4.0 AIR DISPERSION AND DEPOSITION MODELING

Atmospheric dispersion and deposition modeling analyses of ESSROC's cement kiln operations have been conducted in support of the risk assessment. Utilizing procedures in accordance with U.S. EPA guidance (U.S. EPA, 1998a,b) and consistent with a technical project plan submitted to U.S. EPA Region V, model simulations of stack exhaust and fugitive emissions sources were conducted in order to predict ambient air concentrations and deposition flux rates over the study area. Predicted ambient air concentrations and deposition flux rates were then combined with measured cement kiln stack emissions data as well as data on predicted non-stack fugitive VOC and particulate matter emissions from the facility to derive soil, surface water, plant and livestock tissue concentrations.

A U.S.G.S. topographic projection, identified as CLYMERS, Indiana, was utilized to identify the easting and northing UTM location of the kiln stack; which served as the center of : 1) the receptor grid used in the dispersion model simulations; and 2) the gridded terrain file used in the dispersion model simulations. The CLYMERS, Indiana topographic projection is 1:24000 scale and based on 1927 North American Datum. Building locations and emission points were also based on the 1927 North American Datum, but were converted from UTM coordinates to X, Y coordinates prior to input to the BPIP preprocessor.

The following sections present the dispersion model, modeling databases, emission source characterization, and modeling methodology utilized in the air quality impact analysis, and summarize the results of the analysis.

4.1 ATMOSPHERIC DISPERSION MODEL

The air quality impact analysis was conducted utilizing the U.S. EPA's Industrial Source Complex Model, Version 3 ("ISC3", Release No. 99155). ISC3 is a steady-state Gaussian plume model recommended by U.S. EPA for assessing air pollutant impacts from facilities with point and fugitive emissions sources, such as the ESSROC facility. Pollutant transport may be simulated by ISC3 over flat, simple and complex terrain. Further, a full implementation of the U.S. EPA policy on intermediate terrain (defined as terrain between stack top elevation and plume height elevation) has been incorporated into ISC3.

Necessary to conduct a comprehensive risk assessment, ISC3 is capable of providing air pollutant concentrations as well as wet and dry deposition flux rates.

ISC3 consists of a short-term and a long-term model. The short-term model utilizes hourly meteorological data while the long-term model processes a frequency distribution of wind speed, wind direction, and atmospheric stability. Pursuant to U.S. EPA guidance, the short-term version of ISC3 was employed in support of the risk assessment.

Major features of ISC3 applicable to this risk assessment include:

- Rural dispersion coefficients;
- Point and fugitive source simulations;
- Concentration estimates for annual averaging times;
- Concentration estimates over flat, simple, intermediate, and complex terrain;
- Predicted concentration and deposition flux estimates;
- Consideration of building downwash effects; and
- Treatment of calm wind conditions.

4.1.1 BUILDING DOWNWASH EFFECTS

Considering its location to on-site buildings and other structures, plumes emitted from the modeled point source (cement kiln stack) may be influenced by building downwash. As a result, an assessment of potential building downwash effects was conducted utilizing U.S. EPA's Building Profile Input Program ("BPIP", Release No. 95086). BPIP compares stack locations and heights to nearby buildings or structures, generating maximum projected influencing building heights and widths over 36 wind directions (10 degree increments).

Structures located within 5L (the lesser dimension of the height or width of the structure) of a stack may influence plumes emitted from that stack. Consequently, the location and dimensions of each potentially significant structure located within 5L of the cement kiln stack, along with the location and height of the cement kiln stack, were input to BPIP for processing. Structures located within 5L of the cement kiln stack are illustrated in Figure 4-1.

Due to its height (208'), the cement kiln stack is considered good engineering practice ("GEP") height to all but four of the fourteen structures input to BPIP. GEP stack height is defined as a stack height of no less than $H_b + 1.5$ L, where H_b is the height of a potentially influencing structure.

Maximum projected lateral and vertical building dimensions, as estimated by BPIP, were subsequently input to ISC3.

4.1.2 DISPERSION COEFFICIENTS

Atmospheric conditions affecting the downwind dispersion of air contaminants may be influenced by localized land use. Dispersion coefficients have been developed for ISC3 that represent both rural and urban environments. Based on U.S. EPA guidance, the selection of either rural or urban dispersion coefficients should follow one of the procedures suggested by Irwin (1978); which include a land use classification procedure, based on a typing scheme recommended by Auer (1978), or a population based procedure. Of the two methods, the land use classification procedure is considered by U.S. EPA more definitive.

The land use classification procedure is conducted as follows:

1) Classify the land use within the total area, A_o, circumscribed by a 3 km radius circle about the source using Auer's land use typing scheme;

2) If land use type I1, I2, C1, R2, and R3 account for 50 percent or more of A_o, use urban dispersion coefficients; otherwise, use appropriate rural dispersion coefficients.

Table 4-1 summarizes Auer's land use typing scheme. Following the recommended land use classification procedure, the area surrounding the ESSROC facility is considered rural. As a result, rural dispersion coefficients were utilized in all dispersion model simulations.

4.2 DATABASES USED IN THE AIR QUALITY IMPACT ANALYSIS

Databases required as input to the air quality dispersion model consist of meteorological data, receptor points and geophysical data. A discussion of the databases utilized in the ambient air quality impact assessment is presented below.

4.2.1 METEOROLOGICAL DATA

In accordance with U.S. EPA guidance, five years of meteorological data were utilized in the dispersion modeling analyses. Employing U.S. EPA's PCRAMMET meteorological preprocessor, surface observations measured during the period 1986 through 1990 at the Indianapolis International Airport (Station No. 93819) were combined with coincident upper air observations measured at the Wright Patterson Air Force Base near Dayton, Ohio (Station No. 13840). Surface observation data were retrieved from the Solar Meteorological Observation Network (SAMSON) CD-ROM, while upper air observation data were retrieved from the Support Center for Regulatory Air Models (SCRAM) web site. Located approximately 75 miles south of the ESSROC facility, the Indianapolis International Airport is the closest reporting National Weather Service station.

When predicting ambient air concentrations, meteorological data generally required as input to ISC3 include hourly observations of wind speed, wind direction, temperature, ceiling height, and atmospheric stability classification. Each variable is provided in the surface observation record, with the exception of stability classification; which is estimated by RAMMET.

Additional data is required to predict depletion of the plume due to wet and dry deposition as well as dry and wet deposition fluxes. These data include hourly station pressure, precipitation amount and type, Monin-Obukhov length (L), and surface friction velocity (u_*). The Monin-Obukhov length is a measure of the relative importance of mechanical and buoyant turbulence in the atmosphere. It ranges from small positive values for highly stable conditions to infinity for neutral conditions to small negative values for highly convective conditions. The surface friction velocity is a measure of the momentum flux to the surface, and is a function of wind shear stresses at the surface.

Hourly station pressure and precipitation data are provided in the surface observation record. Hourly values of L and u_* for a modeling analysis are not generally available in a standard meteorological data set, but may be generated by PCRAMMET. In order to generate hourly values of L and u_*, site-specific values of noon-time albedo, Bowen ratio (amount of moisture at the surface), anthropogenic heat flux, surface roughness length (at the application site and the surface meteorological observation site), minimum L, and the fraction of net radiation absorbed at the ground must be obtained. Site-specific values for each variable, with the exception of surface roughness length, were obtained from tables published in Appendix B of the PCRAMMET User's Guide (1995, also published in the U.S. EPA 1998 HHRAP guidance) and are summarized as follows:

Noon-time Albedo:	0.28
Bowen Ratio:	0.7
Anthropogenic Heat Flux:	0.0 (W/m^2)
Minimum Monin-Obukhov Length:	2.0 (m)
Fraction of Net Radiation Absorbed:	0.15

Estimation of surface roughness height was conducted in accordance with guidance provided in Section 3.2.2.2 of the 1998 HHRAP. The guidance provides a six-step process summarized as follows:

Step 1: On a site map, a circle with a 3 kilometer radius was drawn around the center of the stack.

Step 2: The areas within the circle were classified according to PCRAMMET categories.

Step 3: The wind rose directions were calculated from a representative five year meteorological data set.

