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REGION 5

Risk Assessment for the Waste Technologies Industries (WTI) Hazardous Waste Incinerator Facility (East Liverpool, Ohio)

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Volume IV: ATMOSPHERIC DISPERSION AND DEPOSITION MODELING OF EMISSIONS

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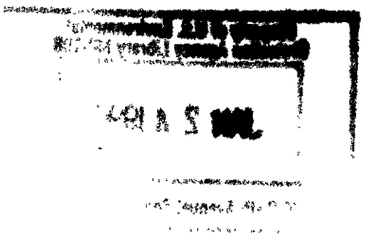

VOLUME IV

ATMOSPHERIC DISPERSION AND DEPOSITION MODELING

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Wind-Tunnel Simulation Study of Terrain Downwash Effects;
CALPUFF and INPUFF simulations of Calm Wind and Fumigation Conditions

I. INTRODUCTION

A. Overview

A preliminary risk assessment entitled, "Preliminary Risk Assessment for the WTI Incinerator Considering Inhalation Exposures to Stack Emissions" (U.S. EPA 1992a), was prepared for the WTI hazardous waste incinerator by Region 5 of the U.S. EPA. At the time of the assessment, both the Industrial Source Complex - Short Term (ISCST) and COMPLEX I dispersion models were used with off-site meteorological data to assess the potential health risk due to inhalation exposure to WTI stack emissions.

In accordance with the "Methodology for Assessing Health Risk Associated with Indirect Exposure to Combustor Emissions" (U.S. EPA 1990), the "WTI Phase II Risk Assessment Project Plan" (U.S. EPA 1990) (hereafter referred to as Project Plan) was designed to make extensive use of on-site data in the calculations of a full multi-pathway assessment of potential health risks from both stack and fugitive emissions from the WTI facility. In addition, the Project Plan proposed the use of the COMPDEP model to predict concentrations and deposition fluxes from stack and fugitive emissions from the WTI facility. COMPDEP is a hybrid model consisting of a combination of the modeling techniques in the COMPLEX I and ISCST dispersion models.

On December 8 and 9, 1993, a peer review workshop was held in Washington, D.C. to discuss the Project Plan. Four Work Groups were formed to discuss different areas of the study. The Meteorology/Air Dispersion Work Group focused on the portions of the plan dealing with air quality dispersion and deposition modeling. In reviewing the Project Plan, the peer review panel made several short-term recommendations to refine and improve the air modeling for the WTI Risk Assessment and long-term recommendations for future studies (U.S. EPA 1993b). The short-term recommendations for the WTI study are summarized below:

- Combine site-specific meteorological observations at WTI with data collected at the 500-foot Beaver Valley Nuclear Power Station meteorological tower in developing an appropriate meteorological data set for the air dispersion modeling;

- Refine model predictions by the use of additional local meteorological data, especially precipitation data for wet deposition calculations and turbulence measurements for dispersion estimation;

- Evaluate the effects of calm wind conditions and fumigation on short- and long-term concentrations in and beyond the valley;

- Evaluate the short-term concentration increases resulting from process upset conditions and accidents;

- Evaluate the impacts of fugitive sources of emissions;
- Evaluate the effects of terrain-induced downwash effects by conducting a wind tunnel study of the WTI site;
- Estimate the uncertainty of the model's concentration and deposition predictions by conducting sensitivity and uncertainty analyses; and,
- Obtain additional peer reviewer comments on the vapor/particle partitioning of pollutants emitted from the facility and the significance of vapor/particle transformations.

In addition, the Peer Review Panel made several long-term recommendations including the development of new guidance to ensure the collection of appropriate atmospheric measurements to support future risk assessments, the requirement for the use of advanced non-steady-state models for these types of studies, the collection of additional meteorological data at WTI to support potential future risk assessments of the facility, and the development of a plan to improve our understanding of wet deposition processes and to develop improved wet deposition models.

Concurrent with the development of the Project Plan, a new model (ISC-COMPDEP) was developed to provide a more refined analysis of dispersion and deposition from a source in complex terrain such as the WTI facility. The model was based on the latest version of the ISCST2 model (U.S. EPA 1992b) in order to take advantage of the updated ISCST2 basic model structure. Among the differences between COMPDEP and ISC-COMPDEP are the inclusion in ISC-COMPDEP of a new particle dry deposition scheme (U.S. EPA 1994), the option to allow receptor-specific land use parameters in determining dry deposition rates, the use of a mass-conserving plume depletion algorithm (Horst 1983), the ability to treat effects of terrain on plume depletion, the inclusion of the Schulman-Scire building downwash algorithm for short-stack emissions in addition to the Huber-Snyder scheme, a full implementation of the EPA policy on intermediate terrain (defined as terrain between stack top elevation and plume height elevation), a generalized wet removal algorithm, an improved area source algorithm (U.S. EPA 1992c), and the option to compute short-term peak concentrations and deposition fluxes as well as long-term averages. ISC-COMPDEP has been independently peer reviewed and is used in the WTI Risk Assessment[1].

[1] An early version of ISC-COMPDEP served as a starting point for the new ISC3 model. The major differences between ISC-COMPDEP and ISC3 are: (a) ISC-COMPDEP includes the ability to use measured profiles of winds and temperatures whereas ISC3 does not; (b) ISC3 uses a different form of the aerodynamic resistance equation in the calculation of deposition velocities; (c) although ISC3 and ISC-COMPDEP both use the same basic scavenging coefficient approach to calculate wet deposition, ISC3 adjusts the removal rate for intermittency of the precipitation, while ISC-COMPDEP applies the observed precipitation rate uniformly through the period during which it was measured.

Many of the peer review panel concerns related to the Project Plan are addressed by the use of ISC-COMPDEP; in fact, additional refinements were made to the model based on their recommendations. To simulate the complex atmospheric dynamics of windflow in and above the Ohio River Valley and adjacent hilly terrain, ISC-COMPDEP allows the use of meteorological data (wind and temperature) measured at various heights in the atmosphere and is executed using both on-site data from WTI and data from the Beaver Valley meteorological tower. In addition, a version of the model was developed to replace Pasquill-Gifford horizontal dispersion coefficients (σ_y) with values based on observed measurements of turbulence (σ_θ) for calculating dispersion rates.

To determine the effect of year-to-year variability in precipitation data on wet deposition, a series of sensitivity test are evaluated using ISC-COMPDEP. In addition, fugitive sources of emissions and upset or accident-related conditions are assessed to allow the development of a cumulative assessment of WTI emissions.

Terrain-induced downwash, like building downwash, can affect plume dispersion. Currently, there are no regulatory models that have the capability of assessing the potential impacts of terrain on ambient concentrations. To evaluate the effects of terrain induced downwash at the WTI site, a wind tunnel study was conducted at the Fluid Modeling Facility in Research Triangle Park, North Carolina (Snyder 1994). The results of the study (see Appendix IV-6) are discussed and compared to ISC-COMPDEP modeling predictions.

For the case of calm wind and fumigation conditions, the basic steady state assumption used in ISC-COMPDEP is invalid. Therefore, when assessing the impact of these conditions for both short term and long term exposures, a limited application of the CALPUFF non-steady-state model (Scire et al. 1995) is conducted. A second non-steady-state model, INPUFF (Petersen and Lavdas 1986) is applied in a separate study to examine the effects of calm wind conditions in flat terrain.

B. External Peer Review

Several components of the WTI modeling application required the use of a non-guideline model or a physical model. To ensure that Region 5 performed these applications appropriately, the Office of Research and Development (ORD) conducted an external peer review. The ORD requested the assistance of six experts, both within and outside of the United States, to perform the peer review. The reviewers' primary task was to determine the technical merit of the ISC-COMPDEP model; to determine the technical merit of the CALPUFF and INPUFF models and their applications; and to determine whether the goals of the Wind Tunnel Simulation were achieved. Appendix IV-7 contains the comments of the external peer review. Based on the review of these comments, Region 5 has incorporated several recommendations into the existing application.

C. Project Scope

A dispersion and deposition modeling study of stack emissions and fugitive emissions from the WTI hazardous waste facility are conducted as part of the risk assessment. A detailed description of the ISC-COMPDEP model and implementation procedures are contained in Chapter II. Chapter III provides a discussion of the input parameters. Chapter IV discusses the results of the base case runs, sensitivity tests and uncertainty analysis. Chapter V provides a discussion of summary and conclusions.

II. TECHNICAL DESCRIPTION OF ISC-COMPDEP

A. Basic Equations and Assumptions

The ISC-COMPDEP model is based on the steady-state Gaussian plume equation for continuous sources as used in the ISC2 model (U.S. EPA 1992b). For receptors in simple terrain, the plume is assumed to be distributed according to a Gaussian distribution in both the horizontal and vertical directions. According to the U.S. EPA definition, simple terrain is terrain at or below the elevation of the stack being modeled. The vertical distribution of the plume is modified to account for the reflection of the pollutant off the ground and the elevated inversion lid (if present). It is also modified to account for depletion of plume material due to dry deposition processes (see Section II.F.2). The effects of plume depletion due to wet deposition is accounted for by adjusting the source term as a function of downwind distance (see Section II.G).

The basic Gaussian equation is

$$\chi = \frac{Q \cdot f_1}{2\pi u_s \cdot \sigma_y \cdot \sigma_z} \exp\left[-1/2\left[\frac{y}{\sigma_y}\right]^2\right] \qquad \text{(II-1)}$$

where Q is the pollutant emission rate (g/s),

f_1 is the vertical term (1/m) of the distribution,

u_s is the stack height wind speed (m/s),

σ_y is the standard deviation (m) of the concentration distribution in the crosswind direction,

σ_z is the standard deviation (m) of the concentration distribution in the vertical direction, and

y is the crosswind distance (m) from the plume centerline to the receptor.

The vertical term of the Gaussian equation accounts for reflection off the ground and the top of the mixing height. It is computed as:

$$f_1 = \exp\left[-0.5\left[\frac{z_r - h_e}{\sigma_z}\right]^2\right] + \exp\left[-0.5\left[\frac{z_r + h_e}{\sigma_z}\right]^2\right]$$

$$+ \sum_{i=1}^{\infty}\left\{\exp\left[-0.5\left[\frac{H_1}{\sigma_z}\right]^2\right] + \exp\left[-0.5\left[\frac{H_2}{\sigma_z}\right]^2\right]\right.$$

$$\left. + \exp\left[-0.5\left[\frac{H_3}{\sigma_z}\right]^2\right] + \exp\left[-0.5\left[\frac{H_4}{\sigma_z}\right]^2\right]\right\} \quad \text{(II-2)}$$

where $h_e = h_s + \Delta h$

$H_1 = z_r - (2iz_i - h_e)$

$H_2 = z_r + (2iz_i - h_e)$

$H_3 = z_r - (2iz_i + h_e)$

$H_4 = z_r + (2iz_i + h_e)$

z_r is the height (m) of the receptor above the local ground level (i.e., a "flagpole" height)

h_e is the effective height (m) of the plume after accounting for plume rise, stack tip downwash, and gravitational settling effects,

h_s is the height (m) of the stack,

Δh is the rise of the plume (m) above the stack top, and

z_i is the mixing height (m).

If the effective height of the plume is greater than the mixing height, the plume is assumed to be fully above the mixed layer, and the ground-level concentration is set equal to zero. Under stable atmospheric conditions, the plume is assumed to reflect only off the ground (i.e., the mixed layer height is considered unlimited). At large downwind distances, and when reflections off the top of the mixing height are considered, the vertical distribution of the plume approaches a uniform distribution. When $\sigma_z/z_i > 1.6$, the summation in Eqn. (II-2) is eliminated, and f_1/σ_z is replaced by $\sqrt{2\pi}/z_i$ (Turner 1970).

The calculation of the effective plume height due to momentum and buoyant rise is discussed in Section II.C. The effect of building downwash on plume rise is described in Section II.D. The modification of the plume height due to stack tip downwash effects and gravitational settling effects is discussed in Section II.E and II.F, respectively.

There are a number of important assumptions implicit in the Gaussian plume formulation. Among these are the assumptions of steady-state meteorological and environmental conditions. The steady-state plume approach does not account for variations in winds, stability, and other meteorological variables occurring over the path of the plume's transport. It does not include plume history or causality effects. That is, it does not allow for a build-up of multiple hours' emissions (e.g., during a stagnation event) and it does not account for the finite amount of time it takes for a plume to actually reach a receptor. It assumes that the current meteorological conditions existed long enough for the plume to reach the receptor, regardless of the source-receptor distance. The steady-state equation also assumes that the plume is bent over by the mean wind. With its inverse wind speed dependence, it cannot treat calm wind and very low wind speed conditions.

The model's treatment of terrain effects is relatively simplistic. For receptors in "complex terrain" (defined as terrain above the plume centerline height), ISC-COMPDEP uses the 22.5° sector-averaging approach of the U.S. EPA COMPLEX I model (U.S. EPA 1993a). For receptors in "intermediate terrain," ISC-COMPDEP follows the U.S. EPA recommendation of selecting the higher of the simple terrain concentration predicted using Eqn. (II-1) or the sector-averaged value of COMPLEX I. See Section II.H for additional discussion of terrain effects in ISC-COMPDEP.

In this study, due to the fundamental limitations of the steady-state approach in calm wind conditions, during stagnation events, and in inversion breakup-type fumigation situations, non-steady-state puff modeling has been performed to evaluate dispersion for these conditions (see Section IV.B.5).

B. Dispersion Coefficients

ISC-COMPDEP contains empirical relationships that describe the variation of σ_y and σ_z as a function of atmospheric stability and source-receptor downwind distance. For rural environments, the Pasquill-Gifford (PG) curves are used (Turner 1970). The equation used to calculate σ_y is:

$$\sigma_y = 465.11628\, x \tan(\mathrm{TH}) \qquad \text{(II-3)}$$

where $\mathrm{TH} = 0.017453293\ (c - d \ln(x))$,

x is the downwind distance (km),

c, d are empirical factors, and

σ_y is in units of meters.

U.S. EPA (1992b) provides tables of the factors c and d as a function of stability class. The vertical dispersion parameter, σ_z is calculated as:

$$\sigma_z = ax^b \quad \text{(II-4)}$$

where a and b are empirical factors that vary with stability class and downwind distance (U.S. EPA 1992b).

Other relationships are available in ISC-COMPDEP for urban dispersion conditions, but in the current study only the rural equations were of interest. Building wake effects can affect the plume dispersion rates if the emissions are released close to buildings or other structures. Section II.D contains a discussion of the dispersion equations used when building effects are important.

1. Buoyancy-Induced Dispersion

The effects of plume buoyancy on dispersion are evaluated using the recommendations of Pasquill (1976).

$$\sigma_{ye} = \left[\sigma_y^2 + \left[\frac{\Delta h}{3.5}\right]^2\right]^{1/2} \quad \text{(II-5)}$$

$$\sigma_{ze} = \left[\sigma_z^2 + \left[\frac{\Delta h}{3.5}\right]^2\right]^{1/2} \quad \text{(II-6)}$$

where σ_{ye}, σ_{ze} are the dispersion coefficients (m) after buoyancy effects have been included, and

Δh is the plume rise (m), which can be a function of distance.

Buoyancy-induced dispersion is not used when the Schulman-Scire downwash option is in effect (U.S. EPA 1992b).

C. Plume Rise

When a single level of meteorological data is used, buoyant and momentum plume rise in ISC-COMPDEP is computed using the same procedures as in ISC2. When multilayer meteorological data are used, the procedures described in Section II.J are employed.

The buoyancy flux parameter is defined as:

$$F_b = gwD^2\left[\frac{\Delta T}{4T_s}\right] \quad \text{(II-7)}$$

where F_b is the buoyancy flux (m^4/s^3),

g is the acceleration due to gravity (m/s^2),
w is the exit velocity (m/s),
D is the stack diameter (m),
T_s is the stack gas exit temperature (K), and
ΔT is $T_s - T_a$, where T_a is the ambient air temperature (K).
The momentum flux, F_m (m^4/s^2) is:

$$F_m = w^2 D^2 \frac{T_a}{4T_s} \tag{II-8}$$

1. Crossover Temperature — Neutral/Unstable Conditions

For cases with a stack gas temperature greater than or equal to ambient temperature, it must be determined whether the plume rise is dominated by momentum or buoyancy. The crossover temperature difference, $(\Delta T)_c$, is determined by matching the momentum and buoyant Briggs plume rise equations, and solving for $(\Delta T)_c$.

$$(\Delta T)_c = \begin{cases} 0.0297 T_s \dfrac{w^{1/3}}{D^{2/3}} & F_b < 55 \text{ m}^4/\text{s}^3 \\ 0.00575 T_s \dfrac{w^{2/3}}{D^{1/3}} & F_b \geq 55 \text{ m}^4/\text{s}^3 \end{cases} \tag{II-9}$$

If the difference between the stack gas and ambient temperatures, ΔT, is greater than or equal to $(\Delta T)_c$, plume rise is assumed to be buoyancy dominated, otherwise plume rise is assumed to be momentum dominated.

2. Buoyant Rise — Neutral/Unstable Conditions

For situations where ΔT exceeds $(\Delta T)_c$ as determined above, buoyancy is assumed to dominate. The distance to final rise, x_f, is assumed to be $3.5x^*$, where x^* is the distance at which atmospheric turbulence begins to dominate entrainment. The value of x_f is calculated as follows:

$$x_f = \begin{cases} 49 F_b^{5/8} & F_b < 55 \text{ m}^4/\text{s}^3 \\ 119 F_b^{2/5} & F_b \geq 55 \text{ m}^4/\text{s}^3 \end{cases} \tag{II-10}$$

The final effective plume height, h_e (m), is:

$$h_e = \begin{cases} h_s + 21.425 \dfrac{F_b^{3/4}}{u_s} & F_b < 55 \text{ m}^4/\text{s}^3 \\ h_s + 38.71 \dfrac{F_b^{3/5}}{u_s} & F_b \geq 55 \text{ m}^4/\text{s}^3 \end{cases} \quad \text{(II-11)}$$

3. Momentum Rise — Neutral/Unstable Conditions

For situations where the stack gas temperature is less than or equal to the ambient air temperature or where $(\Delta T) \leq (\Delta T)_c$, the plume rise is assumed to be dominated by momentum. The plume height is calculated as:

$$h_e = h_s + 3D \frac{w}{u_s} \quad \text{(II-12)}$$

Briggs (1969) indicates that this equation is most applicable when the ratio w/u_s is greater than four.

4. Crossover Temperature — Stable Conditions

For cases with a stack gas temperature greater than or equal to ambient temperature, it must be determined whether the plume rise is dominated by momentum or buoyancy. The crossover temperature difference under stable conditions is:

$$(\Delta T)_c = 0.019582 T_s w \sqrt{s} \quad \text{(II-13)}$$

where $s = g(\partial\theta/\partial z)/T_a$, and $\partial\theta/\partial z$ is the potential temperature lapse rate (K/m). The default values for $\partial\theta/\partial z$ are 0.020 K/m and 0.035 K/m for stability classes E and F, respectively.

