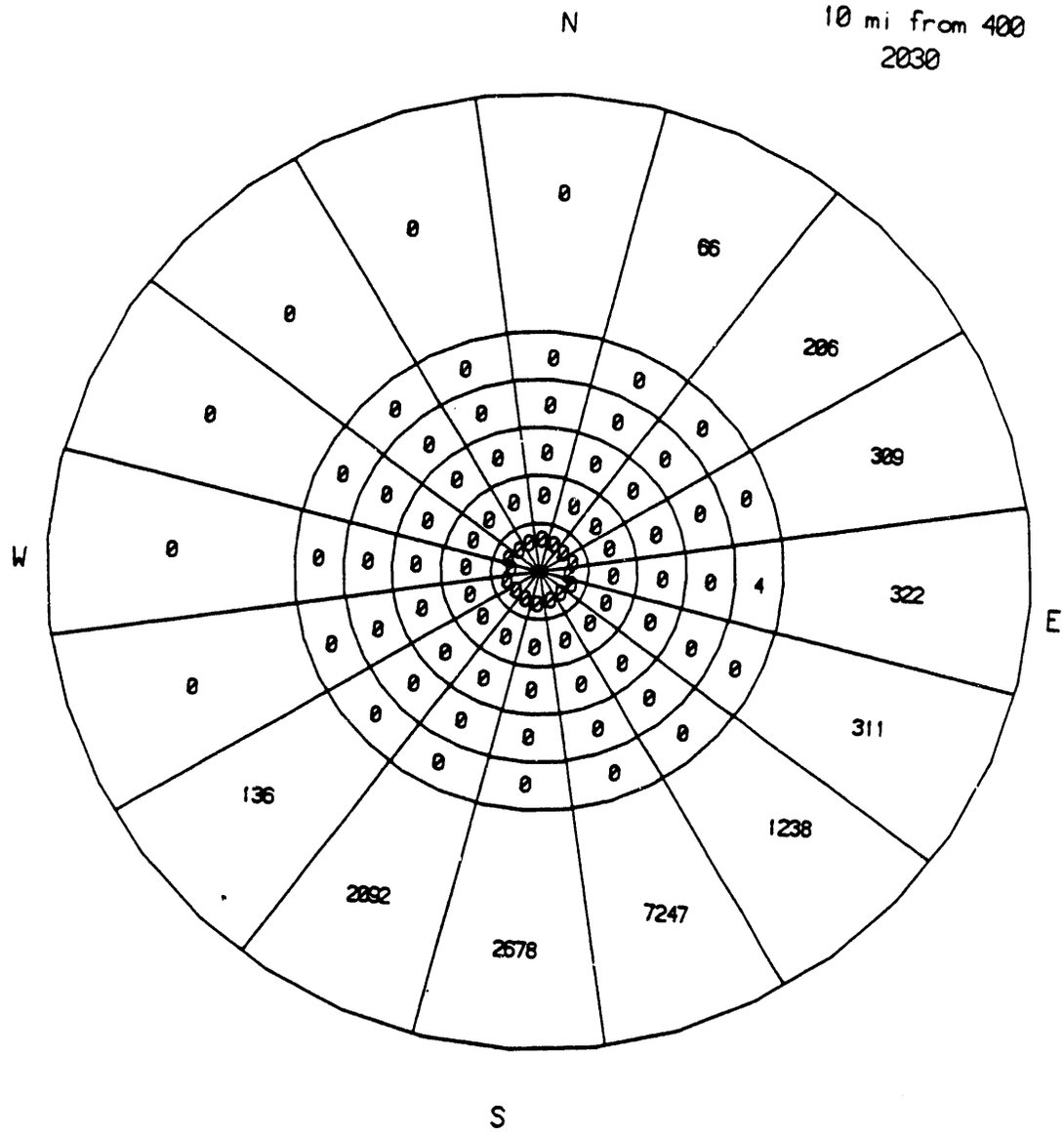


FIGURE C.60. Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 400 Area Meteorological Tower, by Population Grid Sector for 2030