Step 4: The circular area was divided into 16 sectors of 22.5 degrees, corresponding to the wind rose directions.

Step 5: A representative surface roughness height was identified for each sector.

Step 6: The site surface roughness height was calculated by computing an average surface roughness height weighted with the frequency of wind direction occurrence for each sector.

Review of the surface and upper air observation records showed a limited number of missing values during the year 1990 (1986 through 1989 were complete). In accordance with U.S. EPA 1998 HHRAP guidance, appropriate substitute values were entered into the observation records prior to processing with PCRAMMET.

Wind roses summarizing the wind frequency distributions for each of the five years (1986 through 1990), as well as the wind frequency distribution for the years 1986 through 1990 combined, at the Indianapolis International Airport are illustrated in Figures 4-2 through 4-6a.

Table 4-1a summarizes the sector-averaged land use within a 3-kilometer radius of the cement kiln stack. Land use within each sector was assessed by reviewing 1:24000 scale topographic projections prepared by the U.S.G.S. As shown on the table, land use around the facility matches "cultivated" criteria. Seasonal surface roughness parameters for cultivated land use, as specified on Page 3-12 of the 1998 HHRAP, are 0.03 meters (Spring), 0.2 meters (Summer), 0.05 meters (Autumn), and 0.01 meters (Winter); resulting in an average surface roughness height of 0.07 meters.

4.2.2 RECEPTOR POINTS

A radial grid of receptors with 37 rings (1332 receptors) was developed for the air dispersion and deposition modeling, The modeling domain extended out 50 km from the cement kiln stack. Downwind distance and separation of the polar grid rings were established as follows:

0.1 km to 1.0 km, spaced every 0.1 km
1.2 km to 3.0 km, spaced every 0.2 km
3.5 km to 5.0 km, spaced every 0.5 km
6.0 km to 10.0 km, spaced every 1.0 km
15.0 km to 50 km, spaced every 5.0 km

Each receptor ring consisted of 36 receptors located at 10° intervals. All of the receptors were located at local ground level. The terrain elevation of each receptor was specified as the maximum terrain height located within a sector defined as +/- 5° on either side of the receptor and including the area from the receptor ring out to the next distant receptor ring. The polar grid consisted of 1332 discrete receptor points and is illustrated in Figure 4-7.

In addition to the polar grid, 19 discrete receptors were placed at sensitive locations such as hospitals, schools, and homes. Table 4-2 contains a list of the discrete receptors modeled in this study.

4.2.3 GEOPHYSICAL DATA

The terrain surrounding the ESSROC facility and out to a distance of 50 km may be characterized as rolling with frequent changes in elevation. Consequently, terrain elevations were obtained for each receptor point and subsequently considered in the dispersion model simulations.

As part of the AMS/EPA Regulatory Model (AERMOD) system, the U.S. EPA has developed a terrain preprocessor currently identified as AERMAP. AERMAP searches for the terrain height and location that has the greatest influence on dispersion for an individual receptor. Digital Elevation Model (DEM) data, which are digital interpretations of topographic maps or aerial photographs, are required as input to the AERMAP preprocessor. DEM data may be obtained from the USGS in either 7.5-minute (1:24,000-scale) or 1-degree (1:250,000-scale) resolutions. Due to their higher resolution and availability, 7.5-minute DEM files were obtained from the USGS and subsequently input to AERMAP. A total of 122 DEM files were processed to obtain elevations for all modeled receptors.

The cumulative effects of upwind plume depletion resulting from terrain variations across the modeling domain may be considered by preparing as input to ISC3 a gridded terrain database (separate from the already input receptor grid). ISC3 reads the gridded terrain data and internally calculates the terrain heights a plume will encounter along its trajectory, resulting in adjustments to the vertical term of the Gaussian plume equation for each step in the integration of the modified source depletion equations. For example, the presence of a hill upwind of a receptor may cause enhanced dry depletion at the receptor than if the hill did not exist.

Utilizing the AERMAP preprocessor with the 122 DEM files, a gridded terrain file was developed and subsequently input to ISC3. Extending 50 kilometers from the cement kiln stack at a separation distance of 2,500 meters, the gridded terrain file consisted of 1,682 discrete terrain points and is illustrated in Figure 4-8.

4.3 EMISSION SOURCE CHARACTERIZATION

The air quality impact analysis consisted of modeling the cement kiln stack exhaust as well as fugitive emissions sources in order to predict ambient air concentrations and deposition flux rates over the study area. Characteristics of the stack exhaust and fugitive emissions sources are described below.

4.3.1 POINT SOURCE DATA

Potential point source emissions due to cement kiln operations will vent through a single stack, identified as the cement kiln stack. Point source parameters required as input to ISC3 include the physical stack dimensions (stack height and inside diameter) and exhaust flow characteristics (exit temperature and exit velocity). Conservative exhaust flow characteristics were chosen, based on the results of the trial burn tests. Source parameters associated with the cement kiln stack are summarized as follows:

Stack Height	63.4 m
Inside Diameter	4.76 m
Exit Temperature	447.6 K
Exit Velocity	9.0 m/s
UTM Location	547919.0 m easting, 4509110.0 m northing

Model simulations of potential emissions from the cement kiln stack were conducted in three phases. Phase I consisted of modeling the mass-weighted particulate distribution, which is an assessment of those matrix pollutants bound throughout the volume of the emitted particles. Phase II consisted of modeling the surface area-weighted particulate distribution, which is an assessment of those pollutants distributed on the surface of the emitted particles. Phase III consisted of modeling the vapor phase pollutant distribution, which is an assessment of those pollutants emitted in the gas-phase.

When modeling mass-weighted and surface area-weighted particulate distributions, ISC3 will consider the effects of plume depletion due to wet (precipitation scavenging) and dry (gravitational settling) processes while predicting downwind ambient concentrations and wet and dry deposition flux rates. In contrast, when modeling vapor phase pollutant distributions, ISC3 only considers the effects of plume depletion due to wet processes while predicting downwind ambient concentrations and wet deposition flux rates.

An evaluation of particle size distribution is necessary to assess plume depletion and deposition due to dry processes. Specific aspects of the particle size distribution required as input to ISC3 consist of particle diameter for each particle size category, the fraction of the total mass for each particle size category, and a corresponding particle density for each particle size category.

The particle size distribution was partitioned into ten categories based on the results of trial burn tests conducted at the facility (RCRA Trial Burn Report, 1999). Particle diameters are expressed in terms of aerodynamic diameter, defined as the effective diameter of a sphere of unit density that has the same settling velocity as the actual particle. Thus, the aerodynamic diameter takes into account both particle shape factors and particle density effects. In order to be consistent with the definition of aerodynamic diameter, a particle density of 1 g/cm^3 was used in the model simulations. The mass-weighted and surface area-weighted particle size distribution utilized in the dispersion model simulations is presented in Table 4-3.

In addition to particle size distribution, precipitation scavenging coefficients must be input to ISC3 to assess plume depletion and deposition due to wet processes. Precipitation scavenging coefficients are input by precipitation type (liquid or frozen) and are partitioned according to particle size distribution. Scavenging rate coefficients by particle size are provided in the ISC3 User's Guide (1999) and summarized in Table 4-3. Since particle size distribution is not considered during vapor phase model simulations, constant values of liquid precipitation (1.74E-04 [s-mm/hr]$^{-1}$) and frozen precipitation (0.6 E-04 [s-mm/hr]$^{-1}$) were input to ISC3 during the Phase III model simulations.

4.3.2 FUGITIVE SOURCE DATA

Potential fugitive emissions sources associated with the cement kiln operations have been identified and separated into gas-phase sources and dust generating sources. Gas-phase emissions are anticipated to occur from the LWDF tanks, process equipment, and filter basket cleaning operations; while, activities occurring on the surface of the waste pile, including wind erosion, are the primary source of dust generating emissions. Fugitive source release characteristics input to ISC3 are summarized below.