If the difference between the stack gas temperature and the ambient temperature, ΔT, is greater than or equal to $(\Delta T)_c$, plume rise is assumed to be buoyancy dominated. Otherwise, plume rise is assumed to be momentum dominated.

5. Buoyancy Rise — Stable Conditions

For situations where $\Delta T \geq (\Delta T)_c$, buoyancy is assumed to dominate. The distance to final rise, x_f, is determined as:

$$x_f = 2.0715 \frac{u_s}{\sqrt{s}} \quad \text{(II-14)}$$

The final plume height, h_e, is:

$$h_e = h_s + 2.6 \left[\frac{F_b}{u_s s} \right]^{1/3} \quad \text{(II-15)}$$

6. Momentum Rise — Stable Conditions

Where the stack gas temperature is less than or equal to the ambient air temperature or $\Delta T < (\Delta T_c)$, the plume rise is dominated by momentum.

$$h_e = h_s + 1.5 \left[\frac{F_m}{u_s \sqrt{s}} \right]^{1/3} \quad \text{(II-16)}$$

The equation for unstable-neutral momentum rise (Eqn. (II-12)) is also evaluated. The value of h_e that is used as the resulting final plume height is the lower of the two estimates.

7. Transitional Rise — All Conditions

Where gradual or transitional rise is to be estimated for unstable, neutral, or stable conditions, and if the distance downwind from the source to the receptor, x, is less than the distance to final rise, the plume height is determined as:

$$h_e = h_s + 1.6 \left[\frac{F_b^{1/3} x^{2/3}}{u_s} \right] \quad \text{(II-17)}$$

This height will be used only for buoyancy dominated conditions. The value of h_e from Eqn. (II-17) is always compared to the final neutral or stable rise, and the lower of the two values is used.

For momentum-dominated conditions, with neutral or unstable conditions, the following equations (U.S. EPA 1992b) are used to calculate a distance dependent momentum plume rise:

$$h_e = h_s + \left[\frac{3F_m x}{\beta_j^2 u_s^2}\right]^{1/3} \quad \text{(II-18)}$$

where x is the downwind distance (m), with a maximum value defined by x_{max} as follows:

$$x_{max} = \begin{cases} \dfrac{4D(w + 3u_s)^2}{w u_s} & \text{for } F_b = 0 \\ 49F_b^{5/8} & \text{for } 0 < F_b \leq 55 \text{ m}^4/\text{s}^3 \\ 119F_b^{2/5} & \text{for } F_B > 55 \text{ m}^4/\text{s}^3 \end{cases} \quad \text{(II-19)}$$

Under stable conditions,

$$h_e = h_s + \left[3F_m \frac{\sin\left(x\sqrt{s}/u_s\right)}{\beta_j^2 u_s \sqrt{s}}\right]^{1/3} \quad \text{(II-20)}$$

where x is the downwind distance (m), with a maximum value defined by x_{max} as $0.5\pi u_s / \sqrt{s}$.

The jet entrainment coefficient, β_j, is defined as $1/3 + u_s / w$. As with the buoyant gradual rise, if the distance-dependent momentum rise exceeds the appropriate neutral or stable final rise, then the final rise is substituted instead.

8. Downwash Effects on Plume Rise

Wind tunnel observations of plume dispersion and plume rise indicate that plume rise can be significantly reduced by building downwash. Huber and Snyder (1982) found that during downwash conditions, plume rise was reduced by one-third below the value obtained in the absence of the building. In an analysis of plume rise observations, Rittmann (1982) found lower plume rise than predicted by the 2/3 law (a form of Eqn. II-17) for smaller sources which are most likely to be affected by downwash. Several studies (e.g., Bowers and Anderson 1981; Scire and Schulman 1981; Thuillier 1982) with the original version of the ISC building downwash algorithm, which did not account for the effects of building downwash on plume rise, showed that neglecting building downwash effects on plume rise can significantly underestimate peak concentrations during downwash conditions.

The increased mechanical turbulence in the building wake which leads to enhanced plume dispersion, causes a rapid dilution of the plume. This dilution reduces the rate of rise of the plume and leads to lower plume heights. One method of treating the initially high dilution rate is to assume an initial "dilution radius" for the plume (Scire and Schulman 1980). This technique is incorporated in the Buoyant Line and Point Source (BLP) model (Schulman and Scire 1980) and the ISC2 model (U.S. EPA 1992b). It has been shown to produce more realistic estimates of ground-level concentrations during building downwash conditions (Schulman and Hanna, 1986).

The plume rise of a downwashed plume with $\sigma_{yo} \leq \sigma_{zo}$ during neutral-unstable conditions is given by:

$$z_d^3 + \left(3R_o z_d / \beta_1 + 3R_o^2 / \beta_1^2\right) z_d = \left[3F_m x / \left(\beta_j^2 u_s^2\right) + 3F_b x^2 / \left(2\beta_1 2u_s^3\right)\right] \quad \text{(II-21)}$$

where R_o is the dilution radius [$R_o = (2)^{1/2}\sigma_{zo}$], β_1 is the neutral entrainment coefficient, and σ_{yo}, σ_{zo} are the horizontal and vertical dispersion coefficients, respectively, at a downwind distance of $3H_b$ (see Section II.D). The factor of $(2)^{1/2}$ in the R_o equation converts the Gaussian dispersion coefficient into an effective top-hat distribution for the plume rise calculations. A top hat distribution assumes that a variable (e.g., temperature) has a constant value within the plume and that a second constant value applies outside the plume, which leads to a crosswind distribution that resembles the shape of a top hat.

Final stable plume rise is:

$$z_d^3 + \left(3R_o z_d / \beta_2 + 3R_o^2 / \beta_2^2\right) z_d = \left[3F_m / \left(\beta_j^2 u_s s^{1/2}\right) + 6F_b / \left(\beta_2^2 u_s s\right)\right] \quad \text{(II-22)}$$

where β_2 is the stable entrainment coefficient. Transitional plume rise during stable conditions is computed with Eqn. (II-21) until the final plume height predicted by Eqn. (II-22) is obtained.

When horizontal mixing of the plume in the building wake causes $\sigma_{yo} > \sigma_{zo}$, it is necessary to account for the elongated shape of the plume. The plume can be represented as a finite line source. The plume rise for a line source of length L_e during neutral-unstable conditions is:

$$z_d^3 + \left[3L_e / (\pi\beta_1)\right] z_d^2 + \left[3R_o z_d / \beta_1 + 6R_o L_e / \left(\pi\beta_1^2\right) + 3R_o^2 / \beta_1^2\right] z_d = \left[3F_m x / \left(\beta_j^2 u_s^2\right) + 3F_b x^2 / \left(2\beta_1^2 u_s^3\right)\right] \quad \text{(II-23)}$$

and, for final stable plume rise:

$$z_d^3 + \left[3L_e/(\pi\beta_1)\right]z_d^2 + \left[3R_o z_d/\beta_1 + 6R_o L_e/(\pi\beta_1^2) + 3R_o^2/\beta_1^2\right]z_d = \left[3F_m/(\beta_j^2 u_s s^{1/2}) + 6F_b/(\beta_2^2 u_s s)\right] \quad \text{(II-24)}$$

The effective line length, L_e, is $(2\pi)^{1/2}$ $(\sigma_{yo} - \sigma_{zo})$ if $\sigma_{yo} > \sigma_{zo}$. Otherwise, L_e = 0, and Eqns. (II-23) and (II-24) reduce to Eqns. (II-21) and (II-22).

As described in Section II.D, the enhanced dispersion coefficients, σ_{zo} and σ_{yo}, vary with stack height, momentum rise, and building dimensions. The variation of R_o for several stack heights is illustrated in Figure II-1. The value of R_o varies from $R_o = H_b$ when $h_s = H_b$ to $R_o = 0$ when $h_s = 3\ H_b$. As σ_{zo} and σ_{yo} approach zero (i.e., building downwash effects become negligible), Eqns. (II-21) to (II-22) approach the unmodified Briggs equations. The effect of R_o and L_e is always to lower the plume height, thereby tending to increase the predicted maximum ground-level concentration.

D. Building Downwash

The dispersion and buoyant rise of plumes released from short stacks can be significantly modified by the presence of buildings or other obstacles to the flow. Hosker (1984) provides a description of the flow patterns in three regions near buildings. Figure II-2 shows: (1) a displacement zone upwind of the buildings, where the flow is influenced by the high pressure along the upwind building face, (2) a cavity zone characterized by recirculating flow, high turbulence intensity, and low mean wind speed, and (3) a turbulent wake region where the flow characteristics and turbulence intensity gradually approach the ambient values.

The parameterization of building downwash in ISC-COMPDEP is appropriate for use in the turbulent wake region and is based on the procedures used in the ISC2 model. ISC2 contains two building downwash algorithms:

- Huber-Snyder model (Huber and Snyder 1976; Huber 1977). In ISC2, this model is applied when the source height is greater than the building height (H_b) plus one-half of the lesser (L_b) of the building height or projected width (H_w). It applies either a full building wake effect or none at all, depending on the effective height of the emitted plume.
- Schulman-Scire model (Scire and Schulman 1980; Schulman and Hanna 1986). This model applies a linear decay factor to the building-induced enhancement

of the dispersion coefficients, accounts for the effect of downwash on plume rise, and uses wind direction-specific building dimensions. It is used in ISC2 and ISC-COMPDEP for stacks lower in height than $H_b + 0.5L_b$.

1. Huber-Snyder Downwash Procedure

If the stack height exceeds $H_b + 0.5L_b$, the Huber-Snyder algorithm is applied. The first step is to compute the effective plume height, h_e, due to momentum rise at a downwind distance of two building heights. If h_e exceeds $H_b + 1.5L_b$ (where H_b and L_b are the wind direction specific values), building downwash effects are assumed to be negligible. Otherwise, building-induced enhancement of the plume dispersion coefficients is evaluated. For stack heights, h_s, less than $1.2H_b$, both σ_y and σ_z are enhanced. Only σ_z is enhanced for stack heights above $1.2H_b$ (but below $H_b + 1.5L_b$).

A building is defined as a squat building if the projected building width, H_w, exceeds the building height (i.e., $H_w \geq H_b$). A tall building is defined as one for which $H_w < H_b$. Because both the controlling building height and projected width can vary with wind direction, the classification of a building as squat or tall can also vary by direction. For a squat building, the enhanced σ_z is:

$$\sigma_z' = 0.7\ H_b + 0.067\ (x - 3H_b) \qquad 3H_b < x < 10H_b \tag{II-25}$$

where x is the downwind distance (in meters).
For a tall building,

$$\sigma_z' = 0.7\ H_w + 0.067\ (x - 3H_w) \qquad 3H_w < x < 10H_w \tag{II-26}$$

If the ratio h_s/H_b is less than or equal to 1.2, the horizontal dispersion coefficient, σ_y, is enhanced. For a squat building with a projected width to height ratio (H_w/H_b) less than 5, the equation for σ_y is:

$$\sigma_y' = 0.35\ H_w + 0.067\ (x - 3H_b) \qquad 3H_b < x < 10H_b \tag{II-27}$$

For buildings with (H_w/H_b) greater than 5, two options are provided for σ_y.

$$\sigma_y' = 0.35\ H_b + 0.067\ (x - 3H_b) \qquad 3H_b < x < 10H_b \tag{II-28}$$

or,

$$\sigma_y' = 1.75\ H_b + 0.067\ (x - 3H_b) \qquad 3H_b < x < 10H_b \tag{II-29}$$

Eqn. (II-28) results in higher centerline concentrations than Eqn. (II-29), and is considered as an upper bound estimate of the impacts of the source. The ISC2 manual suggests that Eqn. (II-29) is most appropriate if the source is located within $2.5H_b$ of the end of the building. Eqn. (II-28) is a better estimate if the source is located near the center of the building. However, in practice, the more conservative Eqn. (II-28) is usually used for regulatory applications regardless of the position of the stack.

For a tall building, the equation for σ_y is:

$$\sigma_y' = 0.35\ H_w + 0.067\ (x - 3H_w) \qquad 3H_w < x < 10H_w \tag{II-30}$$

2. Schulman-Scire Downwash Procedure

The main features of the Schulman-Scire algorithm are that the effects of building downwash on reducing plume rise are incorporated, and the enhancement of σ_z is a gradual function of effective plume height rather than a step function. In ISC-COMPDEP, both schemes use wind direction specific building dimensions.

The plume rise equations incorporating building downwash effects are discussed in Section II.C. Many studies have shown that plume rise is decreased during downwash conditions. The increased mechanical turbulence in the building wake leads to enhanced plume dispersion (reflected in the enhanced dispersion coefficients), which causes a rapid dilution of the plume. This dilution reduces the rate of rise of the plume and results in lower plume heights. As discussed in Section II.C, the initially high dilution rate is modeled by applying an initial "dilution radius" to the plume. The inclusion of downwash effects in the plume rise equations is a key part of the Schulman-Scire downwash method.

The second component of the model is the linear decay function which is applied to the enhancement of σ_z. The vertical dispersion coefficient is determined as:

$$\sigma_z'' = A\ \sigma_z' \tag{II-31}$$

where σ_z' is determined from Eqns. (II-25) or (II-26), and,

$$A = \begin{cases} 1 & h_e \le H_b \\ (H_b - h_e)/(2\ L_b) + 1 & H_b < h_e \le H_b + 2L_b \\ 0 & H_b + 2L_b < h_e \end{cases} \tag{II-32}$$

where h_e is the plume height due to gradual momentum rise at $2H_b$.

E. Stack-tip Downwash

If the ratio of the stack gas exit speed to the ambient wind speed is less than 1.5, the plume may be drawn into the lee of the stack. Briggs (1973) suggests modifying the stack height to adjust for this stack-tip effect:

$$h_s' = \begin{cases} h_s + 2D(w/u_s - 1.5) & w/u_s < 1.5 \\ h_s & w/u_s \geq 1.5 \end{cases} \quad \text{(II-33)}$$

where h_s' is the adjusted stack top height,

h_s is the physical stack height,

w is the stack gas exit velocity,

u_s is the stack height wind speed

In ISC-COMPDEP, an option is provided to allow the stack-tip downwash adjustment to be applied when the ratio w/u_s is less than 1.5. Stack-tip downwash is not applied when the Schulman-Scire downwash model is used, even if the stack-tip downwash option is selected.

F. Dry Deposition of Particulate Matter

1. Deposition Velocity Calculation

ISC-COMPDEP uses a resistance model to parameterize dry deposition of particulate matter. The deposition velocity is defined as:

$$v_d = \frac{F}{\chi_s} \quad \text{(II-34)}$$

where v_d is the deposition velocity (m/s)

F is the pollutant deposition flux ($g/m^2/s$), and

χ_s is the pollutant concentration (g/m^3)

The deposition velocity for particles depends on a larger number of parameters, including the characteristics of the surface (e.g., surface roughness, vegetation type, and amount), atmospheric variables, such as stability and turbulence levels in the atmosphere, and pollutant characteristics, such as the size, shape, and

density of the particles. In Figure II-3, the strong relationship between deposition velocity and particle size is shown.

In the resistance model, the deposition velocity for particles is expressed as the inverse of a sum of "resistances" plus gravitational settling terms (Slinn and Slinn, 1980; Pleim et al. 1984):

$$v_d = \frac{1}{r_a + r_d + r_a r_d v_g} + v_g \qquad \text{(II-35)}$$

where r_a is the aerodynamic resistance (s/m)

r_d is the deposition layer resistance (s/m), and

v_g is the gravitational settling velocity (m/s)

The resistance model used in ISC-COMPDEP is based on that in the ADOM model (Pleim et al. 1984) and CALPUFF (Scire et al. 1995). In a study comparing observed and predicted deposition velocities (U.S. EPA 1994), the model was found to be within a group of the best performing particle deposition models.

a. Aerodynamic Resistance

The resistances represent the opposition to transport of the pollutant through the atmosphere to the surface. The aerodynamic resistance is used to parameterize the rate of pollutant transfer in a shallow surface layer near the ground. This surface layer rapidly adjusts to changes in surface conditions. Because the vertical fluxes are nearly constant, this layer is also called the constant-flux layer.

The aerodynamic resistance is obtained by integration of the micrometeorological flux-gradient relationships (Wesely and Hicks 1977):

$$r_a = \frac{1}{k\, u_*} \left[\ln(z_r / z_o) - \psi_H\right] \qquad \text{(II-36)}$$

where, z_r is the reference height ($\simeq$10 m),

z_0 is the surface roughness length (m),

k is the von Karman constant ($\sim$ 0.4),

u_* is the friction velocity (m/s), and

ψ_H is a stability correction term.

The stability correction term accounts for the effects of buoyancy on the eddy diffusivity of the pollutant. It is assumed that the pollutant transfer is similar to that for heat (Wesely and Hicks 1977).

$$\psi_H = \begin{cases} -5z_r/L & 0 < z_r/L < 1 \\ 0 & z_r/L = 0 \\ \exp\left[0.598 + 0.39\ln(-z_r/L) - 0.090\left(\ln(-z_r/L)\right)^2\right] & -1 < z_r/L < 0 \end{cases} \quad \text{(II-37)}$$

L is the Monin-Obukhov length (m) (see Eqn. II-110).

b. Deposition Layer Resistance

Over very smooth surfaces, a thin non-turbulent layer (i.e., the "deposition layer") develops just above the surface. For typically rough surfaces, this layer is constantly changing and is likely to be intermittently turbulent. For this reason, Hicks (1982) calls this layer the "quasi-laminar" layer. Under many conditions, the deposition layer resistance, r_d, is the dominant resistance controlling the rate of deposition for particulate matter.

There are three major mechanisms for the transport of particles across the deposition layer. Small particles (<0.1 μm diameter) are transported through the laminar deposition layer primarily by Brownian diffusion. This process becomes less efficient as the particle diameter increases. Particles in the 2- to 20-μm diameter range tend to penetrate the deposition layer by inertial impaction. The stopping time, t, defined as the settling velocity divided by the acceleration due to gravity, is a measure of tendency of a particle to impact, and increases with increasing particle diameter. Particles larger than 20 μm are dominated by gravitational settling effects. Particles in the range of 0.1- to 2-μm diameter range have very small settling velocities and are not efficiently transported across the deposition layer by either the Brownian diffusion or the inertial impaction mechanism. As a result, particles in this size range tend to have the lowest deposition velocities.