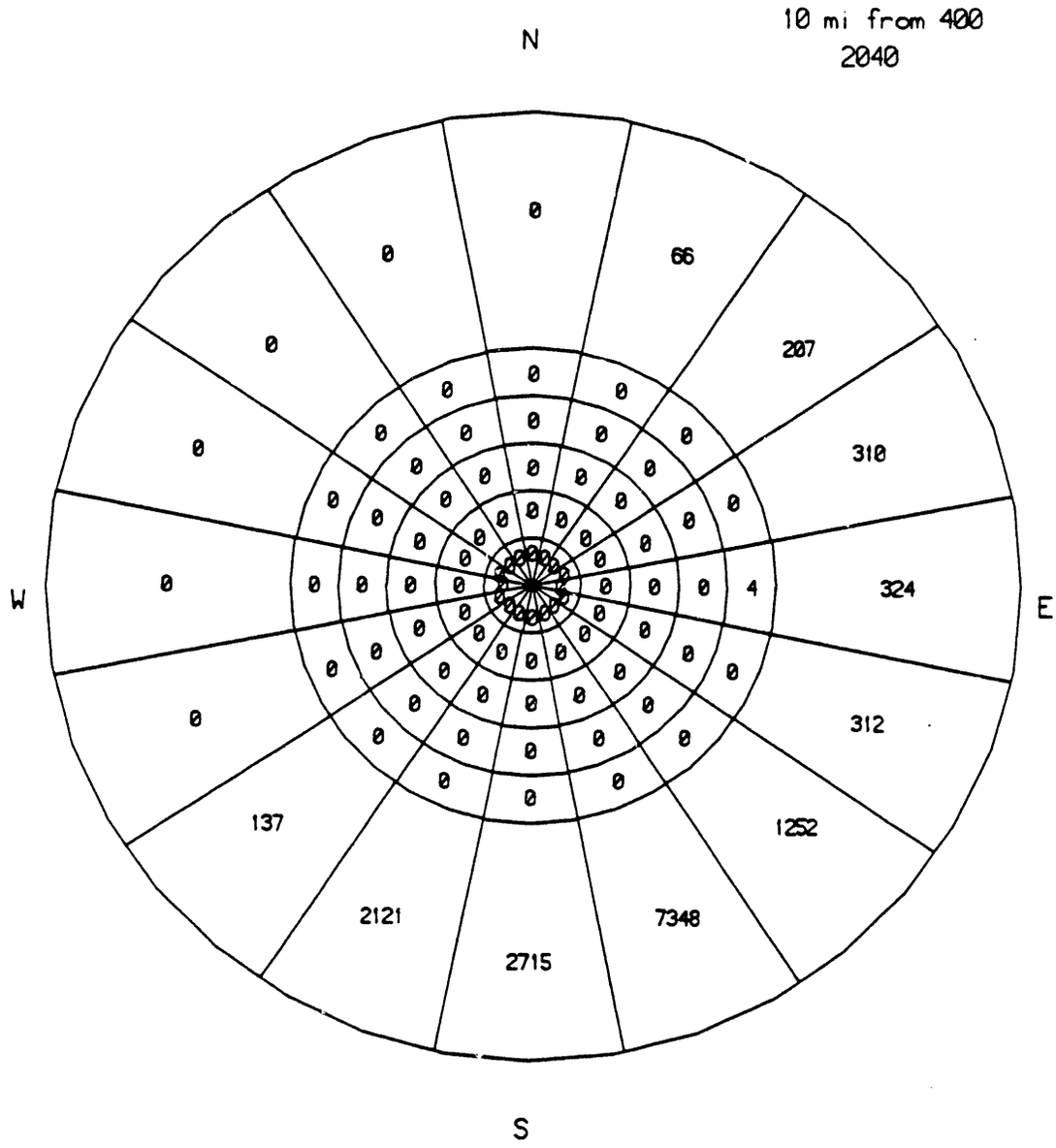


FIGURE C.61. Distribution of Residential Population in a 16-Kilometer (10-Mile) Radius of the 400 Area Meteorological Tower, by Population Grid Sector for 2040

DISTRIBUTION

No. of
Copies

OFFSITE

12 DOE/Office of Scientific and Technical Information

D. B. Pittenger
The Demographics Laboratory
2065 Lakemoor Drive S.W.
Olympia, WA 98502

ONSITE

DOE Field Office, Richland

R. A. Holten

17 Westinghouse Hanford Company

B. A. Bennett
M. D. Davis (5)
S. A. Dawson
K. O. Fein
K. S. McCullough
L. C. Preston
A. L. Ramble
A. B Rau
A. R. Schade
R. L. Schlosser (2)
A. M. Tallman
WHC Central Files

40 Pacific Northwest Laboratory

N. C. Batishko
D. M. Beck (25)
D. E. Deonigi
C. H. Imhoff
D. C. Kavanaugh
B. A. Napier
M. J. Scott
S. F. Shindle
A. G. Thurman
E. F. Yancey
Publishing Coordination
Technical Report Files (5)

END

DATE FILMED

12/16/91