4.3.2.1 Fugitive VOC Source Characterization

The tanks, process equipment, and filter basket cleaning operations were modeled as one volume source with a unit emission rate of 1 g/s and centered at UTM coordinate 547816.0 m easting, 4509179 m northing. The height of the volume was assumed to be 1/2 the height of the tanks (13.72 m), 6.86 m. Volume sources are simulated by ISC3 as virtual point sources with initial vertical (σ_Z) and horizontal (σ_Y) dimensions required as input to the model. The main portion of the tanks and truck loading section was measured at 190'x 80', resulting in a square root equivalent width of 37.58 m. Following the procedure published in the ISC3 User's Guide, the initial lateral and vertical dimensions were estimated as follows:

$$\sigma_Y = \text{width}/4.3 = 8.74 \text{ m.}$$

$$\sigma_Z = \text{height}/2.15 = 6.38 \text{ m.}$$

4.3.2.2 Fugitive Dust Source Characterization

The waste pile was modeled as an area source with an emission rate of 1 $g/s/m^2$ and centered at UTM coordinate 548215.0 m easting, 4509506.0 m northing. The base area of the area was modeled at 800' (243.84 m), representing a maximum exposed area of 59,458 m^2.

Similar to the point source simulations, an evaluation of the particle size distribution, including particle diameter, mass fraction, and particle density for each particle size category, is required to predict deposition flux rates and ambient concentrations due to plume depletion. Estimates of particle mass fraction were obtained for particle sizes of 20 µm, 6.25 µm and 2.5 µm, representing total suspended particulate, inhalable particulate, and respirable particulate, respectively. Based on emissions data published in Appendix B of the fugitive emissions estimation report (SCI-TECH, 2000), particle mass fractions were estimated at 0.5701, 0.2975 and 0.1324 for the particle size diameters of 20 µm, 6.25 µm and 2.5 µm diameter, respectively. The following activities were considered in estimating particle mass fractions for the waste pile model simulations:

- Haul truck travel on surface of waste pile (loaded and unloaded);
- Unloading of waste dust from haul trucks to waste pile;
- Front-end loader travel on waste pile;
- Front-end loader pushing of waste dust over edge of waste pile; and
- Wind erosion of exposed face and top of waste pile.

Consistent with the definition of aerodynamic diameter, a particle density of 1 g/cm^3 was utilized in the dispersion model simulations. Similar to the point source simulations, precipitation scavenging coefficients must be input to ISC3 to assess plume depletion and deposition due to wet processes. Precipitation scavenging coefficients for the three particle size categories, provided in the ISC3 User's Guide, are summarized as follows:

	20 µm	6.25 µm	2.5 µm
Liquid	6.6E-04	4.5E-04	1.8E-04
Frozen	2.2E-04	1.5E-04	6.0E-05

4.4 MODELING METHODOLOGY

Utilizing ISC3 over five years of meteorological data (1986-1990 Indianapolis/Dayton), simulations of cement kiln stack exhaust and fugitive emissions sources were conducted in order to predict annual average ambient air concentrations and deposition flux rates. Initial model simulations of point source emissions were conducted over a 50 km radius to assess locations of maximum impact as well as impacts at discrete receptor locations. As summarized in Section 4.5, initial model simulations of point source emissions show maximum annual average ambient concentrations and deposition fluxes occurring within

4.0 km of the cement kiln stack. Moreover, due to their release characteristics, maximum predicted annual average fugitive emission source impacts are anticipated to occur at or near the facility property boundary.

As a result, subsequent model simulations of point source and fugitive emissions sources conservatively focused on receptor points located outside the property boundary, but within a 4.0 km radius of the cement kiln stack. Figure 4-9 illustrates those receptor points falling within 4.0 km of the cement kiln stack. Employing a procedure described in U.S. EPA 1990, predicted area-weighted ambient concentrations, wet deposition, dry deposition, and total deposition flux rates within the 4.0 km radius (excluding on-property receptor points) were estimated. The results of the air quality impact analysis are summarized in the following section.

All point source model simulations were conducted using a unit emission rate of 1 g/s. Model simulations of the LWDF tank area were conducted using a unit emission rate of 1 g/s, while model simulations of the waste pile activities were conducted using a unit emission rate of 1 $g/s/m^2$. ISC3 model simulations were executed in a regulatory mode, using those options and switches which are recommended for regulatory use in the U.S. EPA's Guideline on Air Quality Models.

4.5 SUMMARY OF MODELED IMPACTS

4.5.1 KILN EMISSIONS

Table 4-4 summarizes the modeled air concentrations, wet and dry deposition fluxes, and total deposition flux rates used in the remainder of this risk assessment. As shown on Table 4-4, air model parameter values were generated for the following three different areas of exposure: maximum exposure area; France Park; and Wabash and Eel Rivers. In order to derive the air model parameter values under the maximum exposure area scenario shown on Table 4-4, predicted area-weighted ambient concentrations, wet deposition, dry deposition, and total deposition flux rates within a 4 kilometer radius (excluding on-site receptor points) were estimated by deriving areal average values. A 4.0 kilometer radius was chosen as the maximum exposure area for several reasons. First, the 4.0 kilometer area represents the area where the highest modeled air concentrations and deposition flux rates occur. Second, the land use within this 4.0 kilometer radius is rural. As such, the activity patterns for many of the indirect exposure pathways evaluated in this risk assessment, such as plant and animal product consumption, are likely to occur at higher rates in this rural area versus the more urban areas (such as within the Logansport city limits). For these reasons, the maximum exposure area modeled in this risk assessment provides a reasonable estimate of the area of highest exposure to emissions from the ESSROC facility.

Figure 4-10 depicts the contours for the modeled surface area weighted total deposition impacts for the receptors located within 4.0 kilometers of the ESSROC kiln. Figure 4-10 also contours the areal average surface area weighted total deposition value of 0.00247 (presented on Table 4-4). As shown on the Figure, the 0.00247 contour is well within the 4.0 kilometer radius used to establish the maximum area of exposure. The location of this contour demonstrates that there are no receptor points beyond the 4.0 kilometer radius which exceed the 0.00247 value used to model maximum exposures. As such, the areal average concentrations and deposition fluxes provide a conservative estimate of the maximum potential exposures to ESSROC emissions by off-site receptors.

The air model parameter values for France Park shown on Table 4-4 represent modeled values at the France Park receptor point. These values were used to model surface water exposures at France Park, a nearby recreational area.

The Wabash and Eel River air parameter values represent areal average values estimated using receptor points located within the Wabash River watershed. The rationale for derivation of these values is provided in Section 5.4.1.1 of the text. These air model values were used to model surface water exposures for the Wabash and Eel rivers.

4.5.2 CKD ACTIVITY EMISSIONS

Model simulations of LWDF and CKD waste pile fugitive source emissions were conducted using ISC3 over a five-year meteorological database (1986-1990 Indianapolis/Dayton). Table 4-5 presents the modeled air concentrations and deposition fluxes for the LWDF and CKD waste pile fugitive emissions. The LWDF impact concentrations shown on Table 4-5 were derived by multiplying the modeled unitized air concentration from vapor phase value by the chemical-specific LWDF long term emission rate in g/s. The unitized air concentration from vapor phase value was derived by taking the areal average of all values within a 2 kilometer radius (excluding those receptor points within the ESSROC property boundary). Unlike emissions from the cement kiln stack where more widespread dispersion would be expected, the highest impacts (i.e., deposition fluxes) associated with fugitive emissions from the CKD activities would be expected to occur closer to the ESSROC facility boundary. Therefore, a smaller radius (i.e., 2 kilometers) was used to establish the maximum exposure area for fugitive emissions.

Similarly, the chemical-specific CKD pile deposition fluxes were derived by multiplying the areal average air modeling scaling factors (i.e., Dydp, Dywp, Dytwp) by the chemical-specific emission rate. It should be noted that the deposition fluxes shown on Table 4-5 for the CKD waste pile activities were derived by assuming that 100% of the fugitive emissions come from the CKD waste pile activities. In actuality, as described in Section 3.3.2 approximately 81% of fugitive emissions actually come from the CKD waste pile activities. It is also noted that the estimated concentrations of metals in fugitive emissions from CKD activities is based on analytical results for cement kiln dust. However, some of the CKD waste pile activities, such as travel on road, generate fugtive dust emissions that likely would not have metal concentrations similar to CKD. More specifically, the concentrations of metals in fugitive emissions from these other activities would most likely be lower than the concentrations of metals in CKD.