The deposition layer resistance can be parameterized (e.g., Pleim et al. 1984) in terms of the Schmidt number (Sc = υ/D, where υ is the viscosity of air, and D is the Brownian diffusivity of the pollutant in air) and the Stokes number (St = $(v_g/g)(u_*^2/\upsilon)$, where v_g is the gravitational settling velocity and g is the acceleration due to gravity).

$$r_d = \left(Sc^{-2/3} + 10^{-3/St}\right)^{-1} u_*^{-1} \quad \text{(II-38)}$$

The diffusivity of a particle in air, D, is a function of the particle size. Smaller particles tend to be more efficiently transported by Brownian motion,

and therefore have higher diffusivities. The Stokes number is a measure of the likelihood of impaction of the particle. It increases with increasing particle size.

c. Gravitational Settling

The gravitational settling velocity is a function of the particle size, shape, and density. For spheres, the settling velocity is given by the Stokes equation:

$$v_g = \left[(d_p)^2\ g(\rho_p - \rho_g)C\right] / (18\ v) \qquad \text{(II-39)}$$

where, d_p is the particle diameter (m)
g is the acceleration due to gravity ($\sim$9.8 m/s^2),
ρ_p is the particle density (g/m^3),
ρ_g is the air density (g/m^3), and,
C is the Cunningham slip correction factor for small particles.

This slip correction factor is given by:

$$C = 1 + (2\ \lambda / d_p)\left[a_1 + a_2 \exp\left(-a_3 d_p / \lambda\right)\right] \qquad \text{(II-40)}$$

where, λ is the mean free path of air molecules (6.5 x 10^{-6} cm), and
a_1, a_2, a_3 are constants (1.257, 0.40, 0.55, respectively).

Because of the sensitivity of the deposition velocity to particle size, the effective deposition velocity is computed for a number of individual size categories, and then weighted by the fraction of mass in each size category. The particle size distributions used in the modeling of the WTI incinerator are discussed in Section III.A.1.

The particle diameters are usually expressed in terms of *aerodynamic* diameters, rather than *physical* diameters. The aerodynamic diameter is defined as the diameter of a sphere of unit density (1 g/cm^3) that has the same gravitational settling velocity as the actual particle with its arbitrary shape and density. Most devices designed to measure particle size distribution (e.g., cascade impactors) report the particle distribution in terms of aerodynamic rather than physical sizes. One advantage of using the aerodynamic diameter is that it implicitly includes the effects of both particle density and shape.

2. Modified Source Depletion

In the absence of any terrain modifications, the deposition flux is modeled as the product of the deposition velocity (v_d) and a near-surface concentration, $C_d(z_d)$, where z_d is a near-surface height at which the deposition flux and deposition velocity are estimated.

$$F_D(x) = v_d\ C_d\ (x, z_d) \tag{II-41}$$

The concentration profile $C_d(x,z)$ is a "corrected" form of the concentration profile $C_o(x,z)$ that is determined in the absence of dry deposition. Following Horst (1983), the crosswind-integrated concentration in the absence of deposition can be written as

$$C_o(x,z) = \int_{-\infty}^{+\infty} C(x,y,z)dy = Q_o\ D(x,z,h) \tag{II-42}$$

$D(x,z,h)$ is the vertical distribution factor for a plume whose axis is at an elevation h above the surface, and is evaluated at an elevation z above the surface.

Deposition of particles will remove mass from the plume, and most of the mass lost will have been removed from the lower portion of the plume. In Horst's corrected source-depletion model, the mass emission rate (Q) is reduced to recognize the mass that is lost from the plume, and the distribution of concentration in the vertical is altered by a profile factor that recognizes that most of this mass is removed from the lower part of the plume. Call $Q(x)/Q_o$ (≤ 1) the depletion factor, and call $P(x,z)$ the profile factor. Then the "corrected" concentration profile is

$$\begin{aligned} C_d(x,z) &= Q(x)\ D(x,z,h)\ P(x,z) \\ &= \frac{Q(x)}{Q_o}\ P(x,z)\ C_o(x,z) \end{aligned} \tag{II-43}$$

The depletion factor is obtained by integrating the deposition flux over the distance traveled by the plume:

$$\begin{aligned} \frac{d}{dx}\ Q(x) &= -v_d\ C_d\ (x, z_d) \\ &= -v_d\ Q(x)\ D(x, z_d, h)\ P(x, z_d) \end{aligned} \tag{II-44}$$

so that

$$\frac{Q(x)}{Q_o} = \exp\left[-\int_o^x v_d\, D(x', z_d, h)\, P(x', z_d)\, dx'\right] \quad \text{(II-45)}$$

This integral is evaluated numerically in the code.

The profile factor is more difficult to obtain. Horst (1993) relates the modified concentration profile ($C_d(x,z)$) near the surface to the deposition flux by assuming that the deposition flux is constant with height near the surface. This requires the deposition flux to be equal to the flux due to turbulence in the layer:

$$v_d\, C_d(x, z_d) = K(z)\, \frac{d}{dz}\, C_d(x, z) \quad \text{(II-46)}$$

where K(z) is the diffusivity (m/s^2).

There is also a flux of particles toward z_d due to gravitational settling in the layer, so that a second term involving the settling velocity, v_g, is added to the right side:

$$v_d\, C_d(x, z_d) = K(z)\, \frac{d}{dz}\, C_d(x, z) + v_g\, C_d(x, z) \quad \text{(II-47)}$$

Note that v_d already incorporates the contribution of the settling velocity in depositing particles to the surface from $z = z_d$. The second term on the right addresses the influence of v_g on determining the shape of $C_d(x,z)$ that is consistent with the constant flux assumption. Horst solves Eqn. (II-47) for $C_d(x,z)$:

$$C_d(x, z) = C_d(x, z_d)\left[1 + \frac{v_d - v_g}{v_g}\left(1 - e^{-v_g R(z, z_d)}\right)\right] \quad \text{(II-48)}$$

where

$$R(z, z_d) = \int_{z_d}^{z} \frac{dz'}{K(z')} \quad \text{(II-49)}$$

R is the atmospheric resistance, a measure of the resistance to pollutant transfer through the layer from z_d to z.

Eqns. (II-48) and (II-43) allow the formulation of a similar expression for $P(x,z)$:

$$D(x,z,h)\ P(x,z) = D(x,z_d,h)\ P(x,z_d) \left[1 + \frac{v_d - v_g}{v_g}\left(1 - e^{-v_t R(z,z_d)}\right)\right] \qquad \text{(II-50)}$$

In the absence of removal at the surface, concentrations in a layer near the surface are independent of height, so that $D(x,z,h) = D(x,z_d,h)$ in Eqn. (II-50), and the approximate result is:

$$P(x,z) = P(x,z_d) \left[1 + \frac{v_d - v_g}{v_g}\left(1 - e^{-v_t R(z,z_d)}\right)\right] \qquad \text{(II-51)}$$

An additional constraint conserves the mass flux in the plume:

$$\int_o^\infty u\ D(x,z,h)\ P(x,z)\ dz = 1 \qquad \text{(II-52)}$$

which, when combined with Eqn. (II-51), gives

$$P(x,z_d) = \left[1 + \frac{v_d - v_g}{v_g} \int_o^\infty \left(1 - e^{-v_t R(z,z_d)}\right) u\ D(x,z,h)\ dz\right]^{-1} \qquad \text{(II-53)}$$

Horst notes once again that deposition is a near-surface process, so that $P(x,z_d)$ may be simplified by replacing $D(x,z,h)$ with $D(x,z,0)$. He argues that $P(x,z_d)$ only needs to be accurate when σ_z is of order h (i.e., the plume is in contact with the surface), and the switch to $h = 0$ is a reasonable approximation for this regime. When this scheme is used in ISC-COMPDEP, the user should note that concentrations obtained at flagpole receptors well above the surface may not be accurate when dry depletion is modeled. With this simplification,

$$P(x,z_d) = \left[1 + \frac{v_d - v_g}{v_g} \int_o^\infty \left(1 - e^{-v_t R(z,z_d)}\right) u\ D(x,z,0)\ dz\right]^{-1} \qquad \text{(II-54)}$$

and $P(x,z)$, the profile correction factor, has no dependence on the plume height.

Horst obtained analytic solutions to the integrals for $P(x,z_d)$ and $R(z,z_d)$ in Eqns. (II-54) and (II-49) for cases in which $v_g R$ is small, for the Briggs expressions

for the rural $\sigma_z(x)$ functions. A numerical integration was implemented to complete the description, and placed in ISC-COMPDEP (see U.S. EPA 1994, for details).

Although $P(x,z_d)$ is independent of h, the plume height still influences the deposition flux through $D(x,z,h)$ in Eqn. (II-43), and so it also influences the depletion factor in Eqn. (II-45). Therefore, the effect of the settling velocity on the height of the plume should be addressed. Horst points out that the "tilted-plume" approximation is typically employed to simulate this settling. Quite simply, h is replaced by an effective height, h_e, given by

$$h_e = \text{MAX}\left[h - \frac{v_g}{u}\,x \quad , \quad 0.0\right] \tag{II-55}$$

This essentially allows all particles in the plume to fall toward the surface at their respective settling velocities, regardless of whether the particles are in the center or upper portion of the distribution. As h_e approaches zero, the lower part of the plume is "reflected" at the surface (in $D(x,z,h)$, not necessarily in $C_d(x,z)$).

a. Deposition/Terrain Interaction

When terrain adjustments are made in either ISC2 (terrain below stack-top) or COMPLEX I, a second plume height is used. Such terrain adjustments are strictly local. Adjustments at adjacent receptors are unrelated, being derived solely on the basis of the elevation of each receptor, relative to the plume height, stack height, and stack-base elevation. Although the end result on plume height is similar to the plume tilt used to simulate gravitational settling, the process differs fundamentally. There is no analogue to the settling flux term in Eqn. (II-47). If there were, both v_d and v_g would be increased as a plume traversed the "front" side of a hill, and decreased as the plume regained its original elevation beyond the hill. In fact, deposition velocity may decrease through zero on the lee of a hill, which would give rise to an upward flux of particles from the surface!

Therefore, the terrain adjustments made to the plume centerline elevation are viewed as a mechanism to enhance the probability that particles may be transported nearer the surface as a plume travels over terrain, thereby increasing the likelihood that more particles will reach the deposition layer. The deposition velocity is not altered in this view, but the deposition flux to the surface of a hill will increase owing to $D(x,z,h_e)$. Furthermore, because the depletion factor is explicitly integrated along the plume trajectory, the

"history" of terrain upwind of a receptor will alter both the concentration and deposition flux predicted at that receptor. In essence, the mechanics of dry deposition and plume depletion are transparent to the terrain adjustments, and those terrain adjustments alter the predicted flux in exactly the same way that they alter the predicted concentrations in the absence of deposition — through a simple, effective plume height.

Both gravitational settling and terrain adjustments alter the effective height of a plume. The settling, modeled with the "tilted plume" approximation, is always computed first. It is viewed as a physical process. Any subsequent terrain adjustments are applied to the "settled" plume height.

b. Gravitational Settling After Plume "Touchdown"

The total deposition velocity, v_d, includes the flux associated with the gravitational settling velocity. The total flux of particles to the surface (associated with the dry deposition) is computed at a near-surface height within an assumed constant flux layer as the product of v_d, the concentration predicted in the absence of deposition (C_o), the source depletion factor ($Q(x)/Q_o$), and a profile correction factor ($P(x,z_d)$) that distributes the loss of material from the plume in a manner that approximates the results obtained from the surface depletion model for deposition.

In addition to augmenting the deposition velocity, v_g also brings the plume as a whole nearer the surface thereby influencing C_o. Gravitational settling causes all particles within the plume to fall, relative to the local (turbulent) velocity field. For an elevated plume, this process causes the center-of-mass to fall (on average) toward the surface at a rate v_g. Because the center-of-mass of a Gaussian plume is the plume centerline (h) when σ_z is small compared to h, the tilted plume model is typically used to simulate the settling process. In this model, an effective plume centerline height is defined

$$h_e = h - (v_g / u)\, x \qquad \text{(II-56)}$$

where h is the initial height of a plume of uniformly-sized particles, and v_g is the settling velocity for these particles.

Horst (1983) points out that this approximation is probably appropriate only for $h > \sigma_z$. Certainly, problems of interpretation arise at distances large enough to drive h_e negative. In the original formulation of ISC2, Eqn. (II-56) is used for all distances, even those that produce negative values of h_e. When partial reflection coefficients are used, this leads to a "bouncing" plume result

in that the plume centerline appears to fall to the surface, and then rise once again. (The exponentials that define the vertical distribution of concentration are invariant to a change in the sign of the plume centerline height.) The revised deposition algorithms for ISC-COMPDEP avoid this by enforcing Eqn. (II-55), which shuts off the effect of v_g on the center-of-mass when h_e becomes zero. Because the deposition process embodied in v_d and $P(x,z)$ assumes that gravitational settling is always active for non-zero v_g, this is not a satisfactory solution to the problem encountered when a tilted plume reaches the surface. Also, note that the tilted plume approach is immediately canceled when h starts at zero.

The bulk property of the plume that is altered by gravitational settling is its center-of-mass. As stated above, this is the plume centerline height when $h \gg \sigma_z$. For $h = 0$, the center-of-mass is proportional to σ_z:

$$h_{cm} = \sqrt{2/\pi}\ \sigma_z \qquad \text{(II-57)}$$

Therefore, we can simulate the effect of gravitational settling on the center-of-mass of a plume that is on the surface by modifying its depth in the vertical, or σ_z. In the absence of gravitational settling, the center-of-mass of a surface-based plume ($h = 0$) will grow in proportion to σ_z. With gravitational settling, the rate of growth is diminished by the settling velocity. Define a modified center-of-mass as h_{cm}'; then

$$\frac{d\ h'_{cm}}{dx} = \frac{d\ h_{cm}}{dx} - \frac{v_g}{u} \qquad \text{(II-58)}$$

This is similar to a differential form of the tilted plume expression in Eqn. (II-56).

Plumes will continue to grow in the vertical when particles are small enough that dh'_{cm}/dx or $d/dx(h'_{cm})$ is positive in Eqn. (II-58). But for larger particles, the plume can shrink in the vertical. Rewrite Eqn. (II-58) in terms of σ_z:

$$\frac{d\,\sigma'_z}{dx} = \frac{d\,\sigma_z}{dx} - \sqrt{\pi/2}\ \frac{v_g}{u} \qquad \text{(II-59)}$$

value σ_z' is the modified value of σ_z accounting for the effects of settling.

If σ_z were a linear function of distance, then the derivatives in Eqn. (II-59) would yield constants, and a modified growth rate would be fixed for all

distances beyond x_o. If the growth rate were negative, then σ_z' would eventually reach $\sigma_z' = 0$. This would represent a singularity in the Gaussian plume formulation, and so it must be avoided. This is done by setting a minimum value equal to twice the (small) value used as the deposition reference height, z_d.

For those cases in which $\sigma_z(x)$ is nonlinear, we note that $d\sigma_z/dx$ typically decreases with distance. As σ_z grows larger, its rate-of-growth diminishes. Under the action of gravitational settling large enough to cause σ_z to shrink, it is assumed that the $\sigma_z(x)$ "curve" is followed backwards. The rate of growth is assumed to be a local property, depending only on the value of σ_z. Therefore, as σ_z grows smaller, $d\sigma_z/dx$ may increase, thereby influencing the value of $d\sigma_z'/dx$ in Eqn. (II-59). If $d\sigma_z/dx$ exceeds $\sqrt{\pi/2}\ \frac{v_g}{u}$ at some value of x, then a balance will be achieved at the corresponding value of σ_z, and σ_z' will become a constant. The point of balance is defined by

$$\frac{d\sigma_z}{dx} = \sqrt{\pi/2}\ \frac{v_s}{u} \qquad \text{(II-60)}$$

The equation that governs this process is clarified by rewriting Eqn. (II-59) as

$$\frac{d\sigma_z'}{dx} = G\left(\sigma_z'\right) - \sqrt{\pi/2}\ v_s/u \qquad \text{(II-61)}$$

where $G\left(\sigma_z'\right) = \frac{d\sigma_z}{dx}$ expressed in terms of σ_z, not x.

Integrate Eqn. (II-61) to obtain:

$$\int \frac{d\sigma_z'}{G\left(\sigma_z'\right) - \sqrt{\pi/2}\ v_s/u} = x + \text{const} \qquad \text{(II-62)}$$

and evaluate the constant of integration by demanding that $\sigma_z'(x = x_o) = \sigma_{zo}$, the value of σ_z at the "touchdown" point. This will yield an equation for distance as a function of σ_z' which must be inverted to obtain $\sigma_z'(x = x - x_o)$, where x_o is the point at which the plume centerline reaches the surface.

Curves of $\sigma_z(x)$ are expressed as a series of piece-wise continuous functions of the form ax^b in ISCST2 for rural locations (the PGT sigmas), and are expressed as continuous functions for urban locations (the Briggs sigmas). Because it is necessary to evaluate $d\sigma_z/dx = G(\sigma_z)$ in Eqn. (II-62), the Briggs

curves are used for both rural and urban locations, as these produce continuous functions of $d\sigma_z/dx$. This model is quantitatively the same as ISCST2 for $x \leq x_o$ because Eqn. (II-62) only applies beyond x_o; and for larger x, the difference in $d\sigma_z/dx$ between the two rural curves is of secondary importance to maintaining the gravitational settling effect.

The Briggs curves have four generic forms:

Case 1

Rural: Stability A,B

Urban: Stability C

$$\sigma_z(x) = a\,x \tag{II-63}$$

$$\frac{d\sigma_z}{dx} = a = G(\sigma_z) \tag{II-64}$$

$$x = \int \frac{d\sigma_z'}{G(\sigma_z') - K} + \text{const} = \int \frac{d\sigma_z'}{a - K} + \text{const} \qquad \left(K = \sqrt{\pi/2}\; v_s/u\right) \tag{II-65}$$

Integrate and match $\sigma_z' = \sigma_{zo}$ at $x = x_o$, to obtain

$$\sigma_z'(x) = \left(a - \sqrt{\pi/2}\; v_s/u\right)(x - x_o) + \sigma_{zo} \tag{II-66}$$

Here it can be seen that σ_z' is a linear function of x, and σ_z' either continues to grow at a reduced rate, or it actually shrinks at a fixed rate if v_g/u is large enough.

Case 2

Rural: Stability E,F

$$\sigma_z = ax(1 + bx)^{-1} \tag{II-67}$$

$$\frac{d\sigma_z}{dx} = \frac{1}{a}(a - b\sigma_z)^2 = G(\sigma_z) \qquad (0 \leq \sigma_z \leq a/b) \tag{II-68}$$

$$x = \int \frac{d\sigma_z'}{\frac{1}{a}\left(a - b\sigma_z\right)^2 - K} + \text{const} \qquad \left(K = \sqrt{\pi / 2}\ v_s / u\right) \tag{II-69}$$

Integrate and match $\sigma_z' = \sigma_{zo}$ at $x = x_o$, to obtain

$$\left(x - x_o\right) = \frac{-a}{2b\sqrt{aK}} \ln \left[\frac{\left(\left(a - b\sigma_z'\right) - \sqrt{aK}\right)\left(\left(a - b\sigma_{zo}\right) + \sqrt{aK}\right)}{\left(\left(a - b\sigma_z'\right) + \sqrt{aK}\right)\left(\left(a - b\sigma_{zo}\right) - \sqrt{aK}\right)} \right] \tag{II-70}$$

Invert to obtain

$$\sigma_z'\left(x - x_o\right) = \frac{a}{b} - \frac{\sqrt{aK}}{b} \left[\frac{1 + \gamma\left(x - x_o\right)}{1 - \gamma\left(x - x_o\right)} \right] \tag{II-71}$$

where

$$\gamma\left(x - x_o\right) = \left[\frac{\left(a - b\sigma_{zo}\right) - \sqrt{aK}}{\left(a - b\sigma_{zo}\right) + \sqrt{aK}} \right] e^{-\frac{2b}{a}\sqrt{aK}\left(x - x_o\right)} \tag{II-72}$$

Eqns. (II-71) and (II-72) are more interesting than Eqn. (II-66) in that they allow σ_z' to reach equilibrium values where the local turbulent entrainment in the vertical is in balance with the bulk settling process.

Case 3

Rural: Stability C,D

Urban: Stability D,E,F

$$\sigma_z(x) = ax\left(1 + bx\right)^{-1/2} \tag{II-73}$$

$$\frac{d\sigma_z}{dx} = \frac{\sqrt{1 + \left[\frac{2a}{b\sigma_z}\right]^2}}{\frac{b\sigma_z}{2a^2}\left[1 + \sqrt{1 + \left[\frac{2a}{b\sigma_z}\right]^2}\right]^2} = G(\sigma_z) \qquad \text{(II-74)}$$

$$x = \int \frac{d\sigma_z'}{\frac{\sqrt{1 + \left[\frac{2a}{b\sigma_z}\right]^2}}{\frac{b\sigma_z}{2a}\left[1 + \sqrt{1 + \left[\frac{2a}{b\sigma_z}\right]^2}\right]^2} - K} + \text{const} \qquad \left(K = \sqrt{\pi/2}\, v_s/u\right) \qquad \text{(II-75)}$$

Due to the complexity of this integral, an approximate solution to the integral is developed by solving for large σ_z and small σ_z separately, and then matching the two solutions.

$$\text{Large Limit: } G(\sigma_z \gg 2a/b) = \frac{a^2}{2b\sigma_z} \qquad \text{(II-76)}$$

$$\text{Small Limit: } G(\sigma_z \ll 2a/b) = \frac{a}{\left[1 + \frac{b\sigma_z}{a}\right]^2} \qquad \text{(II-77)}$$

Note that these two forms of $G(\sigma_z)$ match at $\sigma_z = 2a/b$. Plots of $G(\sigma_z)$ versus σ_z show that Eqns. (II-76) and (II-77) provide a very good representation of Eqn. (II-74).

Develop the complete solution by solving

$$x = \int \frac{d\sigma_z'}{\frac{a^2}{2b\sigma_z} - K} + \text{const} \qquad (\sigma_z > 2a/b) \tag{II-78}$$

$$x = \int \frac{d\sigma_z'}{\frac{a}{\left[1 + \frac{b\sigma_z}{a}\right]^2} - K} + \text{const} \qquad (\sigma_z < 2a/b) \tag{II-79}$$

Then demand that $\sigma_z'(x_o) = \sigma_{zo}$, using the correct form of solution ($\sigma_{zo} > 2a/b$ or $\sigma_{zo} < 2a/b$) to determine one of the integration constants. The second integration constant is found by matching the solutions for σ_z' at $2a/b$. The result is an implicit equation in σ_z' for each region:

$$\sigma_z' > 2a/b: \quad \frac{\sigma_z' - \sigma_{zo} - \sigma_{zL} + K(x - x_o)}{-(a/K)^2 K/2b} = \ln\left|1 - \frac{2bK}{a^2}\sigma_z'\right| \tag{II-80}$$

$$\sigma_z' < 2a/b: \frac{\sigma_z' - \sigma_{zo} - \sigma_{zs} + K(x - x_o)}{-(a/K)^{3/2} K/b} = \ln\left|\frac{1 + \frac{b\sigma_z'}{2a} - \sqrt{a/K}}{1 + \frac{b\sigma_z'}{2a} + \sqrt{a/K}}\right| \tag{II-81}$$

where σ_{zs} and σ_{zL} are constants that depend on the size of σ_{zo} relative to $2a/b$:

$$\sigma_z > 2a/b: \quad \sigma_{zL} = (a/K)^2 \frac{K}{2b} \ln\left|1 - \frac{2bK}{a^2}\sigma_{zo}\right| \tag{II-82}$$
$$\sigma_{zs} = \sigma_{zL} - \Delta\sigma_z$$

$$\sigma_{zo} < 2a/b: \quad \sigma_{zs} = (a/K)^{3/2} \frac{K}{b} \ln\left|\frac{1 + \frac{b\sigma_{zo}}{2a} - \sqrt{a/K}}{1 + \frac{b\sigma_{zo}}{2a} + \sqrt{a/K}}\right| \tag{II-83}$$
$$\sigma_{zL} = \sigma_{zs} + \Delta\sigma_z$$

and where

$$\Delta\sigma_z = \frac{a^2}{2bK}\left[\left(1 - \sqrt{\frac{4K}{a}}\right)\ln\left|\sqrt{\frac{4K}{a}} - 1\right| + \left(1 + \sqrt{\frac{4K}{a}}\right)\ln\left(\sqrt{\frac{4K}{a}} + 1\right)\right] \quad \text{(II-84)}$$

Numerical iteration is used to solve these implicit equations for $\sigma_z'(x - x_o)$. The method chosen for this iterates directly on:

$$\sigma_z' = F\left(\sigma_z', x - x_o\right) \quad \text{(II-85)}$$

where $F(\sigma_z', x - x_o)$ is either a natural logarithm function or an exponential function, depending on which choice results in the condition for convergence:

$$\left|\frac{dF}{d\sigma_z}\right| < 1 \quad \text{(II-86)}$$

Case 4

Urban: Stability A,B

$$\sigma_z(x) = ax(1 + bx)^{1/2} \quad \text{(II-87)}$$

The function $G(\sigma_z)$ that corresponds to Eqn. (II-87) involves the solution of a cubic equation, which precludes a simple expression for the integral in Eqn. (II-62). Because the growth of σ_z is rapid for this case, the settling velocity will generally have a small effect on σ_z'. Therefore, the feedback embodied in Eqn. (II-62) is neglected, and Eqn. (II-59) is solved instead to obtain

$$\sigma_z' = \sigma_z(x) - \sqrt{\pi/2}\ v_s\ (x - x_o)/u \quad \text{(II-88)}$$

c. Implementation in ISC-COMPDEP

Adjustments to the mass of the plume, its distribution in the vertical, and the effective σ_z are characterized in terms of correction factors. This allows the effects of dry deposition to be calculated for either simple terrain or complex terrain models in one group of subroutines, controlled by a single call. This group is isolated from the central commons of ISC-COMPDEP, being passed all needed information through its argument-list. When complex

terrain adjustments are requested by setting a logical variable in the argument-list, the COMPLEX I adjustments are made by a subroutine taken directly from COMPLEX I.

The factor for the effective σ_z is defined as

$$\sigma_{zCOR} = \frac{\sigma_z'(x)}{\sigma_z(x)} \tag{II-89}$$

Likewise, the source depletion factor is defined as

$$Q_{COR} = \frac{Q(x)}{Q_o(x)} \tag{II-90}$$

and evaluated by Eqn. (II-45). The profile correction factor was defined in Eqn. (II-51):

$$P_{COR} = P(x,z) \tag{II-91}$$

Substantial terrain effects can complicate the integrals needed for Q_{COR}, because the local terrain elevation must be known at each point in the integral in order to compute the deposition flux. In the simplest application, the local terrain elevation is interpolated between that at the source and that at the receptor (the end-point of the path of integration). Terrain for most applications is not sufficiently smooth for this type of characterization. For example, both the source and receptor may be at nearly the same elevation, but the path of integration may encounter a hill between them.

To better resolve the influence of terrain on the mass depletion due to dry deposition, a file of gridded terrain elevations may be used in ISC-COMPDEP. The gridded data are interpolated to obtain the elevation at any point in the modeling domain (defined as that rectangular region which contains all sources and receptors in the simulation). The gridded terrain file may be specified on a new pathway (TG), as described in Section III.

G. Wet Deposition

A scavenging ratio approach is used to parameterize the wet removal of gases and particles. In this model, the flux of material to the surface is the product of a scavenging ratio times the concentration, integrated in the vertical:

$$F_w(x,y) = \int_o^{\infty} \Lambda\ C(x,y,z)\ dz \qquad \text{(II-92)}$$

where the scavenging ratio (Λ) has units of s^{-1}. Across the plume, the total flux to the surface must equal the mass lost from the plume so that

$$-\frac{d}{dx}\ Q(x) = \int_{-\infty}^{+\infty} F_w(x,y)\ dy = \Lambda\ Q(x)/u \qquad \text{(II-93)}$$

Solving this equation for $Q(x)$, the source depletion relationship is obtained:

$$Q(x) = Q_o\ e^{-\Lambda x/u} = Q_o\ e^{-\Lambda t} \qquad \text{(II-94)}$$

As with dry deposition (Section II.F), the ratio $Q(x)/Q_o$ is computed as a wet depletion factor.

It is assumed in the ISC-COMPDEP model that the plume is subject to wet removal whenever precipitation is occurring, even when the plume may be above the mixing height. Even though the plume may be elevated, and the ground level pollutant concentration low or zero, the plume is assumed to be within or below cloud base, and thus subject to wet scavenging.

The scavenging ratio is computed from a scavenging coefficient and a precipitation rate (e.g., Scire et al.
1995):

$$\Lambda = \lambda(R/R_1) \qquad \text{(II-95)}$$

where the coefficient λ has units s^{-1}, the precipitation rate R has units (mm/hr), and R_1 is a reference precipitation rate of 1 mm/hr. The scavenging coefficient depends on the characteristics of the pollutant (e.g., solubility and reactivity for gases, size distribution for particles) as well as the nature of the precipitation (e.g., liquid or frozen). Jindal and Heinold (1991) have analyzed particle scavenging data reported by Radke et al. (1980), and found that the linear relationship of Eqn. (II-95) provides a better fit to the data than the nonlinear assumption $\Lambda = \lambda R^b$. Furthermore, they report best-fit values for λ as a function of particle size. These values of the scavenging coefficient are displayed in Figure II-4. Jindal and Heinold (1991) suggest that λ should reach a plateau beyond 10 μm, which is why the curve is flat beyond 10 μm in Figure II-4. Figure II-5 shows the correspondence between scavenging ratios computed with Eqn. (II-95) and those determined by Radke et al.

(1980) from observations. The scavenging coefficients for frozen precipitation are expected to be reduced to about 1/3 of the values in Figure II-4 based on data for sulfate and nitrate.

National Weather Service (NWS) meteorological stations typically report hourly precipitation codes describing the type of precipitation. ISC-COMPDEP uses this precipitation code to determine if the value of λ for liquid or frozen precipitation is most appropriate. The reported precipitation code is related to precipitation type as shown in Table II-1. The liquid precipitation values are used for precipitation codes 1-18, and frozen precipitation for precipitation codes 19–45. If the precipitation code is missing, the ambient temperature, T_a, is used as a surrogate ($T_a < 32°F$, frozen precipitation is assumed, otherwise liquid precipitation is assumed).

The approach to specifying the scavenging ratio for particles used in ISC-COMPDEP is similar to that used in the COMPDEP model (after Bowman et al. 1987). However, Bowman et al. group Λ-values into three particle size ranges, and three precipitation rate categories. Therefore, the linear trend in Λ with precipitation rate is not resolved as well since all precipitation rates within a category use one value. Furthermore, the default COMPDEP scavenging coefficients use a single value of Λ for all precipitation rates in the largest of the three particle size classes. See Section II.L for a discussion of the differences between ISC-COMPDEP and COMPDEP.

H. Complex Terrain

The Environmental Protection Agency (U.S. EPA), through its Office of Air Quality Planning & Standards (OAQPS), provides guidance on the application of air quality models for regulatory purposes. Several dispersion models are considered "Guideline models" by the U.S. EPA (U.S. EPA 1993a), and results from these models, when properly applied, are accepted for use in decision-making without a site-specific validation program. Among several classifications which are used to establish the preferred modeling approaches, one is the classification of the terrain surrounding a facility that must be modeled. Terrain is considered "simple" if it does not rise above the height at which pollutant plumes are emitted into the atmosphere (i.e., the stack height). Terrain is considered "complex" if it rises above the stack height. By this definition, the terrain may appear "simple" for some sources, and "complex" for others. Because modeling techniques differ for simple terrain and complex terrain applications, the U.S. EPA has determined that the use of either model should be decided on a source-by-source and receptor-by-receptor basis. Receptors located at a height below the stack height for a source are modeled with the simple terrain model. Those located above the effective plume height after accounting for momentum and buoyant plume rise are modeled with the complex terrain model. Receptors that fall between these two heights are characterized as "intermediate," rather than as either simple or complex, and

are modeled with both simple and complex terrain models, and the larger modeled concentration used in subsequent analyses and decisions.

The result of this approach is that the correct model for a particular source and a particular receptor during a particular hour depends on the height of the receptor relative to the stack height of the source and the modeled plume height for that hour. Because plume rise, and therefore the effective plume height, depends on meteorological conditions, the model selected may change from hour-to-hour. A further complication: because stack heights vary from source-to-source, the model selected for one source may not be the model selected for another. An illustration of how the definition of terrain varies with source and plume heights is shown in Figure II-6.

This figure shows a cross-section of terrain downwind of two sources. Ten receptors located on the terrain are identified, and the centerline of the plume from each source is marked by a solid line. These plumes are not deflected by the terrain in this figure, because this schematic only depicts the process of selecting the appropriate model, rather than depicting the treatment of plumes within a model. Table II-2 summarizes the choice of the appropriate type of model for each combination of source and receptor. The dotted lines in the figure mark the height of each of the stacks. Receptors 2, 3, 4, and 5 all lie at heights equal to or less than the shorter stack, so that concentrations at these receptors are always obtained from a simple terrain model, regardless of the calculated plume heights. Receptors 1 and 6 lie below the top of the taller stack (Source 1), so that the simple terrain model is used to estimate concentrations at Receptors 1 and 6 that are the result of emissions from Source 1. But the concentrations that result from emissions from Source 2 must be estimated by both a simple terrain model and a complex terrain model, because these receptors lie between stack-top and plume height (intermediate terrain). The larger concentration modeled at each receptor is retained, and added to the concentration due to Source 1 to obtain the total concentration estimate at Receptors 1 and 6. Receptors 7 and 10 lie above the plume height for Source 2, and so concentrations due to Source 2 are estimated by the complex terrain model. These receptors lie between stack-top and plume height for Source 1, so concentrations due to Source 1 must be estimated by both the simple and complex terrain models, with the larger concentration retained and added to the concentration due to Source 2 at each receptor. The remaining two Receptors, 8 and 9, lie above the height of both plumes, so concentrations at these receptors are estimated by the complex terrain model.

Note that the simple terrain model is <u>always</u> used for Receptors 2, 3, 4, and 5; both simple terrain and complex terrain models are used for Receptors 1, 6, 7, and 10, depending on which source is being modeled. For the particular plume heights chosen for this illustration, concentrations at Receptors 8 and 9 are obtained from the complex terrain model alone. Therefore, it is apparent that the use of just a simple terrain model, or just a complex

terrain model, at a particular receptor cannot be guaranteed. With the exception of those receptors that lie below height of the shortest stack, or those that lie above the height of the greatest conceivable plume-height, both models will be needed to implement the procedure for estimating concentrations at intermediate terrain heights.

To streamline the treatment of terrain, and to broaden the application of the modeling assumptions, simple terrain and complex terrain modeling algorithms were combined in ISC-COMPDEP, so that the intermediate terrain processing could be completed in one application of the model. A Guideline model for simple terrain is ISCST2 and a Guideline complex terrain model is COMPLEX I. ISCST2 serves as the base for ISC-COMPDEP, so its terrain treatment was already in place. The COMPLEX I model was prepared as a callable module or subroutine for use in ISC-COMPDEP. The COMPLEX I module in ISC-COMPDEP was implemented in regulatory default mode. The intermediate terrain processing algorithm was embedded in ISC-COMPDEP, and one or both terrain algorithms are called as required. The primary differences in the way these models simulate the effect of terrain on ground-level concentrations are outlined below.

1. ISCST2 Terrain Treatment

ISC is not intended for use in situations in which receptors are placed on terrain that exceeds the height of the "stack." Any receptors that are found above this height are lowered to a height that is 0.005 m below the height of the stack. This is done hourly for each source in the simulation, and is therefore source-specific. The mixing height is not adjusted for the presence of any terrain feature, and the result of any downwash calculations does not modify the stack height used to determine the height of the receptor. Once the receptor height is determined, the vertical distribution factor contains the difference in elevation between the centerline of the plume and the receptor. In effect, the centerline of the plume is lowered by an amount equal to the modified elevation of the receptor above the base of the stack.

2. COMPLEX I Terrain Treatment

COMPLEX I is a screening model for use in complex terrain. It uses 22.5° sector-averaging rather than the Gaussian lateral distribution function, and it employs the partial height correction method to simulate the effect of terrain. The height of the plume at a receptor depends on the height of the plume over level terrain (which is taken to be the height of the plume above the elevation at the base of the stack from which the plume was released), the receptor height (above the base of the stack), and the plume path coefficient (which depends on the stability class). Values for the plume path coefficient are typically $C = 0.0$ for stable (classes E and F), and

$C = 0.5$ for the rest (classes A, B, C, and D). The "half-height" correction model is equivalent to $C = 0.5$.

Let z_s be the elevation of the base of the stack above sea level, and z_r be the elevation above sea level at the receptor. Furthermore, let h_s be the height of the plume at the source, and h_r be the height of the plume at the receptor. If the elevation at the receptor exceeds the elevation of the centerline of the plume at the source,

$$h_r = h_s \cdot C \tag{II-96}$$

If the elevation at the receptor lies below the centerline of the plume at the source,

$$h_r = h_s - (z_r - z_s) \cdot (1 - C) \tag{II-97}$$

In either case, h_r is not allowed to be less than some minimum value, which is typically set at 10 m. Note that $z_r \geq z_s$ is assumed in the above equation, so that the terrain-following plume result is obtained ($C = 1$) if the terrain on which the receptor sits lies below the elevation of the base of the stack. The mixing height is not altered unless $C = 0.0$, in which case the mixing height is reset to 5000 m to simulate unlimited mixing.