4.5.3 DISCRETE RECEPTOR POINTS

In addition to the 1332 radially distributed modeling receptor points, a number of discrete receptor points were also selected for dispersion and deposition modeling. These receptor points represent areas of particular interest for this risk assessment including local schools, the state hospital, and nearby residential and recreational properties. These points are of greater interest because population activities tend to concentrate at these locations relative to the area as a whole. A listing of the calculated surface area weighted total deposition rates (five year averages, assuming unit emissions) for each discrete receptor point is presented on Table 4-2.

As shown on Table 4-2, the areal average surface area weighted total deposition flux of 0.00247 is similar in almost all cases to the specific deposition rates determined for each specific location. In fact, in 11 out of 19 cases, the calculated total deposition flux is greater than the receptor-specific modeled deposition rate. Based on these comparisons, it can be assumed that at essentially all of these specific receptors of interest, the receptor-specific deposition would essentially be the same as the areal average deposition. Based on this discussion, it is generally assumed in the remainder of this risk assessment that generic exposures determined for the maximum area of exposure can be applied to these specific receptors without significantly underestimating the exposures at these receptors. The potential risks, however, associated with discrete receptor points, are evaluated further in Section 9.0.

FIGURES

Figure 4-1
Emission Points in Relation to Building Structures
ESSROC Corporation
Logansport, Indiana

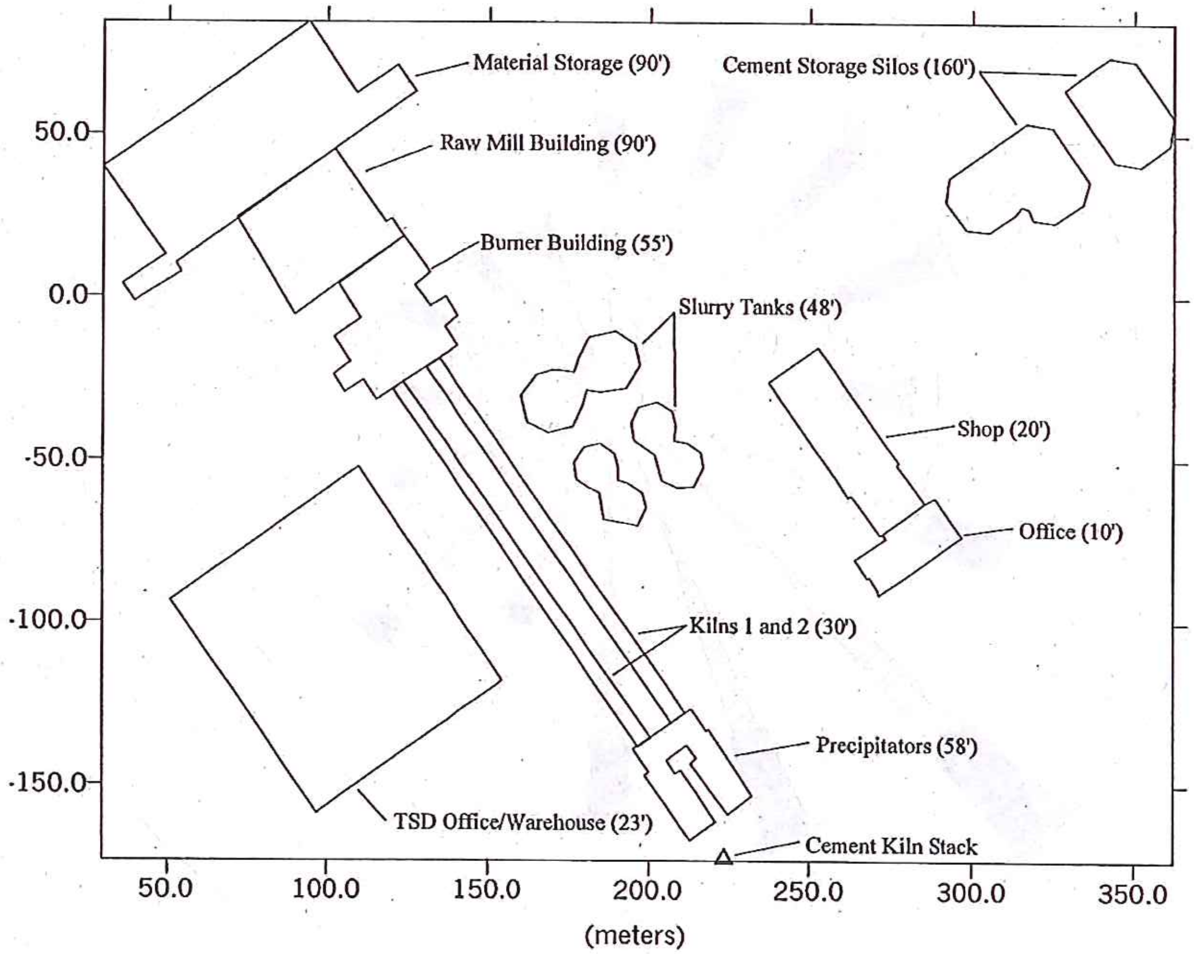
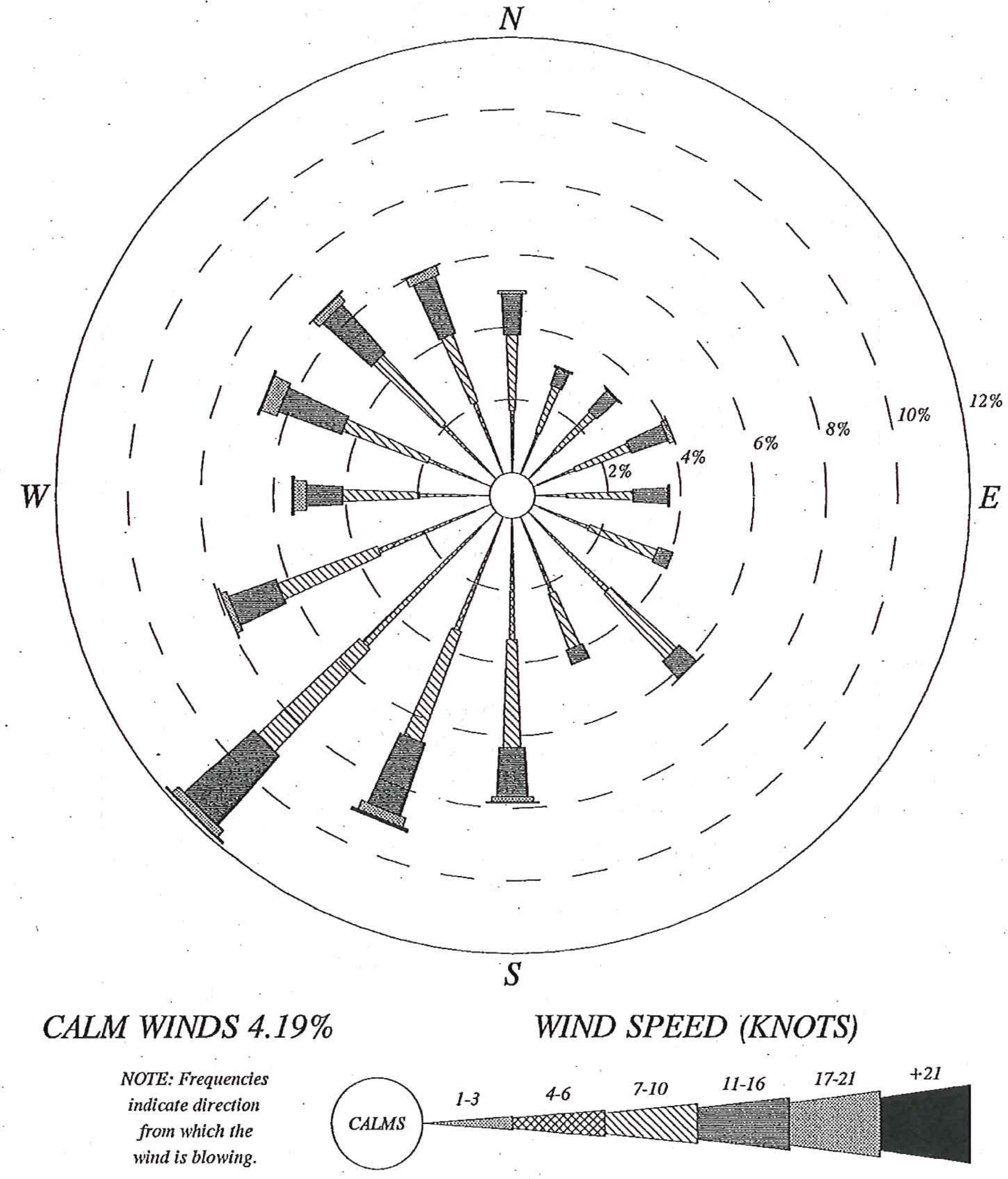