When $C = 0.0$, the full difference between the plume height and the receptor height is obtained, subject to the specified minimum. This gives the appearance of keeping the plume level, and is therefore known as the level-plume treatment. It also results in sending the plume over all terrain greater than plume height, which is not consistent with the behavior of plumes in stably-stratified flows. Therefore, the "400-m correction" factor originally used in the Valley model (Burt 1977) is applied. This factor, which varies linearly from 1.0 at the plume centerline height to 0.0 at 400 m above the plume centerline height, is applied to the concentration estimate to reduce reported concentrations to zero on all terrain that lies at least 400 m above the height of the plume.

I. Treatment of Calm Wind Conditions

Calm conditions are typically defined as those periods in which the measured wind speed is less than 1 m/s. U.S. EPA guidance (U.S. EPA 1993a) on applying plume models suggests that predicted concentrations become unrealistically large when wind speeds less than 1 m/s are input to a plume model, and such predictions are not considered valid. Therefore, the procedure adopted by the U.S. EPA is to "skip" all calm hours in a meteorological record when calculating hourly average concentrations, and to remove most

such hours from multiple-hour averages (e.g. 24-hour averages). When an hour is skipped, all concentrations for the hour remain at their initial value: zero. If the calm hours were included in multiple-hour averages, these zeros would artificially reduce the magnitude of the average for the period, since non-zero concentrations are expected to occur during the calm hours. However, a minimum number of hours is also set for each averaging period. These are: 18 in a 24-hour period, 6 in an 8-hour period, and 3 in a 3-hour period. No such minimum number of hours is specified for an annual average, so all calm hours are ignored when forming the annual average. ISC-COMPDEP implements this U.S. EPA-recommended procedure.

As an example of this regulatory scheme to deal with calm winds, assume that 2 days in a non-leap-year have calm hours; Day 113 has calms reported 2 hours, and Day 267 has 23 hours reported as calm (Hours 1-23). The annual average would be the arithmetic average of all 8735 concentrations calculated for the non-calm hours. However, on Day 113, the 24-hour average would consist of the arithmetic average of all 22 concentrations calculated for the non-calm hours in the day. However, on Day 267, the 24-hour average would consist of the concentration for Hour 24 divided by 18 (the minimum number of hours required) because only 6 calm hours in a 24-hour period may be excluded, and the remaining 17 calm hours contribute zero concentrations to the average.

J. Treatment of Multilevel, Multistation Meteorological Data

In response to peer reviewer's comments, changes made to ISC-COMPDEP allow it to accept vertical profiles of wind speed, wind direction, and temperature measured at one location. This is a significant departure from ISC2 and COMPLEX I, the component models of ISC-COMPDEP, which assume that wind and temperature data are available from only one height above the surface, at one location. Implementation of the vertical profiles allows the model to respond to potential "layered" flow situations in that plume rise is calculated iteratively using the mean wind speed and temperature gradient within the portion of the atmosphere through which the plume rises. (Prior versions of the model use a stability-class-dependent temperature gradient, and they extrapolate the wind speed to stack-top to characterize the mean speed for plume rise calculations, using a stability-class-dependent power law exponent.) Furthermore, the wind speed used for transport and dilution in the new version is obtained at plume height, rather than at stack-top. The direction of transport is obtained at the final (equilibrium) plume height. However, even with the multilevel capabilities, the plume trajectory in ISC-COMPDEP is still assumed to be a straight-line (i.e., the plume does not respond to changes in the flow field along its trajectory).

The changes to ISC-COMPDEP allow vertical layering in the temperature and wind fields (as resolved by a nearby instrumented tower) to influence plume rise and transport

(both speed and direction). An iterative approach similar to that used in CTDMPLUS (Perry et al. 1989) allows the plume rise equations of ISC2 to make use of the average wind speed and temperature gradient across the region through which the plume rises. The iteration is done as follows:

- Interpolate wind speed at stack-top (assign to new variable, UST)
- Set new variable UMEAN equal to UST (for now)
- Calculate final plume height (final rise) using stack-top wind speed and the default temperature gradient
- Perform iteration

    - Calculate a layer-average speed between stack-top and final rise (assign to UMEAN)
    - Interpolate T at current estimate of final plume height
    - Calculate the mean $d\theta/dz$ from stack-top to final plume height (impose a minimum value of 0.01 deg/m)
    - Recalculate final plume height
    - Average new and old plume height estimates to obtain final rise
    - Calculate a layer-average speed between stack-top and final rise (assign to UMEAN)
    - Interpolate T at current estimate of final rise
    - Calculate the mean $d\theta/dz$ from stack-top to final plume height (impose a minimum value of 0.01 deg/m)
    - Recalculate final plume height and compare with previous value
    - Repeat all steps again until the change in plume height is less than 1% (i.e., until the mean wind speed and temperature gradient are consistent with the plume rise)

If the iteration fails to find a plume height consistent with the temperature and wind speed profiles, an "information" message is sent to the error log, and UMEAN is set equal to UST, but the mean temperature gradient from the last iteration is retained (and the final plume height is recalculated). Once the process is completed, the wind direction is interpolated at final plume height (DIRS). The transport wind speed (US) is interpolated to plume height (transitional or final).

The wind at stack-top (UST) is used for stack-tip downwash and building downwash calculations, and for computing transitional rise. The average wind in the layer over which the plume rises (UMEAN) is only used in computing the distance to final rise and the final rise height (which also limits the transitional rise height). The wind direction at final rise determines the plume transport direction (the wind direction in the file of surface meteorological data is used in the direction-specific building downwash calculations). The wind speed (US) at transitional or final plume height, depending on the receptor location (i.e., downwind distance), is used in the remainder of the code for transport and dilution. There is no attempt to segment the plume, allowing it to track changes in wind direction as it rises. Furthermore, integrations over distance from the source to a receptor, which are required for plume depletion due to dry deposition, use the plume height and wind speed (US) that are appropriate for the receptor location for all distances in the integral. This is consistent with the intuitive expectation that dry deposition is negligible while the "lower edge" of the plume remains elevated above the surface, as it generally does during transitional rise.

1. Interpolation Methods

The methods used by ISC-COMPDEP to interpolate and extrapolate temperature data obtained from the observed profile is illustrated in Figure II-7. Within the range of observed data points (indicated by the asterisks in the figure), the temperature is interpolated linearly. Beyond the range of the observed points (e.g., below 20 m and above 150 m in the illustration), the temperature gradient (dT/dz) is extrapolated using a straight line fit through the nearest two points. In the figure, the solid lines show the region of interpolation, and the dashed lines show the extrapolated region.

The wind speed is handled in the same way as temperature (linear interpolation within the range of data points, and extrapolation of the rate of change outside the range of data), except for heights less than 10 m (see Figure II-8). Following the convention in the regulatory model ISC2, wind speeds extrapolated to heights less than 10 meters are assigned the 10-meter wind speed value. That is, the wind speed at heights below 10 meters is assumed constant at the value measured at 10 meters or extrapolated down to 10 meters from a higher anemometer height.

Figure II-9 shows the extrapolation of wind direction data. Within the vertical range of the observed data, the wind direction is interpolated linearly between the observed data points. Above the top observational point and below the lowest observational point, the wind directions are persistent at their "edge" values.

K. Micrometeorological Parameters

Applications of ISC-COMPDEP that do not involve either wet or dry deposition may use meteorological data files described in the ISC2 users guide. For dry deposition, additional parameters such as the surface friction velocity (u_*), Monin-Obukhov length (L), and surface roughness length (z_o) must be added to the meteorological data file; also, wet deposition requires an hourly precipitation code, and a precipitation rate (mm/hr). These can be provided by the meteorological processor called DEPMET. Note that the hourly precipitation rate is obtained from running the PMERGE program, which is part of the CALPUFF system of processors (Scire et al. 1995).

DEPMET combines a file of standard meteorological data (for ISCST2) in either binary or ASCII form with cloud data (either CD144 format or free format) and precipitation data (either binary or ASCII from the PMERGE processor) to estimate the surface heat flux, and to provide precipitation rates. The methods of Holtslag and van Ulden (1983) are used to estimate solar radiation and surface sensible heat flux from these routinely-available meteorological data and surface (land use) data. The Holtslag-van Ulden scheme has been implemented into the HPDM model (Hanna and Chang 1991), extensively compared and tested with field data (e.g., Hanna and Chang 1992), and has been shown to produce reasonable results. Therefore, the techniques used in the HPDM meteorological preprocessor are used to produce the micrometeorological variables required in ISC-COMPDEP.

1. Unstable/Neutral Conditions

The energy balance at the surface can be written as:

$$Q_* + Q_f = Q_h + Q_e + Q_g \qquad \text{(II-98)}$$

where Q_* is the net all-wave radiation (Watts/Meter^2 or W/m^2),

Q_f is the anthropogenic heat flux (W/m^2),

Q_h is the sensible heat flux (W/m^2),

Q_e is the latent heat flux (W/m^2), and

Q_g is the ground/storage heat flux (W/m^2).

Holtslag and van Ulden (1983) provide the following parameterization of the net radiation term:

$$Q_* = \frac{(1-A)Q_{sw} + c_1 T^6 + c_2 N - \sigma T^4}{1 + c_3} \qquad \text{(II-99)}$$

$$Q_{sw} = (a_1 \sin\phi + a_2)(1 + b_1 N^{b2}) \qquad \text{(II-100)}$$

$$c_3 = 0.38 \left[\frac{(1-\alpha)(S)+1}{S+1} \right] \qquad \text{(II-101)}$$

where T is the measured air temperature (K),

A is the albedo,

σ is the Stefan-Boltzmann constant (5.67×10^{-8} W/m^2/K^4),

N is the fraction of the sky covered by clouds,

ϕ is the solar elevation angle (deg.),

α is an empirical surface moisture parameter, and,

S is the slope of the saturation enthalpy curve [$S = s/\gamma$], where

$s = \partial(q_s)/\partial(T)$ and $\gamma = c_p/L$,

q_s is the saturation specific humidity, and,

c_p is the specific heat at constant pressure (996 m^2/(s^2 K)).

The four terms in the numerator of Eqn. (II-99) account for absorption of short-wave radiation at the surface, incoming long-wave radiation from gaseous components of the atmosphere (e.g., water vapor and carbon dioxide), incoming long-wave radiation due to clouds, and outgoing long-wave radiation from the surface, respectively. The factor in the denominator ($1 + c_3$), results from the use of air temperature rather than the more difficult-to-determine surface radiation temperature in the equation. The term in the first set of parentheses in Eqn. (II-100) represents short-wave solar radiation in the absence of clouds. The second term ($1 + b_1 N^{b2}$), accounts for the reduction of incoming solar radiation due to clouds (b_1 is negative). The values for the empirical constants c_1, c_2, a_1, a_2, b_1, and b_2 suggested by Holtslag and van Ulden (1983) are shown in Table II-3.

The flux of heat into the ground or storage in surface materials, Q_g, is usually parameterized during the daytime as a fraction of the net radiation (e.g., DeBruin and Holtslag, 1982; Oke, 1978).

$$Q_g = c_g Q_* \qquad \text{(II-102)}$$

where c_g is an empirical coefficient which depends on the properties of the surface. Holtslag and van Ulden (1983) obtained a value of c_g of 0.1 for a grass covered surface in the Netherlands. Oke (1982) indicates that typical ranges for c_g are 0.05 to 0.25 in rural areas, 0.20 to 0.25 in suburban areas, and 0.25 to 0.30 in urban regions and suggests that typical values of c_g are 0.15, 0.22, and 0.27 for rural, suburban, and urban areas, respectively. The anthropogenic heat flux, Q_f, can usually be neglected, except in highly urbanized areas.

The sensible heat flux, Q_h, and latent heat flux are determined by Holtslag and van Ulden (1983) as:

$$Q_h = \left[\frac{(1-\alpha)+S}{S+1}\right] (Q_* + Q_f - Q_g) - (\alpha)(\beta') \quad \text{(II-103)}$$

$$Q_e = \left[\frac{\alpha}{S+1}\right] (Q_* + Q_f - Q_g) + (\alpha)(\beta') \quad \text{(II-104)}$$

where β' is an empirical coefficient ($\simeq$ 20 W/m^2).

Typical values of α, based on empirical data of Holtslag and van Ulden and summarized by Hanna and Chang (1991) are:

α = 0.2 (arid rural areas)

α = 0.5 (urban areas, some parks, crops and fields during mid-summer when rain has not fallen for several days)

α = 0.8 (crops, fields, or forest with sufficient moisture)

α = 1.0 (normal wet grass in a moderate climate)

In neutral and unstable conditions, the following relationship developed by Wang and Chen (1980) is used in HPDM and other models such as MESOPUFF II to compute the friction velocity.

$$u_* = \frac{ku}{\ln[(z-d)/z_o]}\left[1 + d_1 \ln(1 + d_2\, d_3)\right] \quad \text{(II-105)}$$

where

$$d_1 = \begin{cases} 0.128 + 0.005\ln(z_o/z) & z_o/z \le 0.01 \quad \text{(II-106)} \\ 0.107 & z_o/z > 0.01 \quad \text{(II-107)} \end{cases}$$

$$d_2 = 1.95 + 32.6(z_o/z)^{0.45} \quad \text{(II-108)}$$

$$d_3 = \frac{Q_h}{\rho c_p}\frac{k\,g\,z}{T u_{*n}^3} \quad \text{(II-109)}$$

The term $d_1\ln(1 + d_2 d_3)$ represents the correction due to instability, $u_{*n} = ku/[\ln(z - d)/z_o]$, k is the von Karman constant (~ 0.4), and d is the displacement height (m).

Hanna and Chang (1990, 1992) tested the analytical formula against values produced by the iterative solution of u_* and L. They found that the Wang and Chen (1980) expression produced values within 10% of the results determined by the iterative solution for z = 10 m, d = 0, z_o = 1 m, and a large value of Q_h (400 W/m^2). Better agreement was found for smaller roughness elements and smaller sensible heat fluxes. In addition, the analytical solution was computationally significantly faster.

The Monin-Obukhov length can then be computed directly from its definition once u_* is determined from Eqn. (II-105) and Q_h from Eqn. (II-103).

$$L = -\frac{u_*^3 T \rho c_p}{k g Q_h} \qquad \text{(II-110)}$$

2. Stable Conditions

The Weil and Brower (1983) method for estimating u_* is used in ISC-COMPDEP during stable conditions. A first estimate of the scaling temperature, θ_*, is calculated using Holtslag and Van Ulden's (1983) equation:

$$\theta_{*1} = 0.09(1 - 0.5N^2) \qquad \text{(II-111)}$$

where N is the total fractional cloud cover and θ_* has units of K. Another estimate of θ_* is made from the profile equation for temperature:

$$\theta_{*2} = \frac{T C_{dn} u^2}{18.8 z g} \qquad \text{(II-112)}$$

where the neutral drag coefficient C_{dn} is defined as $k/\ln[(z - d)/z_o]$, and θ_* is set equal to the smaller of θ_{*1} and θ_{*2}.

The sensible heat flux, Q_h, is defined during stable conditions as:

$$Q_h = -\rho c_p u_* \theta_* \qquad \text{(II-113)}$$

For large values of u (or u_*), θ_{*1} (which depends only on cloud cover) is smaller than θ_{*2}, but an additional check on the product $u_*\theta_*$ must be made, since Q_h does not keep

increasing indefinitely with higher wind speeds. In HPDM, the value of θ_* is not allowed to exceed $0.05/u_*$, where the numerator has units of K m/s and the denominator has units of m/s. This limit is estimated from observations of heat fluxes during high-wind, stable conditions.

The friction velocity, u_*, can be calculated from:

$$u_* = \frac{C_{dn}u}{2}\left[1 + \left[1 - \left[\frac{2u_o}{C_{dn}^{1/2}u}\right]^2\right]^{1/2}\right] \qquad \text{(II-114)}$$

where $u_o = (4.7zg\theta_*/T)^{1/2}$

Because θ_* is set equal to the smaller of θ_{*1} and θ_{*2}, the following condition is always met:

$$\frac{2u_o}{C_{dn}^{1/2}u} \leq 1 \qquad \text{(II-115)}$$

During stable conditions, Hanna and Chang (1992) suggest a lower limit on L in recognition of the fact that the atmosphere is less stable over urban areas than over rural surfaces. Their suggested values for use for the various land use categories defined in the Auer (1978) scheme are shown in Table II-4.

L. Differences Between the COMPDEP and ISC-COMPDEP Model Formulations

The original project plan called for the use of the COMPDEP model to evaluate concentration and deposition fluxes due to emissions from the WTI facility. However, ISC-COMPDEP has been developed in a parallel effort, and contains more refined algorithms for treating advection, dispersion, and deposition processes. Therefore, ISC-COMPDEP has replaced COMPDEP in this risk assessment. A discussion of the most significant differences in the models is contained in Schwede and Scire (1994). Since that paper was written, however, addition enhancements have been made to ISC-COMPDEP to address the points raised by the peer review panel. In this section, a brief overview of the differences in the current versions of the COMPDEP and ISC-COMPDEP models is provided.

COMPDEP and ISC-COMPDEP contain many similarities because they were both developed to implement U.S. EPA's policy on simple, intermediate, and complex terrain.

Both models use the basic algorithms in the ISC2 model to evaluate impacts in simple terrain. Both models use the algorithms in COMPLEX I for complex terrain receptors, and they both select the higher of the ISC2 or COMPLEX I estimates for intermediate terrain receptors on a hour-by-hour, receptor-by-receptor, and source-by-source basis. COMPDEP and ISC-COMPDEP both contain reasonable sophisticated (but different) dry deposition and plume depletion models. They also both contain a wet removal scheme based on a scavenging coefficient approach (although it is implemented differently).

COMPDEP was developed using the COMPLEX I model code as a starting point, and a module reproducing the main features of ISC2 was added. ISC-COMPDEP, however, used the latest version of the ISC2 model as a starting point. This was done to take advantage of the features available in ISC2 but not in COMPLEX I. Included in this list are:

- urban and rural dispersion coefficients,
- volume sources,
- new area source algorithm,
- flexible output options, including short-term averaging capabilities,
- revised building downwash procedures, and
- new dry deposition module for particulate matter.

As a result of the developmental history of the models, some of the technical algorithms contain differences. These are summarized below.