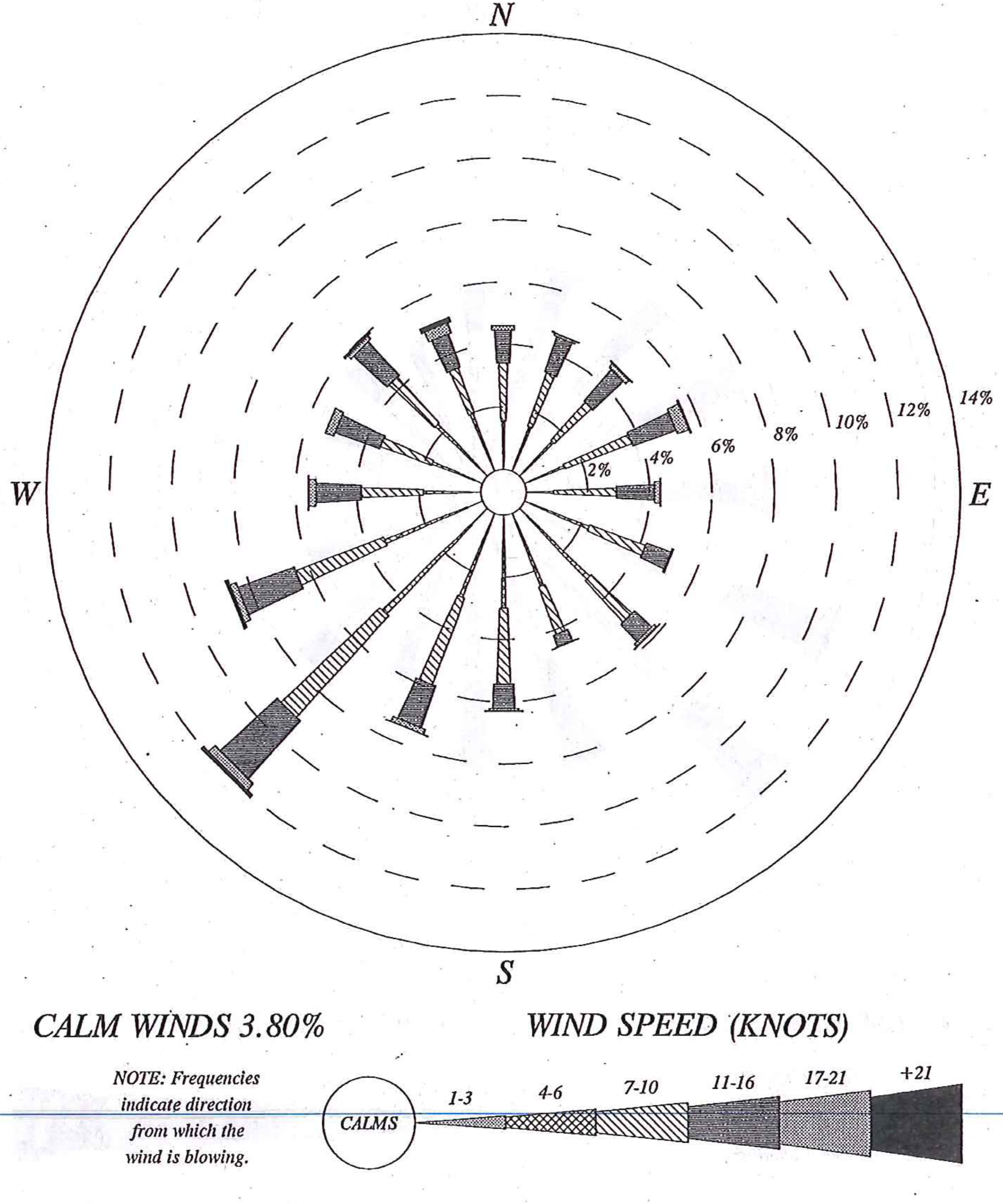
Figure 4-2
Annual Wind Rose - 1986
Indianapolis International Airport



CALM WINDS 4.19%

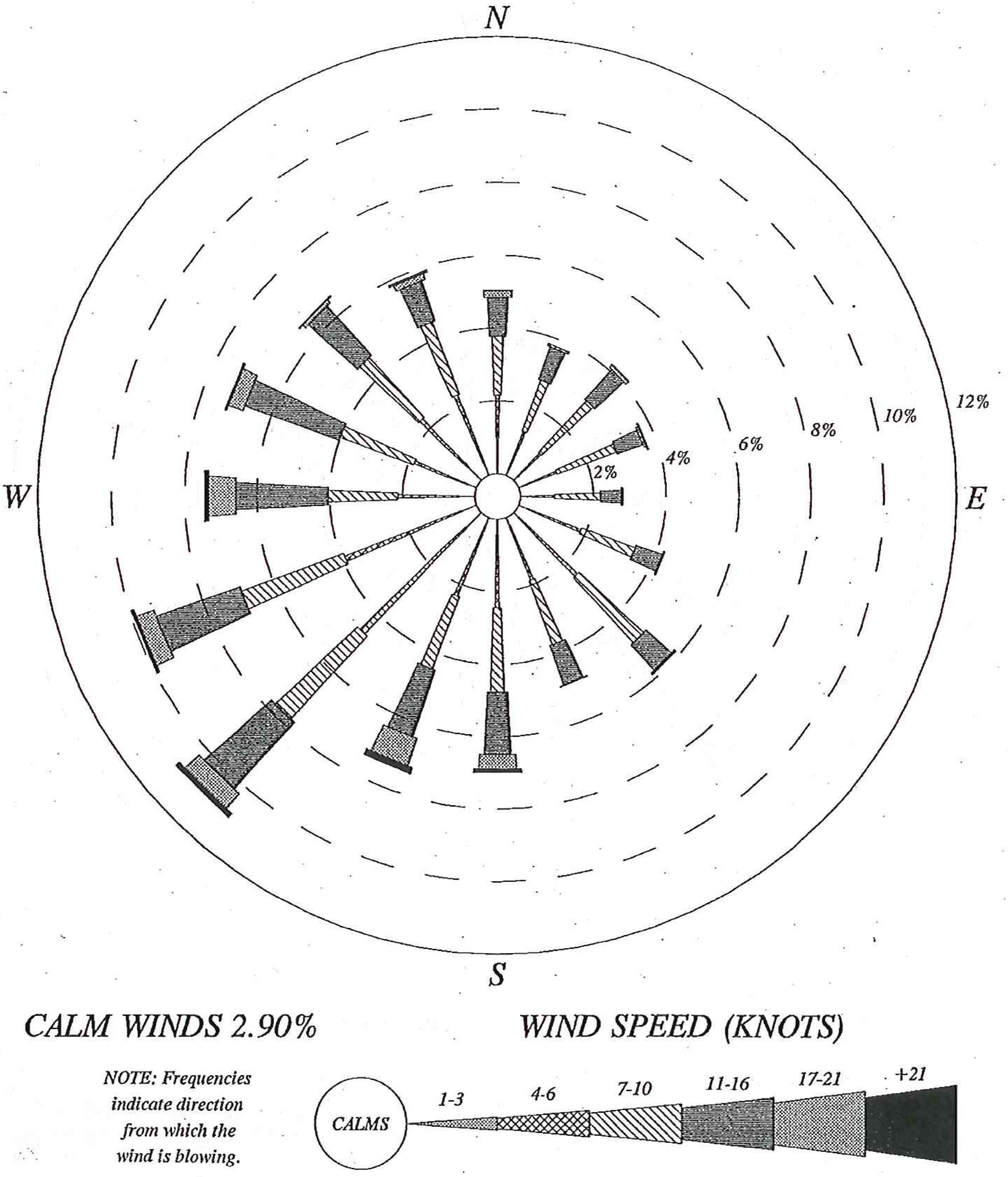
NOTE: Frequencies indicate direction from which the wind is blowing.

Figure 4-3
Annual Wind Rose - 1987
Indianapolis International Airport



NOTE: Frequencies indicate direction from which the wind is blowing.

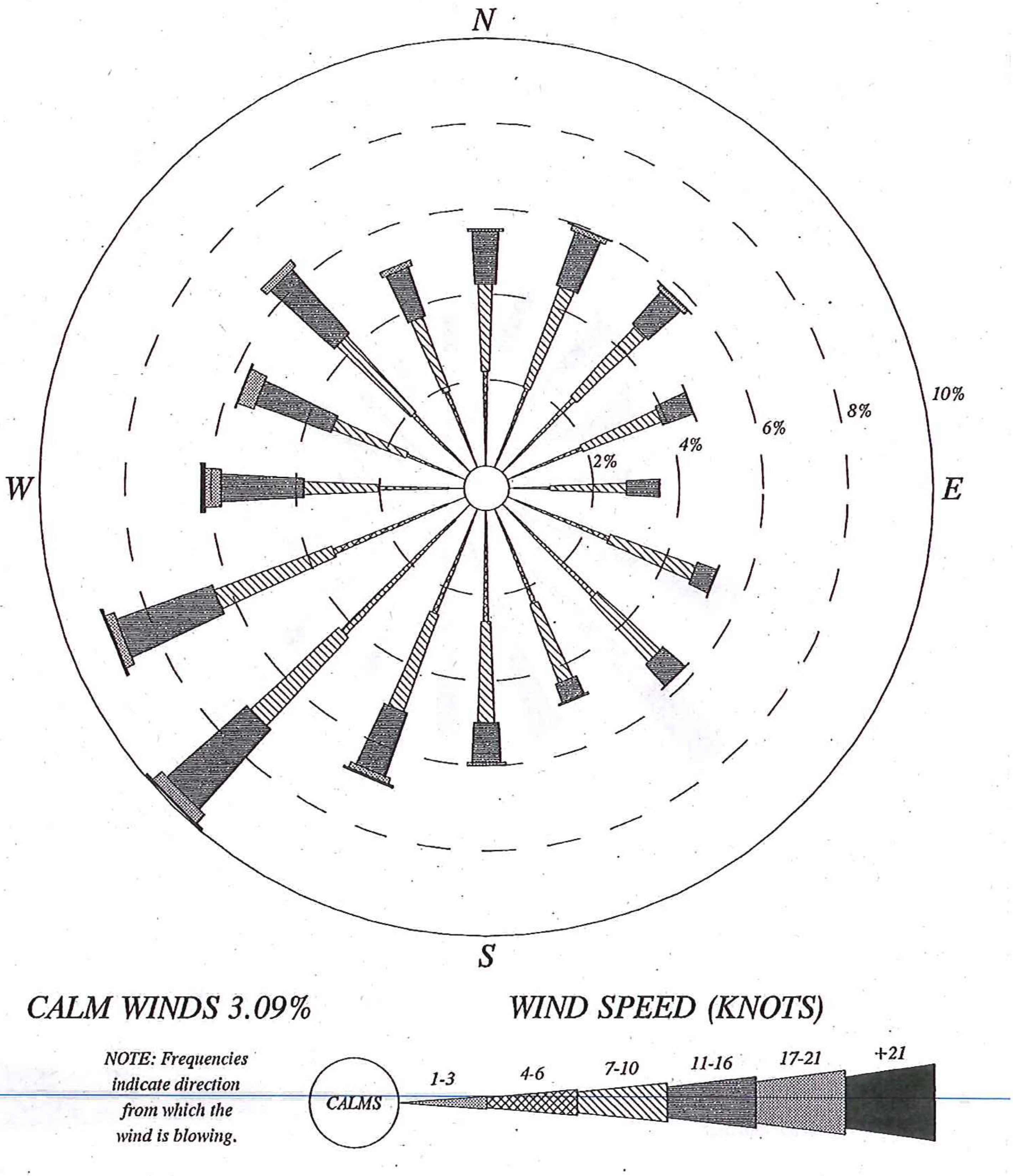
Figure 4-4
Annual Wind Rose - 1988
Indianapolis International Airport



CALM WINDS 2.90%

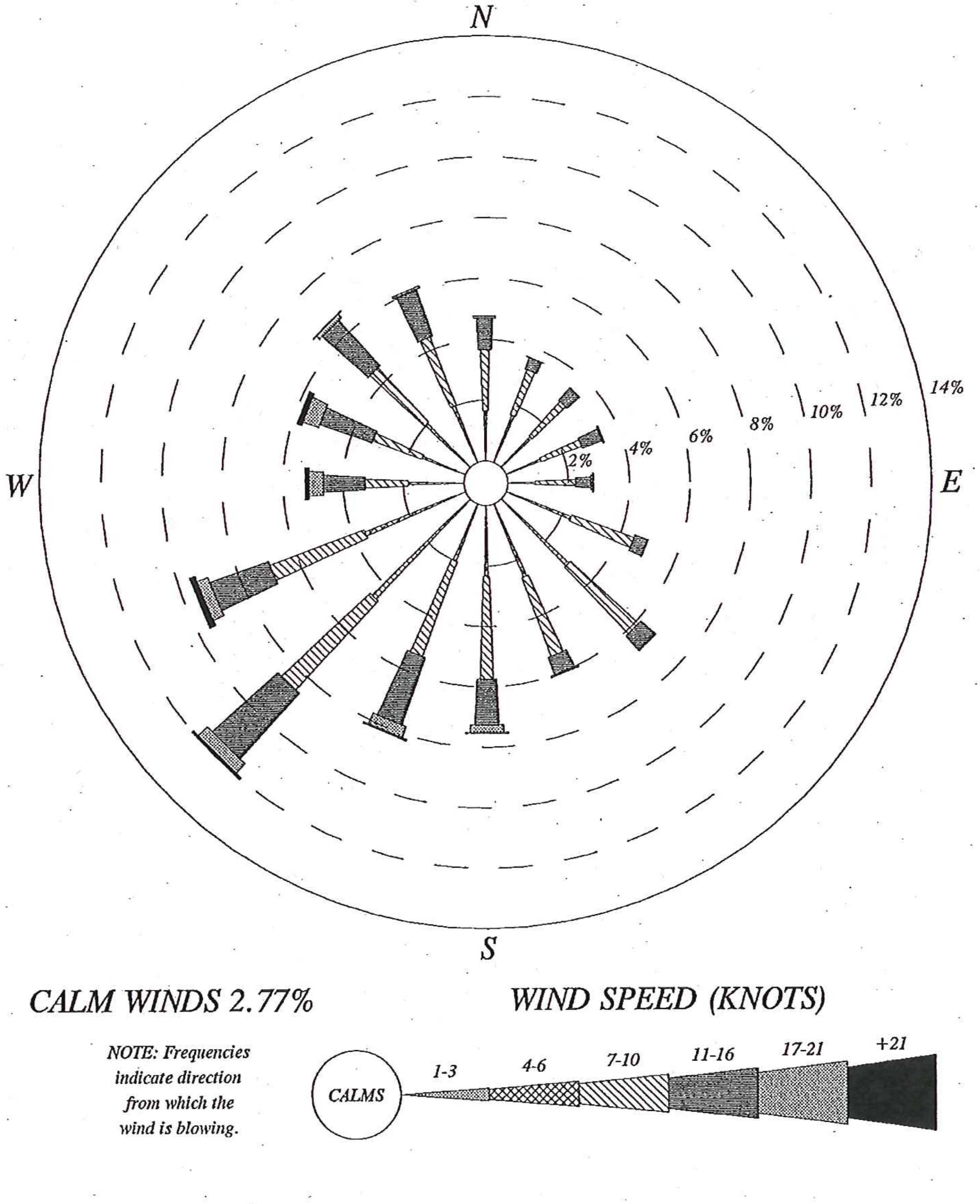
NOTE: Frequencies indicate direction from which the wind is blowing.