1. Building Downwash

COMPDEP contains a building downwash algorithm that was used in an older version of ISC (Bowers et al. 1979). It is based of the work of Huber and Snyder (1976). A few years ago, U.S. EPA modified ISC to include the Schulman-Scire downwash algorithm for short stacks. (ISC was later re-coded to develop ISC2). The Huber-Snyder scheme is still used for taller (but still sub-Good Engineering Practice (GEP) height) stacks. COMPDEP does not contain the Schulman-Scire downwash algorithm, but rather uses the Huber-Snyder scheme for all downwash cases. ISC-COMPDEP contains a full implementation of the currently-recommended building downwash algorithms. See Section II.D for details. This difference in the models can result in possible underprediction of the effect of building downwash by COMPDEP for short stacks. Based on the building analysis, it appears that the WTI incinerator would not be affected by this difference in the models. It is high enough to use the Huber-Snyder method. However, some of the fugitive emission sources at WTI are affected by building downwash, and they are short enough that current U.S.

EPA guidance calls for the use of the Schulman-Scire method. The impacts from these sources could be underestimated with COMPDEP.

Another difference in COMPDEP and ISC-COMPDEP is that COMPDEP allows only one set of building dimensions to be entered. Because they are used for all wind directions, usually the worst-case building dimensions are used. ISC-COMPDEP allows direction-specific building dimensions to be entered. The lack of a direction-specific building dimension option in COMPDEP is a conservative feature of the model, which could lead to an overprediction of building effects under some conditions.

2. Dry Deposition

COMPDEP contains a dry deposition module for particulate matter based on the work of Sehmel and Hodgson (1978) and Sehmel (1980). This scheme was coded by the California Air Resources Board (CARB) and is sometimes known as the CARB scheme. The basis for the model is a set of wind tunnel deposition measurements of monodispersed particles to a variety of low-roughness length surfaces. The deposition equations are empirical curve fits of the data, and express the deposition velocity as a function of particle size, particle density, surface roughness length, and friction velocity.

The plume depletion scheme in COMPDEP is a K-theory method based on Rao (1981). It accounts for the removal of the pollutant from the plume at the surface, and computes the remaining pollutant mass as a function of upwind removal. It can account for particle settling due to gravitational effects. One of the assumptions necessary to solve the gradient transfer equation in this method is that the dispersion coefficients vary as a function of $x^{1/2}$. Since this is not necessarily consistent with the empirical dispersion coefficients in the COMPDEP model, the K-theory scheme does not always conserve mass exactly. However, in practice for many combustion sources such as the WTI incinerator, mass conservation problems in the COMPDEP plume depletion scheme are likely to be small.

ISC-COMPDEP uses a resistance-based particle deposition module derived from the Acid Deposition and Oxidant Model (ADOM) (Pleim et al. 1984) and modified for the CALPUFF model. It computes gravitational settling, inertial impaction, and Brownian motion effects (see Section II.F.1). The deposition velocities are functions of the particle size, density, surface roughness, friction velocity, and atmospheric stability. Both the COMPDEP and ISC-COMPDEP deposition schemes produce qualitatively similar deposition curves as a function of particle diameter (see Schwede and Scire 1994). However, their quantitative

predictions can be different. Generally (but not always), the COMPDEP scheme produces higher deposition velocities in the intermediate size range (0.1 μm diameter up to 10 μm diameter). ISC-COMPDEP can produce higher values for very small particles ($< \sim 0.05$ μm diameter). The deposition velocities from both models approach the gravitational settling velocity as the particle size becomes large.

The ISC-COMPDEP model uses the modified source depletion method of Horst (1983) to compute plume depletion effects. The Horst equations were extended for use in ISC-COMPDEP for stability classes A and B (which were not solved in his paper). The modified source depletion method, described in detail in Section II.F.2, uses a profile correction factor to adjust the vertical distribution of the pollutant for removal at the surface. The resulting vertical pollutant distribution takes on a non-Gaussian shape. The Horst scheme conserves mass exactly. It was found by Doran and Horst (1985) to compare very well with the reference surface depletion method (Horst 1977), but requires only a small fraction of the computational time of the surface depletion scheme.

One feature of ISC-COMPDEP that is not in COMPDEP is the ability to specify a detailed, gridded field of terrain heights. This allows ISC-COMPDEP to compute the effects of enhanced deposition due to the interaction of terrain features with the plume. The terrain data are specified independently of the receptor field, and the depletion effect is evaluated regardless of whether receptors are placed on the terrain. This is done because the depletion effect is cumulative, and it will influence concentrations at receptors further downwind.

3. Micrometeorological Parameters

The COMPDEP model internally estimates the surface friction velocity (u_*) and Monin-Obukhov length (L) from meteorological information already provided to the model. The Monin-Obukhov length is approximated as a function of the stability class and surface roughness length using Golder (1972). The friction velocity is then computed from the wind speed, surface roughness length, and Monin-Obukhov length using the integral form for the flux profile relationship (McRae 1981).

ISC-COMPDEP relies on externally-computed values of u_* and L that are supplied to it in the hourly meteorological file. The DEPMET processor (see Section II.K) is provided with ISC-COMPDEP for this purpose. DEPMET uses the energy balance method of Holtslag and van Ulden (1983) to compute sensible heat fluxes at the surface. An empirical method of Wang and Chen (1980) is used to compute the friction velocity. Once the heat flux and deposition velocity is known, L can be computed directly from its definition. The algorithms in DEPMET are derived from

the HPDM model (Hanna and Chang 1990). They found that the friction velocities computed from the Wang and Chen method were generally within 10% of the results determined by a fully iterative solution of the u_* and L equations. The best agreement was found for smaller roughness elements and smaller sensible heat fluxes. Overall, Hanna and Chang found good agreement of the predicted values of the friction velocity and heat fluxes with observational data.

In comparing the values of u_* predicted by the COMPDEP and the ISC-COMPDEP (DEPMET) methods, Schwede and Scire (1994) noted that the COMPDEP scheme tended to produce smaller values of u_* than those from DEPMET. Since the deposition models in COMPDEP and ISC-COMPDEP are both sensitive to the value of u_*, the COMPDEP meteorological technique is likely to lead to smaller values of deposition velocity, with other factors being held constant.

4. Wet Deposition

Both COMPDEP and ISC-COMPDEP use a scavenging coefficient approach to estimate wet removal. However, COMPDEP divides the scavenging coefficients into a matrix of values as a function of a particle size category and precipitation intensity category. COMPDEP uses an intermittence (F) factor which reduces the wet flux to account for unsteady precipitation. F serves as a multiplier of the wet flux estimates. The values for F in the COMPDEP Overview Document provided by U.S. EPA recommend F = 1.0 (steady precipitation), 0.5 (showers) and 0.25 (thunderstorms or squalls).

ISC-COMPDEP computes the scavenging ratio as a continuous function of the precipitation rate. The scavenging coefficient for each particle size category is specified separately in ISC-COMPDEP. ISC-COMPDEP does not explicitly include intermittency effects, but rather uses the cumulative precipitation measured during the hour to compute the scavenging ratio. It allows different scavenging coefficients for liquid and frozen precipitation. It is suggested that the values of the scavenging coefficients for frozen precipitation are about one-third of those for liquid precipitation, although this is based on very limited data for sulfate and nitrate (Scire et al. 1984).

The scavenging coefficient method in both models allows only a rough parameterization of the complex processes involved in wet scavenging. It is likely that the technique significantly overestimates wet deposition fluxes in the near field of the source. The reasons for this are discussed in Section IV.D.1.

5. Plume Rise and Transport

One of the enhancements made to the ISC-COMPDEP model in response to the peer review was the introduction of multilayered meteorological data (winds and temperatures). This is discussed in detail in Section II.J. This feature allows, for example, plumes from low-level fugitive sources released within the valley to be channelled with the valley flow, while the incinerator plume, that may have risen above the valley walls, to be transported with the gradient, or above-valley, winds. In the multilayer mode, ISC-COMPDEP uses measured temperature gradients in the valley to determine the inversion strength and plume rise. The plume rise algorithm in ISC-COMPDEP, based on the CTDM algorithm (Perry et al. 1989), makes use of the vertical profile of winds to account for wind shear effects in a more refined manner than COMPDEP. In general, ISC-COMPDEP should provide a better representation of plume transport and plume rise than COMPDEP. However, both models suffer from the fundamental limitation of the steady-state approach in that they do not allow the plume trajectories to deviate from a straight line. Especially in complex terrain situations, this is likely to produce errors in the predicted concentration and deposition fields.

Table II-1
Classification of Reported Precipitation Type/Intensity To Precipitation Code

Precipitation Code	Type	Intensity
Liquid Precipitation		
1	Rain	Light
2	Rain	Moderate
3	Rain	Heavy
4	Rain Showers	Light
5	Rain Showers	Moderate
6	Rain Showers	Heavy
7	Freezing Rain	Light
8	Freezing Rain	Moderate
9	Freezing Rain	Heavy
10	Not Used	-
11	Not Used	-
12	Not Used	-
13	Drizzle	Light
14	Drizzle	Moderate
15	Drizzle	Heavy
16	Freezing Drizzle	Light
17	Freezing Drizzle	Moderate
18	Freezing Drizzle	Heavy
Frozen Precipitation		
19	Snow	Light
20	Snow	Moderate
21	Snow	Heavy
22	Snow Pellets	Light
23	Snow Pellets	Moderate
24	Snow Pellets	Heavy
25	Not Used	-
26	Ice Crystals	*
27	Not Used	-
28	Snow Showers	Light
29	Snow Showers	Moderate
30	Snow Showers	Heavy
31	Not Used	-
32	Not Used	-
33	Not Used	-
34	Snow Grains	Light
35	Snow Grains	Moderate
36	Snow Grains	Heavy
37	Ice Pellets	Light
38	Ice Pellets	Moderate
39	Ice Pellets	Heavy
40	Not Used	-
41	Hail	*
42	Not Used	-
43	Not Used	-
44	Small Hail	*
45	Not Used	-

* Intensity not currently reported for ice crystals, hail, and small hail.

Table II-2
Model Type Selected For Situation Depicted in Figure II-6

Receptor	Source 1	Source 2
1	simple	simple & complex
2	simple	simple
3	simple	simple
4	simple	simple
5	simple	simple
6	simple	simple & complex
7	simple & complex	complex
8	complex	complex
9	complex	complex
10	simple & complex	complex

Table II-3
Values of Net Radiation Constants
(Holtslag and van Ulden 1983)

Constant	Value
a_1	990 W/m^2
a_2	-30 W/m^2
b_1	-0.75
b_2	3.4
c_1	5.31×10^{-13} $W/m^2/deg.\ K^6$
c_2	60 W/m^2

Table II-4
Minimum Values of Monin-Obukhov Length
During Stable Conditions
for Various Land Use Types
(From Hanna and Chang 1992)

Auer (1978) Category	Class	Description	Minimum L
C1	Commercial	> 40-story buildings 10- to 40-story buildings 10-story buildings	150 m 100 m 50 m
I1, I2	Industrial	-	50 m
R3	Compact Residential	-	50 m
R1, R2	Residential	-	25 m
A	Agricultural	-	2 m

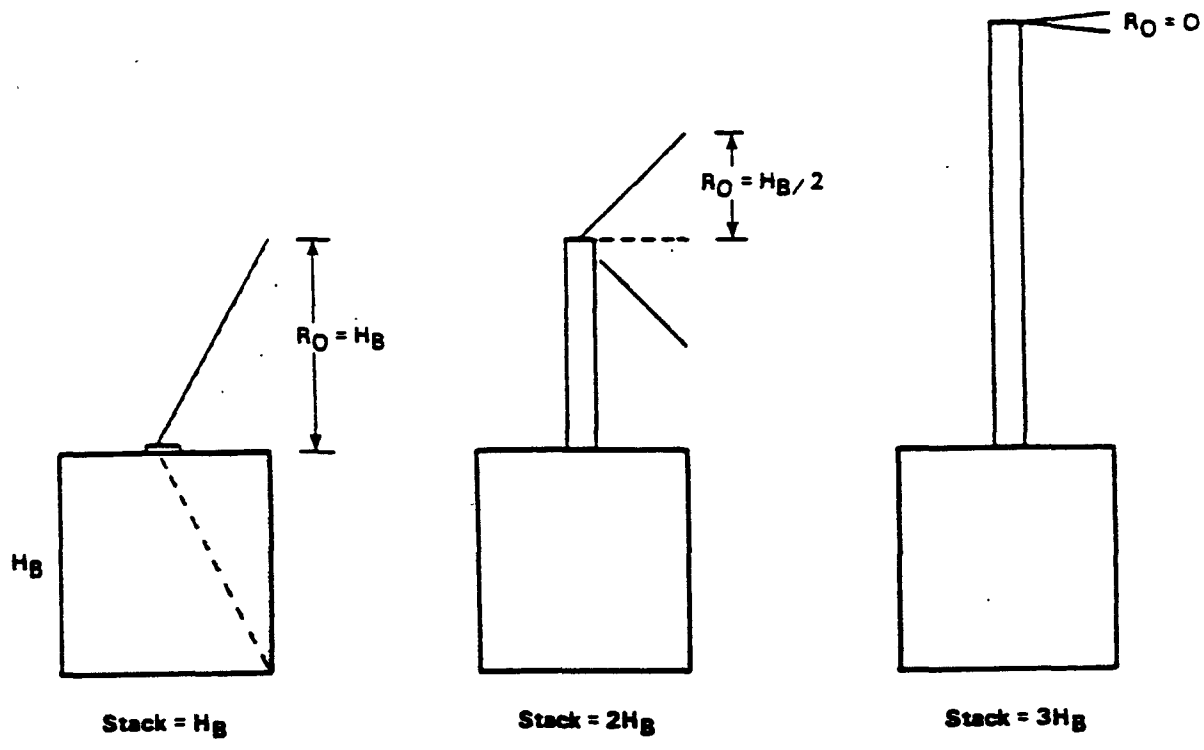

Figure II-1. Illustration of the initial dilution radius, R_o, as a function of stack height for a squat building (from Schulman and Scire (1981)). Momentum plume rise is neglected in the figure. Initial dilution radius varies from zero when $H_s = 3\ H_b$ to H_b when $H_s = H_b$.

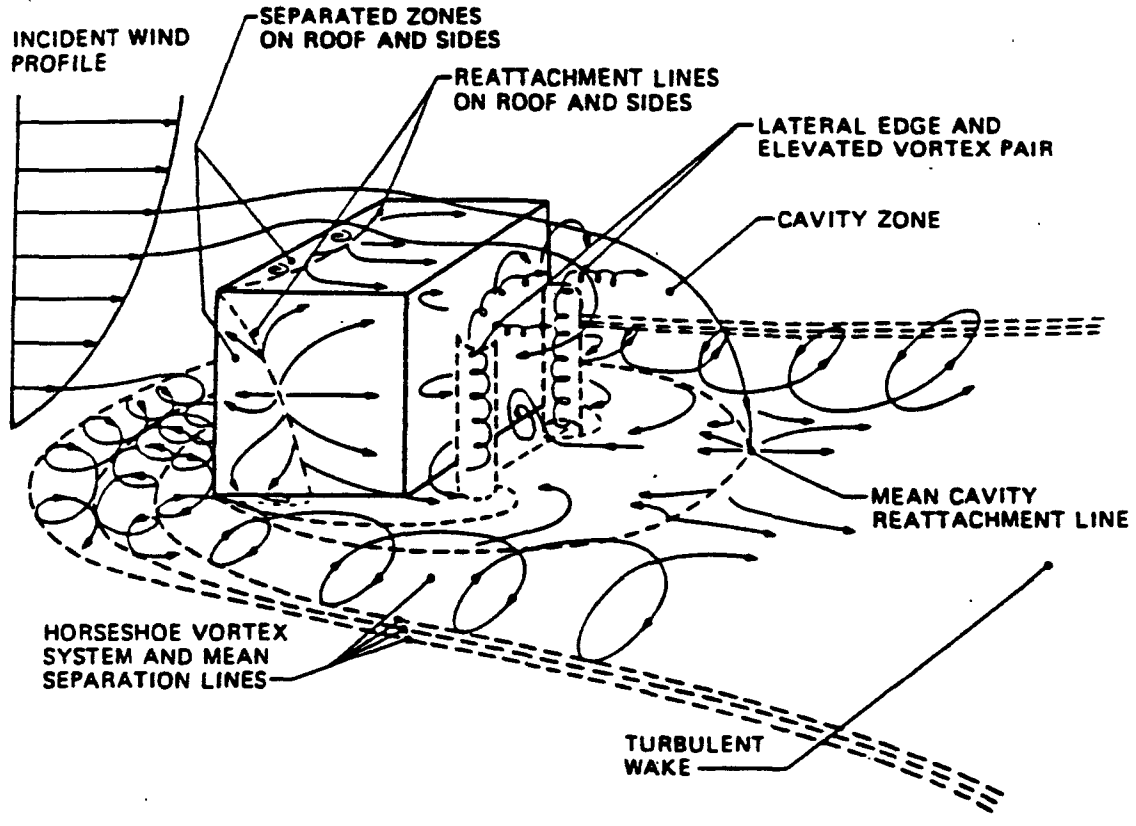

Figure II-2. Flow near a sharp-edged building in a deep boundary layer. [From Hosker, (1984)]

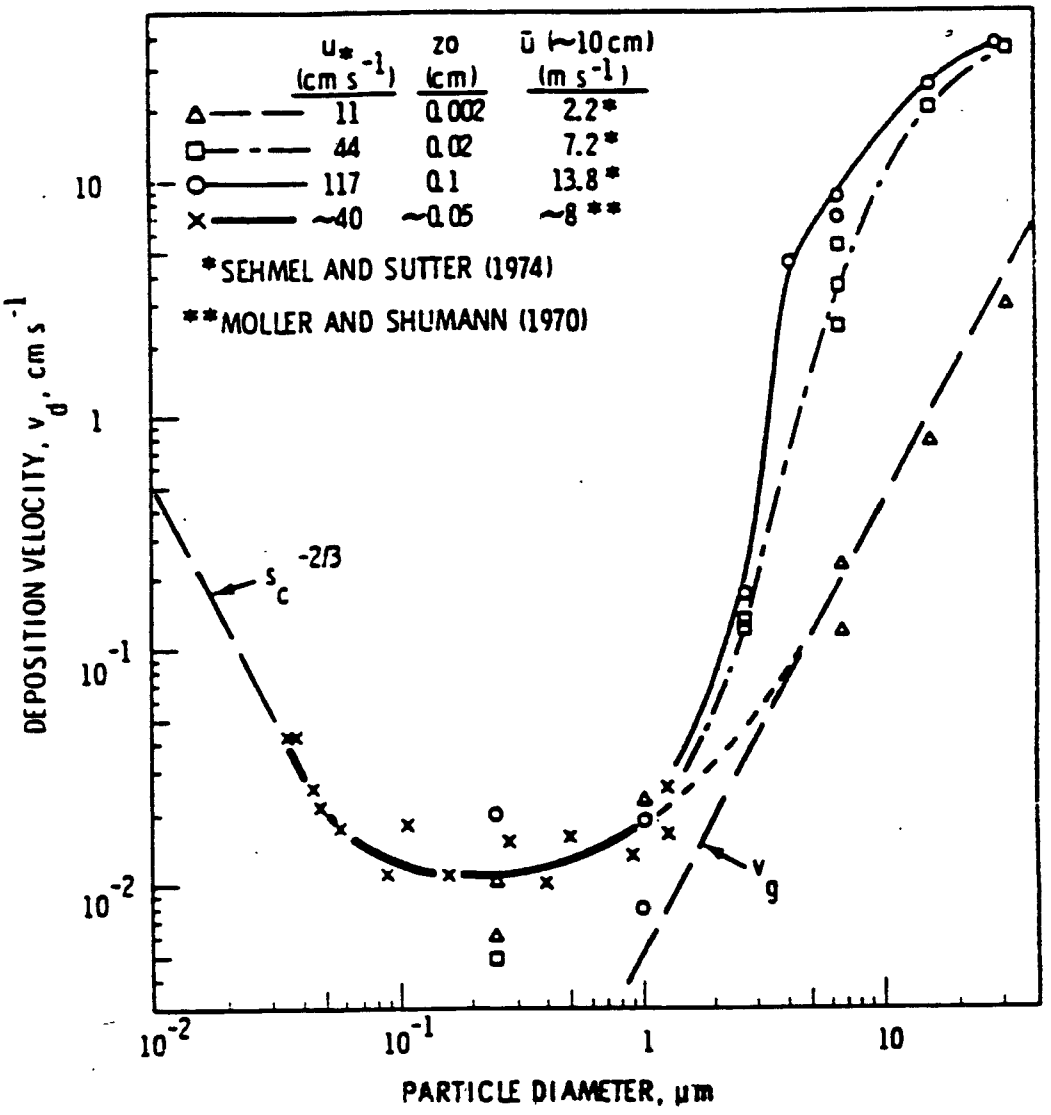

Figure II-3. Observed deposition velocities as a function of particle size for 1.5 g/cm density particles. Measured by Sehmel and Sutter (1974) and Moller and Schumann (1970). Figure from Slinn et al. (1978).