Figure 4-5
Annual Wind Rose - 1989
Indianapolis International Airport



NOTE: Frequencies indicate direction from which the wind is blowing.

Figure 4-6
Annual Wind Rose - 1990
Indianapolis International Airport



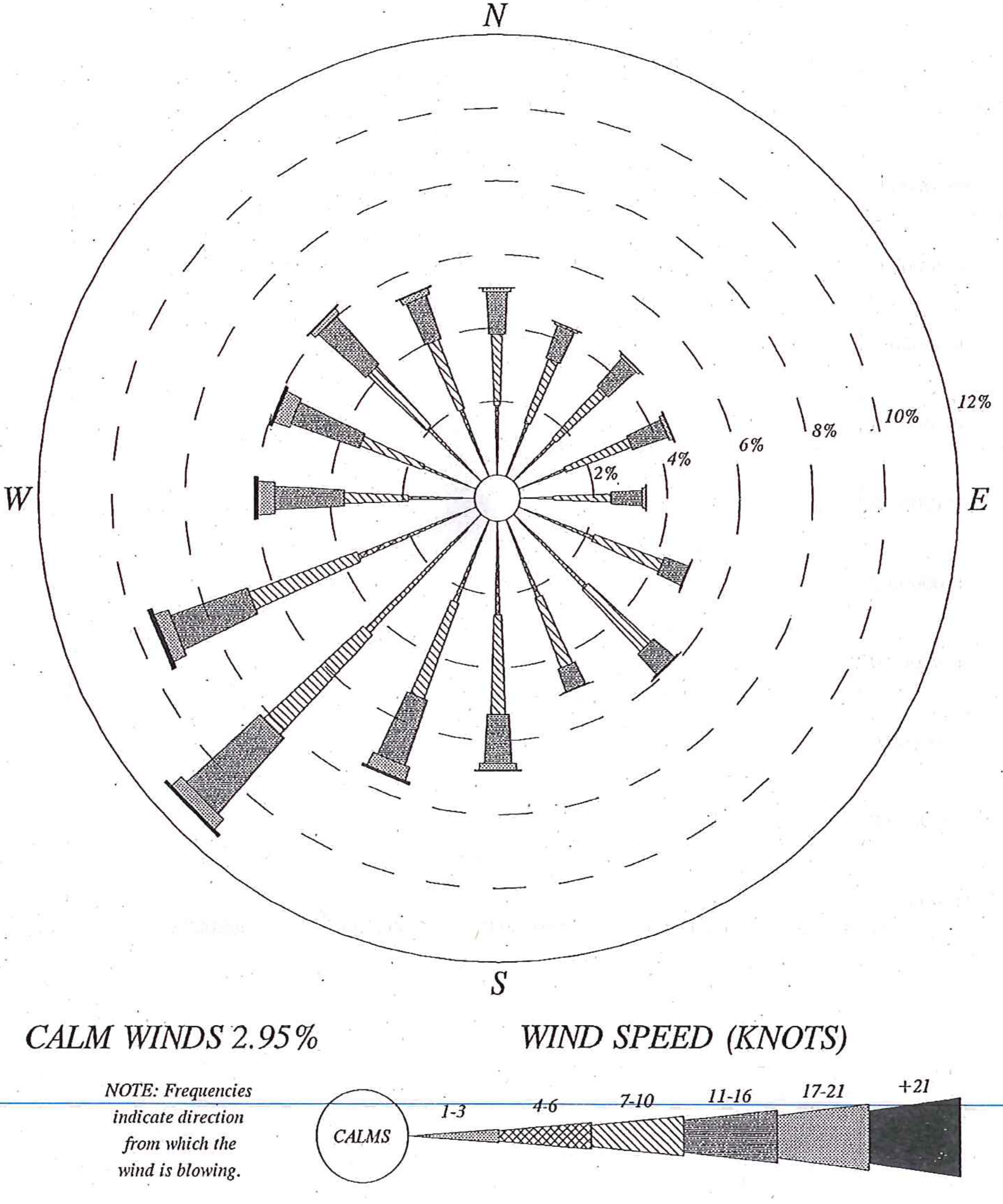
CALM WINDS 2.77%

NOTE: Frequencies indicate direction from which the wind is blowing.

Figure 4-6A

INDIANAPOLIS '87-'91

January 1-December 31; Midnight-11 PM



NOTE: Frequencies indicate direction from which the wind is blowing.