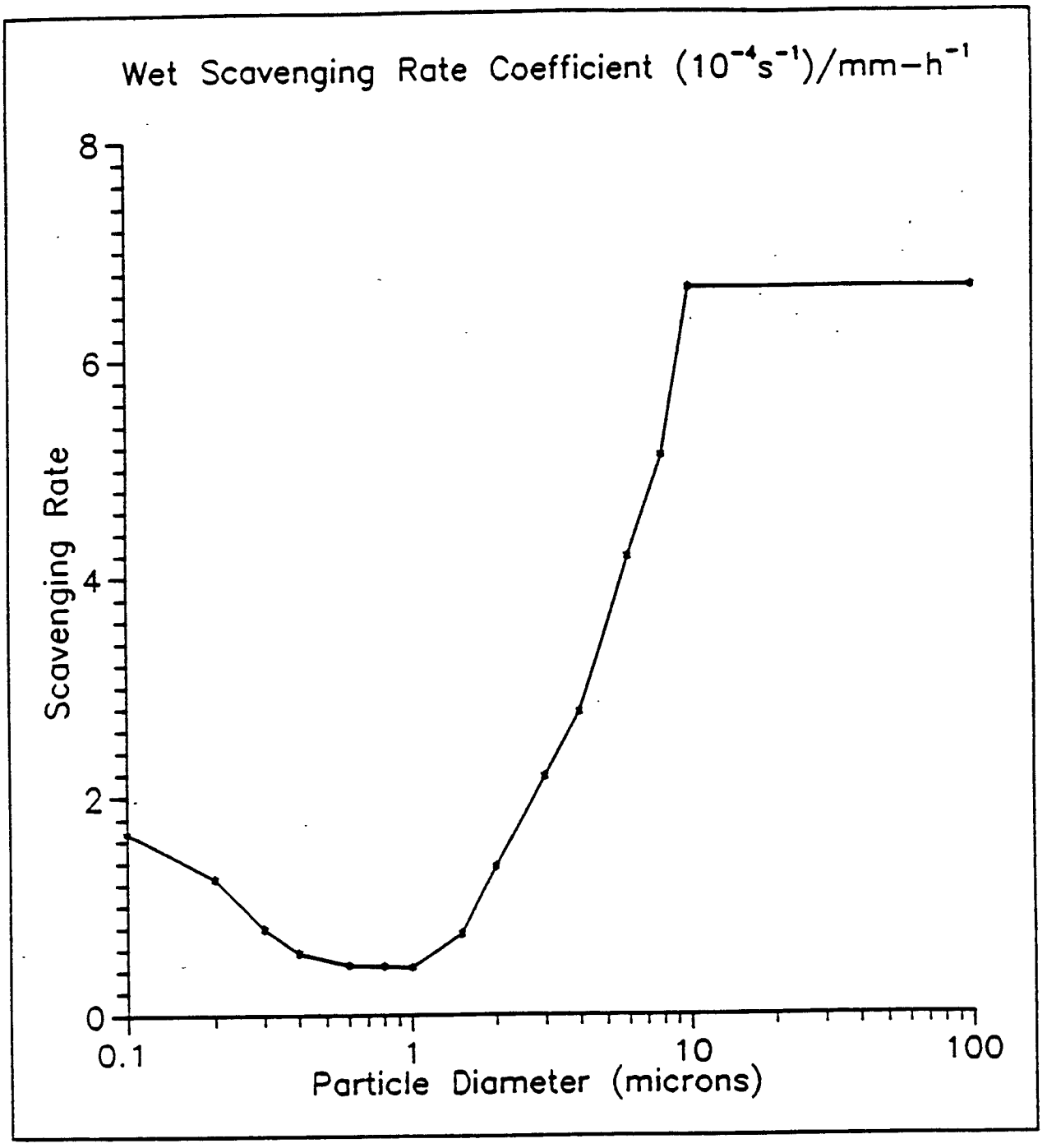

Figure II-4. Wet scavenging coefficient as a function of particle size (Jindal and Heinold, 1991).

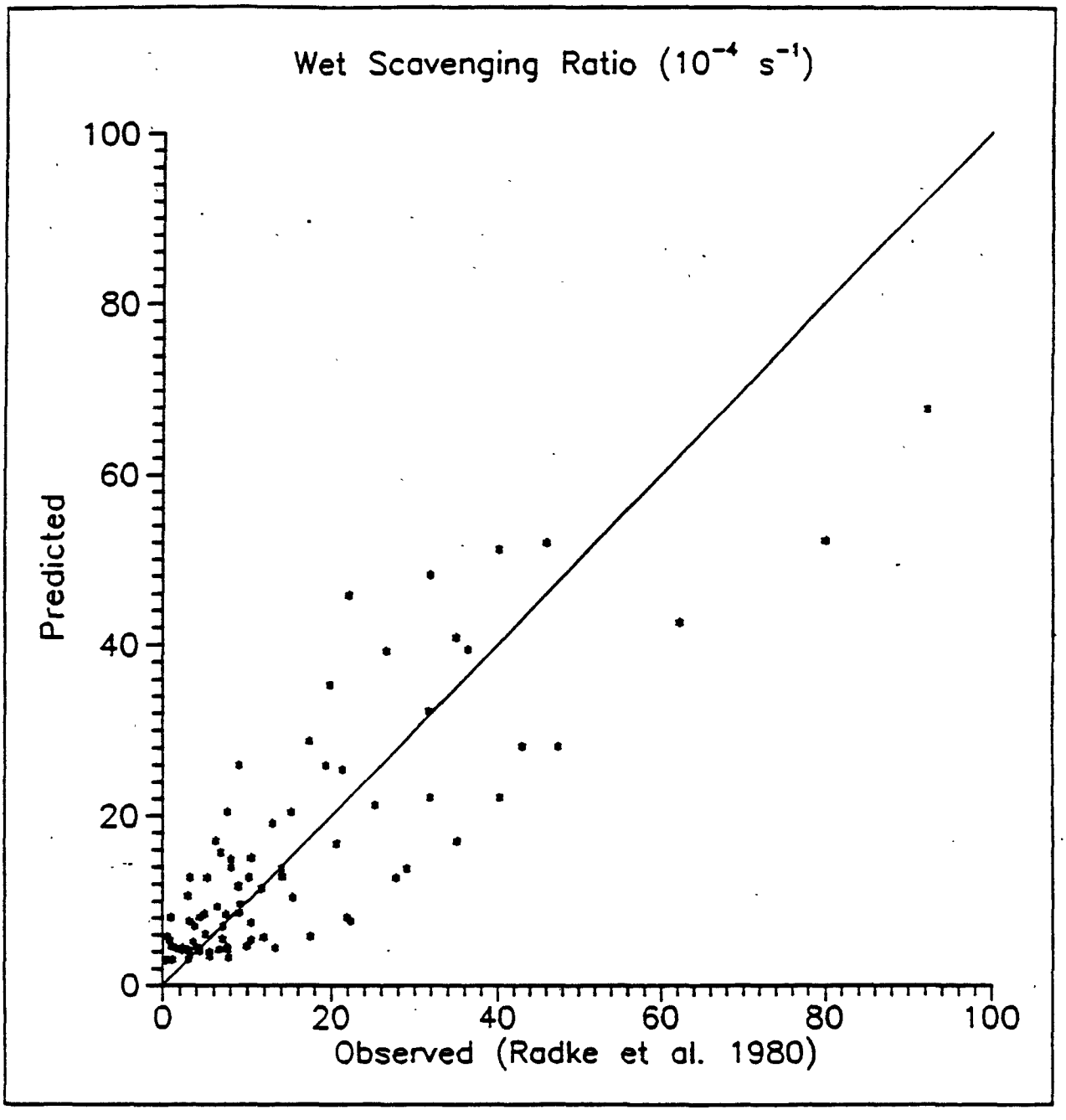

Figure II-5. Comparison of predicted scavenging ratio with observed.

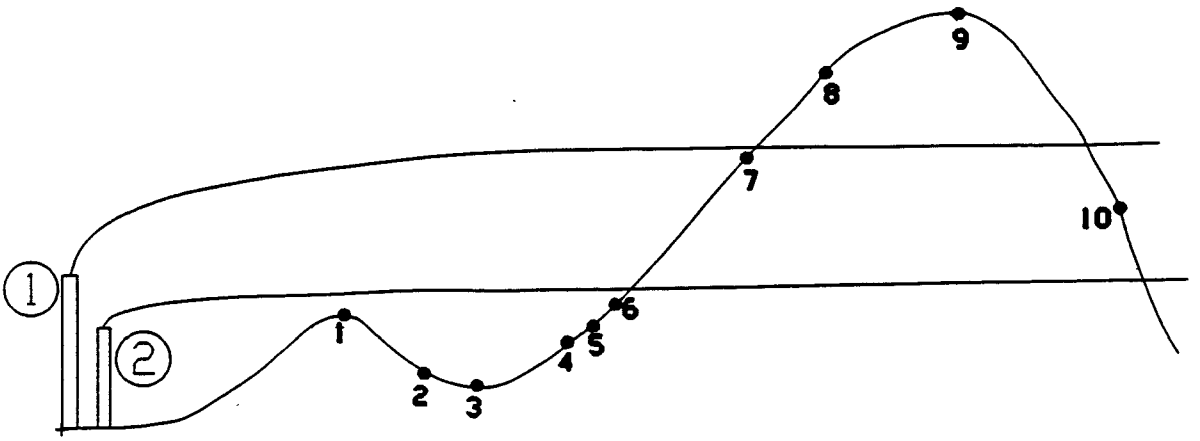

Figure II-6. Cross-section of terrain illustrating positions of sources and receptors.

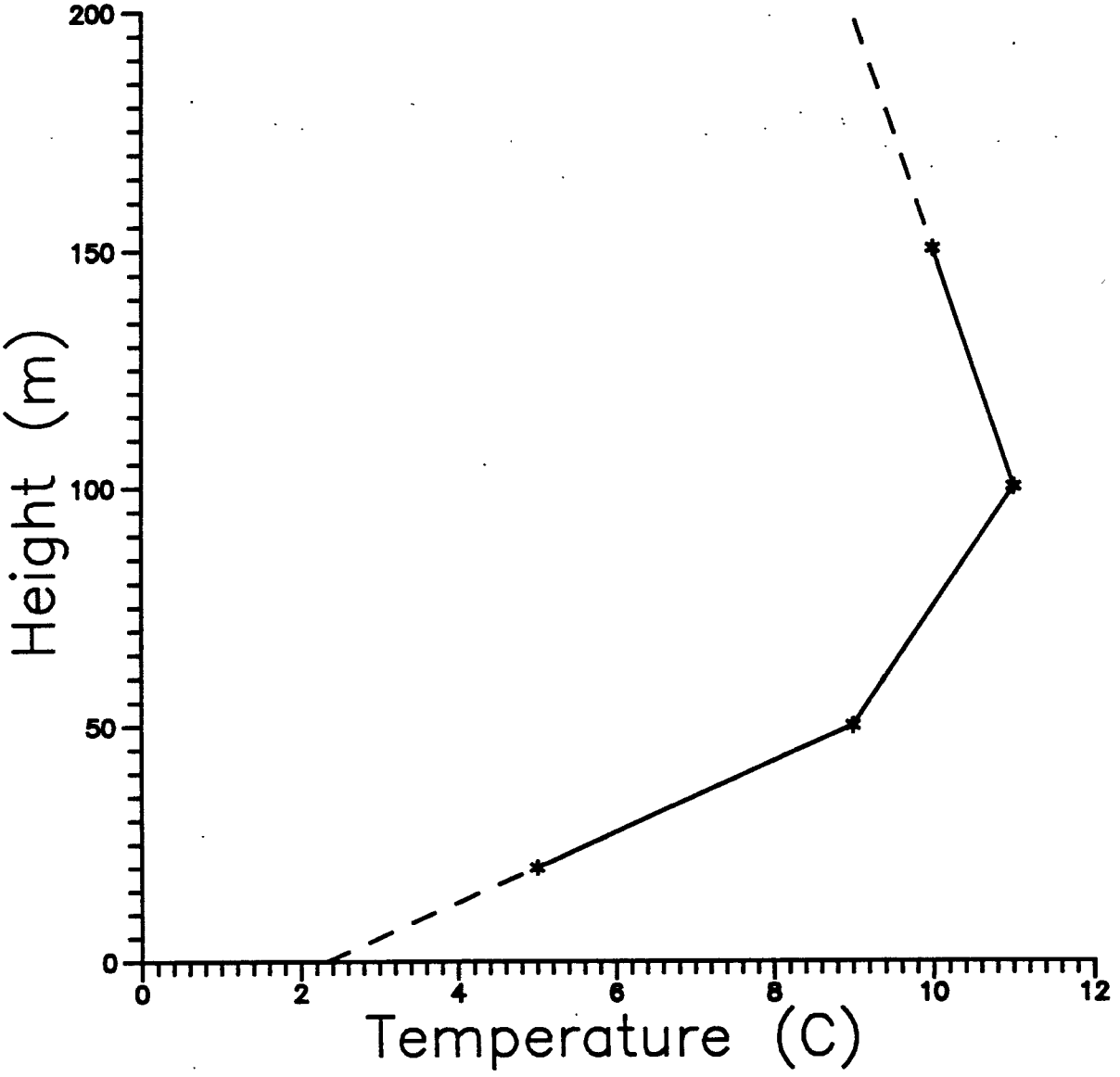

Figure II-7. Illustration of temperature interpolation/extrapolation.

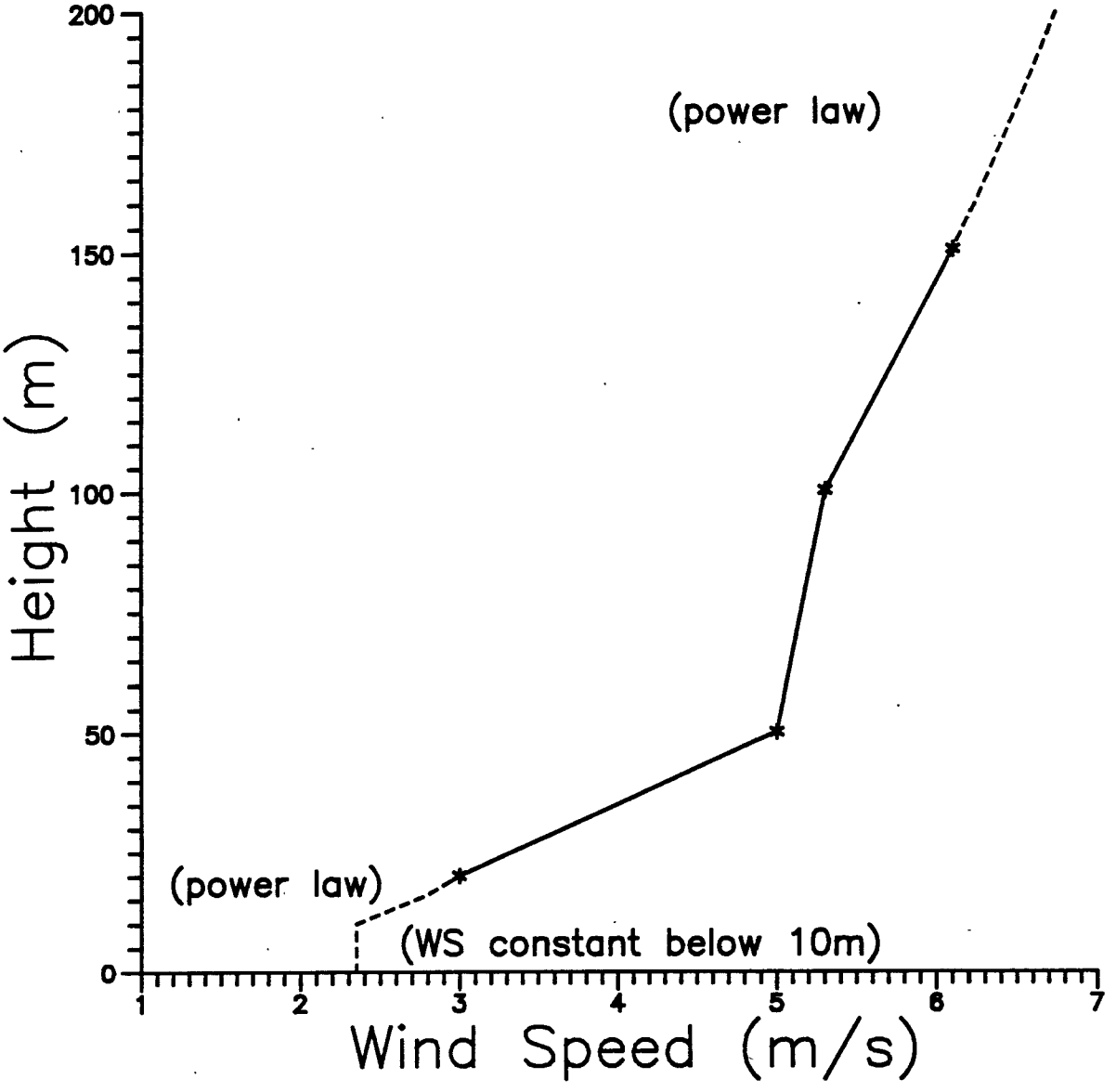

Figure II-8. Illustration of wind speed interpolation/extrapolation.