Figure 4-7
Receptors Used in the Air Quality Impact Analysis

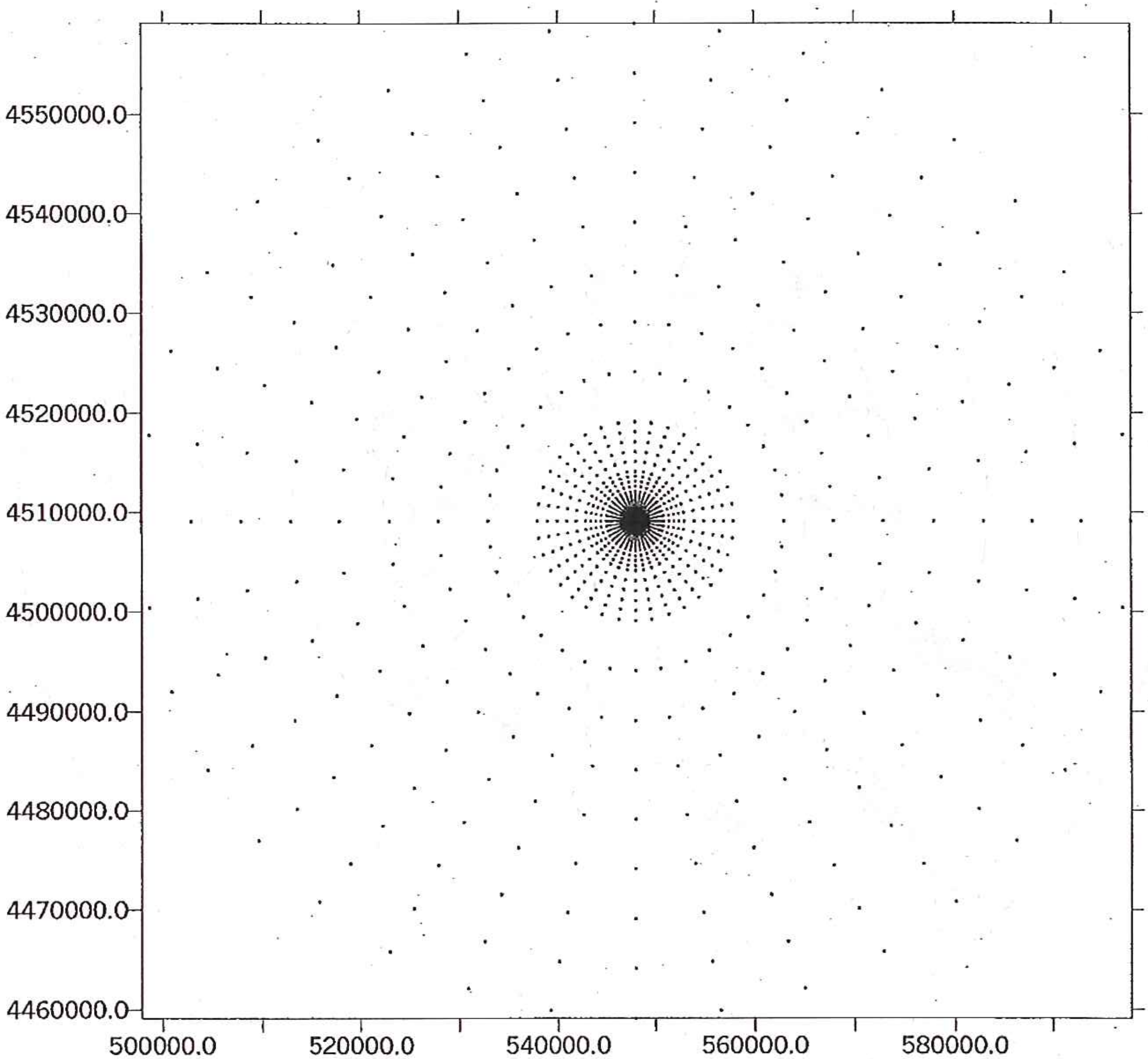


Figure 4-8
Gridded Terrain File
Used in AERMAP Preprocessor

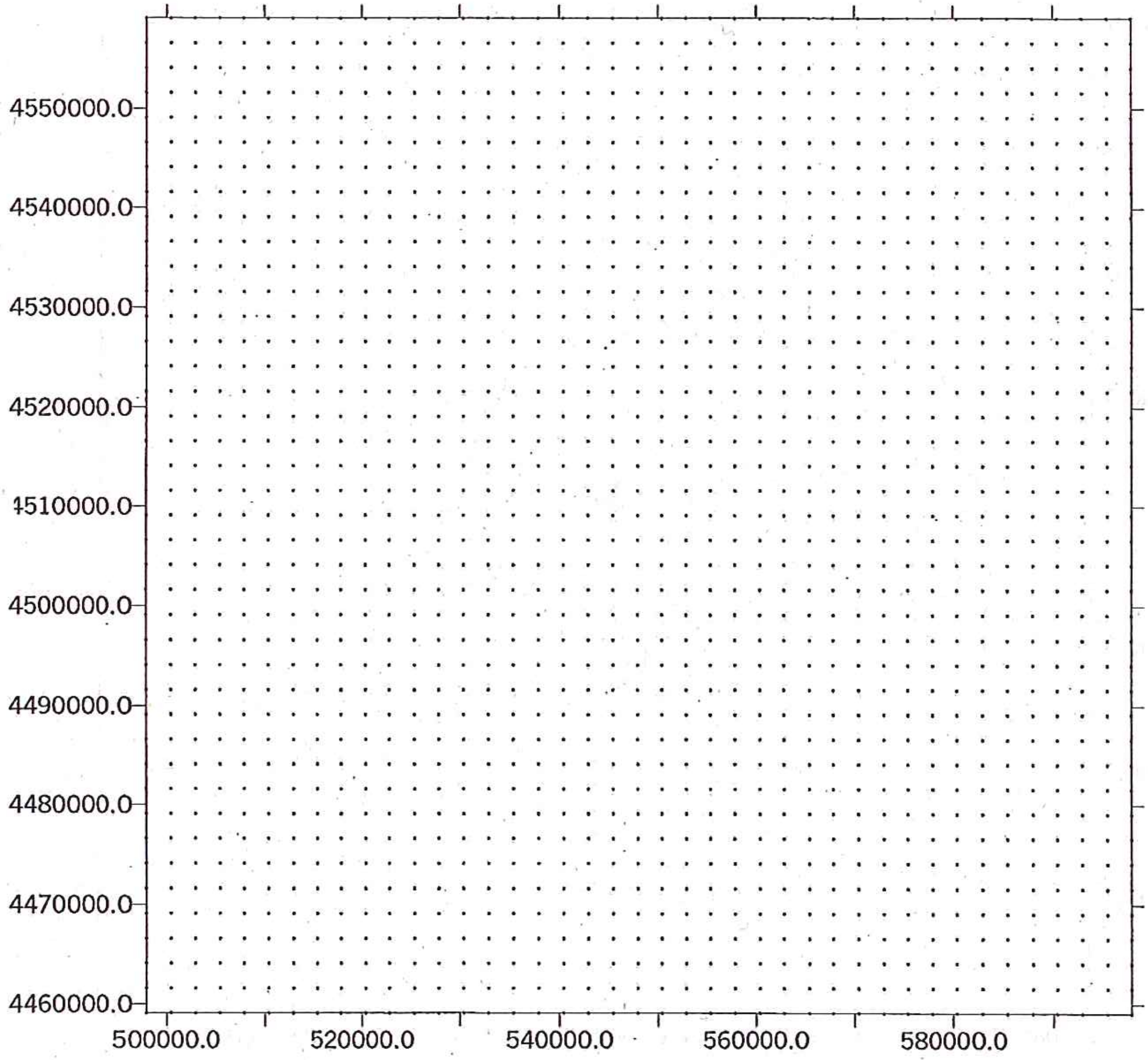


Figure 4-9
Off-Property Receptors
Located Within 4 Kilometers of ESSROC Facility

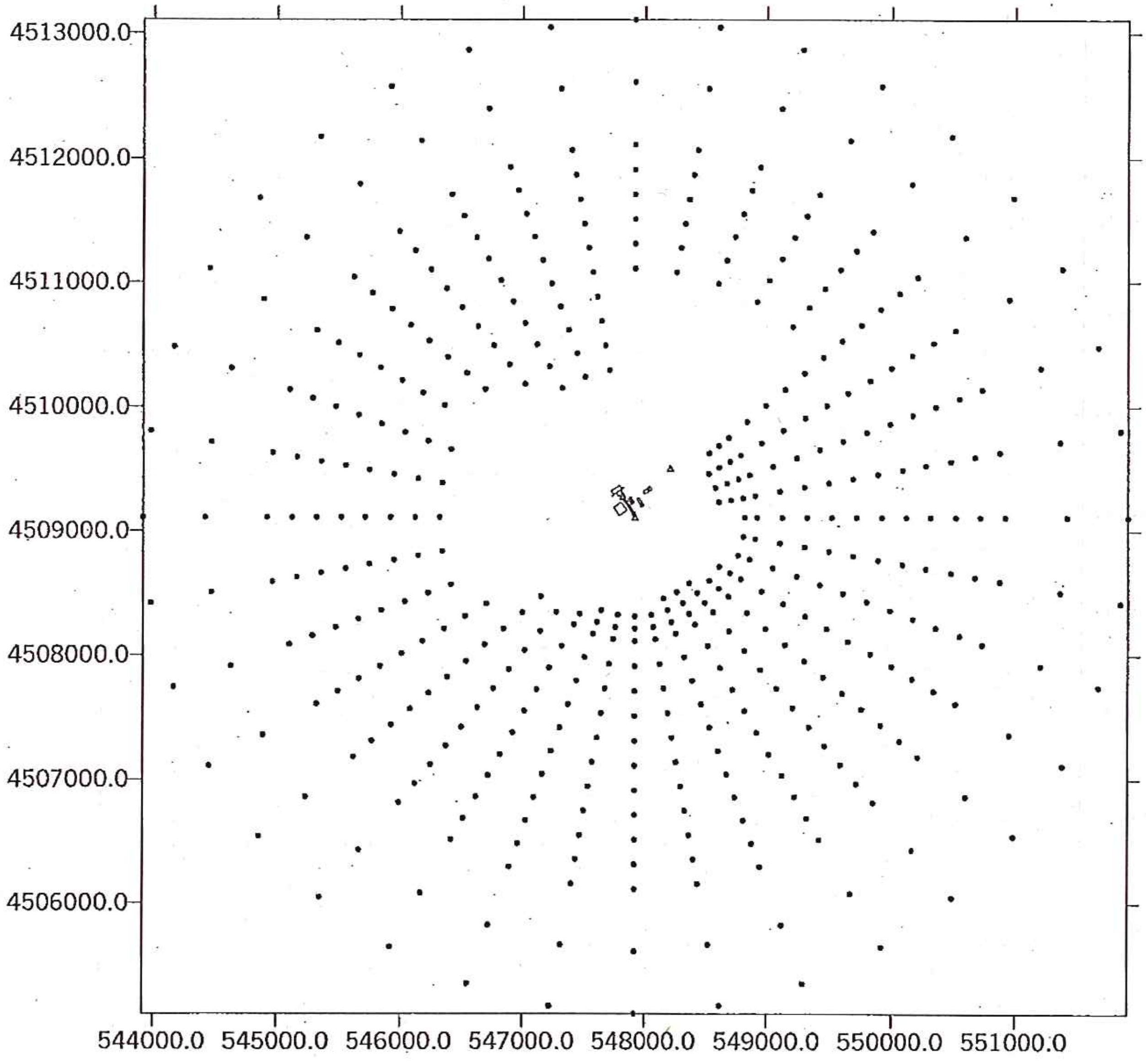


Figure 4-10
Modeled Total Deposition Impacts
Surface Area-Weighted Distribution
5-Year Composite