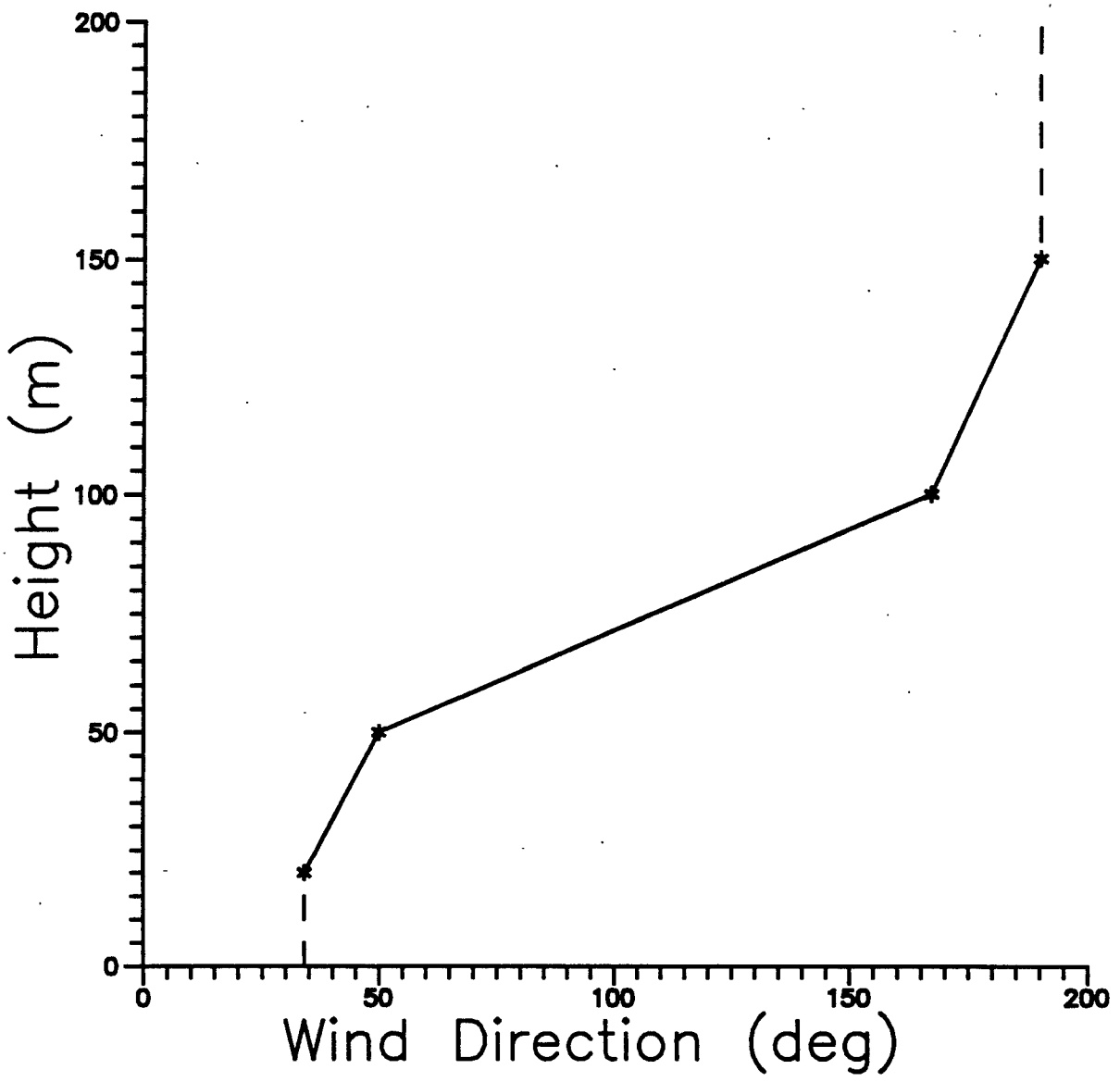

Figure II-9. Illustration of wind direction interpolation/extrapolation.

III. MODELING INPUT PARAMETERS

A. Source Data

1. Main Incinerator Stack

The source and emission parameters required for the air quality modeling include the physical stack dimensions (i.e., stack height and stack diameter) and stack gas parameters such as the exit velocity and exit temperature. Table III-1 contains a listing of the stack parameters for the main incinerator stack. The physical stack characteristics are based on site drawings submitted by WTI to U.S. EPA (U.S. EPA 1992a). The stack gas parameters were derived by U.S. EPA from measurements made at the WTI facility during a trial burn conducted in March 1993 and performance testing conducted in August 1993 (U.S. EPA 1993f).

The fraction of the particulate matter by weight in various particle diameter size categories is shown in Table III-2 which is obtained from a report on the trial burn tests (U.S. EPA 1993f). The particle distribution data for the test run is plotted in Figure III-1, where six categories, 2.97, 1.89, 0.93, 0.55, 0.40, and <0.40-μm diameter are defined. In order to resolve the particle distribution in the size range less than 0.40-μm diameter, a best-fit curve that passes through the observed data points is drawn (solid line) and extrapolated to smaller particle diameters. The extrapolated segment produces five additional particles sizes. These are 0.27, 0.18, 0.12, 0.062, and 0.03 μm diameter. From Figure III-1, their corresponding weight fractions are determined graphically as 11.91%, 10.0%, 5.0%, 4.0%, and 1.0%, respectively. These fractions sum up to 31.91%, which is the fraction listed in Table III-2 in the <0.4-μm diameter size category. The particle diameters are expressed in terms of *aerodynamic diameter*, defined as the effective diameter of a sphere of unit density which 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 is used in the modeling.

The size distribution of the particulate matter is appropriate to characterize the distribution of pollutants bound throughout the volume of the emitted particles, such as non-volatile metals, and is referred to as the volume or mass-weighted distribution.

It is derived directly from the stack test measurements of the particle size distribution. A second pollutant distribution, called the surface area distribution, assumes that the pollutant is distributed on the surface of the particles, and therefore is apportioned among the particles according to the relative surface area of the particulate matter. This distribution is appropriate for pollutants, such as semi-volatile organics, which adsorb onto the outer surface of the particles (U.S. EPA 1993d). It is computed by determining the percentage of the total surface area of all of the particles that is contained in particles of a particular size category. For example, if 50% of the surface area of all particles is in size category i, then the surface area weighting for that size category is 50%. Because smaller particles have a higher surface area (S_i) to volume (V_i) ratio ($S_i / V_i = \pi D_i^2 / (\pi D_i^3/6) = 6 / D_i$), the surface area distribution will tend toward higher weightings for the smaller particle size categories. The surface area weighting is computed from the particle sizes and the mass-weighting factors as follows:

- Compute the product of the mass-weighted fraction with the surface area to volume ratio for category i: $R_i = 6 W_i / D_i$, where W_i is the fraction of mass in size category i, and D_i is the diameter of size category i;
- Sum the values of R_i for all size categories ($R_t = \Sigma R_i$); and
- Compute the surface area-weighted fraction for size category i as: R_i / R_t.

Table III-3 summarizes the observed mass-weighted distribution and the computed surface area-weighted pollutant distributions used in the base case WTI simulations. Note that, as expected, the surface area distribution has a higher fraction of the pollutant associated with smaller particles than the mass-weighted distribution.

2. Routine Fugitive Emission Sources

The U.S. EPA conducted an analysis of fugitive emissions from the WTI facility, and has compiled an inventory of the type, location, characteristics, and magnitude of fugitive emissions for modeling purposes. Five locations were identified where fugitive emissions may be released on a routine basis. These are described by as (U.S. EPA 1995):

- CARBON ADSORPTION BED. The carbon adsorption bed consists of 4 units open to the atmosphere. The estimated size of the units together

is 20 ft by 30 ft. The emissions are vented through a single 92 ft stack. The carbon adsorption bed is modeled as a point source It is subject to building downwash effects.

- OPEN WASTEWATER TANK. This tank is located on the plot plan (Figure III-2) as the "C" water tank. It has a diameter of 10.1 m and is open to the atmosphere. The average liquid surface height is 25 ft. The top of the tank is approximately 35 ft above the ground level. The wastewater tank is modeled as a volume source because of the rapid vertical mixing expected due to flow of air around and over the tank structure itself.

- ORGANIC WASTE TANK FARM. The organic waste tank farm is enclosed in a building that has four vents to the atmosphere. The vents are located on the top of the building. Each vent is about 5 ft tall. It can be assumed that each vent handles an equal amount of emissions. The fugitive emissions from the organic waste tank farm are modeled as four point sources, corresponding to the four vents at the top of the building.

- TRUCK WASH. The truck wash is a building enclosed on two sides and open to the atmosphere on the ends in such a way as to allow trucks to drive through. The truck wash building is 25 ft by 70 ft. The truck wash emissions are modeled as a volume source. As with the wastewater tank, there is expected to be rapid mixing of the emissions due to building-induced turbulence and flow perturbations.

- ASH HANDLING. The source for fugitive emissions from ash handling operations is a stack located at the top of the southeast corner of the steam plant building. The steam plant building is 50 ft by 80 ft. The top of the building is 22 ft above the ground. The ash handling stack is modeled as a point source subject to building downwash effects.

The fugitive emission sources are modeled using an unit emission rate (1 g/s for each point and volume sources, and 1 $g/m^2/s$ for the area source). Source-specific concentrations and deposition fluxes can be obtained by scaling the modeling results obtained with the unit emissions by the actual emission rates. The base elevation of

all fugitive emission sources is 212.1 m MSL. Other source characteristics for the fugitive emission sources are listed in Table III-4. All of the fugitive emissions are assumed to be at ambient temperature, so buoyant plume rise is not a factor. For the point sources, the diameter and exit velocity is set to arbitrarily small values to produce negligible plume rise estimates while avoiding numerical problems associated with zero values for the stack parameters in the model.

B. Building Downwash Analysis

Because stack heights associated with point source emissions at WTI are less than Good Engineering Practice (GEP) height, the effects of building downwash must be considered in the modeling. As part of a building downwash analysis conducted by Region 5 (U.S. EPA 1992a), the dimensions and location of each structure in the vicinity of the WTI stack were collected. This information has been supplemented and revised with building information provided by WTI, and re-analyzed using the U.S. EPA Building Profile Input Program (BPIP). BPIP (U.S. EPA 1993c) was developed by U.S. EPA to incorporate its guidance on GEP and building downwash (U.S. EPA 1985; U.S. EPA 1988; U.S. EPA 1989; U.S. EPA 1993c), including recently clarified rules for assessing the complimentary effects of buildings which are sufficiently close to each other to have interacting wakes. Table III-5 contains a list of the buildings at the plant that have been evaluated for possible downwash effects. The building locations are shown on the plot plan of the WTI facility (Figure III-2).

According to the U.S. EPA guidance, a stack which is within a distance $5L_b$ of a building, where L_b is the lesser of the building height (H_b) and the projected building width (H_w) may be influenced by building downwash effects, if the stack height is also less than $H_b + 1.5L_b$. Since L_b cannot be greater than the building height, a minimum building height for consideration in the downwash analysis is $h_s/2.5$. In the case of the main (150 ft) incinerator stack, there are five structures shown which could influence the dispersion from the plume: the incinerator feed, scrubber, precipitator, spray dryer, and boiler structures. In addition, there are three structures potentially affecting the fugitive emissions from other point sources at the facility: the container processing building, steam plant, and water treatment building. The other structures in Table III-5 are beyond the $5L_b$ distance to the stack, or are lower, non-controlling structures. Detailed building information (location, height, orientation) is provided in the BPIP output files contained in Appendix IV-1. In the BPIP analysis, the origin of the coordinate system is defined at the main incinerator stack location, and the coordinates are listed in terms of plant north, rather than true north. As shown on the plot plan, plant north is rotated by BPIP counter-clockwise from true north by 22° 47′ 12″.

The ISC-COMPDEP model allows the use of direction-specific building dimensions. The BPIP program produces a set of effective building dimensions (height and width) at 10° direction intervals which are directly compatible with the ISC-COMPDEP input requirements and format. The building dimensions produced by the latest version of BPIP (Version 94074) for the main incinerator stack are shown in Table III-6. For some directions, the buildings are sufficiently close to result in a combination of the buildings in accordance with the U.S. EPA complimentary structure guidelines. The GEP height determined by BPIP is 72.69 m, based on the combined effects of the scrubber and spray dryer structures. The direction-specific building dimensions for the fugitive point source emissions are shown in Appendix IV-1.

C. Meteorological Data Selection and Processing

Meteorological data in the vicinity of the East Liverpool Area that are available for use in the air quality modeling of the WTI facility include the following:

- Observations of wind and temperature made at three sites on or near the WTI property. Data from two 10-m towers and one 30-m tower are available for the time period April 1992 through March 1993.

- Standard meteorological observations of wind, temperature, cloud cover, ceiling height, and precipitation made at the National Weather Service (NWS) station at the Greater Pittsburgh International Airport. The Pittsburgh Airport is located approximately 25 miles southeast of East Liverpool.

- Wind, temperature, precipitation, and turbulence measurements made at three heights on the 500-ft Beaver Valley Power Station meteorological tower (BVPSMT). The BVPSMT is located near Shippingport, Pennsylvania, approximately 8 miles east of the WTI site.

One of the recommendations of the Peer Review Panel was to use data from multiple meteorological stations and at multiple heights in order to better characterize the flow and temperature structure both within and above the Ohio River valley. The ISC-COMPDEP model has been modified to allow vertical profiles of winds, temperatures, and turbulence, derived from the BVPSMT and the WTI onsite towers, to be used in determining atmospheric stability; plume transport, and dispersion. The vertical temperature gradient data from the BVPSMT have been incorporated into the model in order to provide an improved representation of stability conditions at plume height during stable atmospheric conditions (i.e., inversions), which are common in the area. Meteorological parameters that may be required for the modeling, but are not available on-site or at the BVPSMT, such as cloud cover and ceiling height estimates, are extracted from the Pittsburgh Airport data set.

In the remainder of this section, a discussion and analysis of the meteorological data are provided. The modifications to the ISC-COMPDEP model to allow the use of wind and temperature data at multiple levels are discussed in Section II.J.

1. WTI Site Data

Wind data are available from two sites at the WTI source location and a third site nearby (at the East End School). Due to interference from nearby structures at the other sites/levels, the most representative wind observations are from the 30-m level of the Site 2 meteorological tower and the 10-m level of the Site 3 meteorological tower. Site 2 is located near the stack, while Site 3 is situated near the eastern extreme of WTI's property. One year of wind data (April 1992 through March 1993) from these sites are analyzed. The results, presented in Figures III-3 and III-4, show obvious channeling along the axis of the Ohio River Valley at the source. At the point where the WTI facility is located and for some distance up river (to the east) the river valley is angled at about 70° from north. Just down river (to the southwest) the angle changes to about 40° from north. The vast majority of reported wind directions reflect the 70° orientation, being from the southwest or the northeast with a maximum along the axis. Cross-axis winds are rare, with hardly any winds from the southeast. There is a steep cliff across the river to the southeast. It is likely that the data from the low-level WTI meteorological sites are not representative of conditions on the hills on top of the valley where elevations generally are some 500 to 600 ft higher than river level. Figure III-5 shows the terrain surrounding the WTI site.

2. Beaver Valley Power Station Meteorological Tower Data

Wind data are available at three levels (35, 150 and 500 ft) from the meteorological tower associated with the Beaver Valley Power Station near Shippingport, Pennsylvania. An analysis is conducted to investigate whether one or more of the levels at this tower might be more representative of conditions atop the valley. According to information provided by Duquesne Light (1993), the tower is operated in accordance with NRC regulations and includes primary and backup instrument systems. The tower is located midway between the Beaver Valley and Bruce Mansfield Power Stations, on the southern side of the Ohio River at about river mile 34.5, and is at 735 ft above sea level (ASL). Thus, the 500-ft level of the tower, at 1235 ft ASL, is at or above the terrain surrounding the river valley. Figure III-6 shows the topography in the vicinity of the tower. The tower is located at a bend in the river valley. Just down river to the west, at the bend, the valley is

somewhat wider and bends nearly east-west for about 1.5 miles before turning NW-SE further downstream. Up river from the tower the river valley becomes narrower and runs at an angle of 30° to 40° from North for about 1.5 miles before changing to about 70° from north. The BVPSMT tower is about eight miles east of the WTI site. There are several tributary valleys that feed into the main valley between the WTI and BVPSMT sites and the river bends several times in the intervening distance.
Figure III-7 is a cross-sectional plot of the terrain through the Ohio River valley at the locations of the BVPSMT and WTI meteorological towers. The cross sections are taken in a line roughly perpendicular to the river at each site. Also shown are the heights of the various levels of the meteorological towers. The plot shows that the lower tower levels are well within the valley, while the 500-ft (1235 ft MSL) level of the BVPSMT extends above the valley walls.

Hourly-average tower data for six years: 1986-1990 and 1992 are used. At each level, data capture is over 99 percent. The annual data are combined to construct a six-year wind rose for each level. Figures III-8 and III-9 show the wind rose for the 35-ft level. Winds are reported from all points of the compass but the vast majority of winds from the east and south are very light. Most stronger winds are from the southwest, which is the only direction for which there is a relatively long fetch and is also the direction most likely to experience synoptic flow. The surface level winds appear to show the effects of drainage winds.

Figure III-10 shows the wind rose for the 150-ft level. Valley channeling effects are more evident at this level than at 35 ft. Along-valley winds predominate over cross-valley flow. Again, southeast winds are least common. The location of the tower closer to the river bend compared to WTI seems to allow a larger range in the direction of westerly winds with synoptic winds having more influence.

The pattern at 500 ft (Figure III-11) is different from that seen at the other two levels. The most predominant winds are from the west and southwest, similar to the 150-ft level, but the other sectors are more evenly represented and, in contrast to the 150-ft level, the wind comes from the northeast less often than from other directions. To see whether the 500-ft data are more representative of the synoptic conditions likely to influence sites above the valley, data from the Greater Pittsburgh International Airport are examined as well.

The wind roses for each year are analyzed separately to see if there were any significant changes in the wind patterns from year to year. These plots are included in the Appendix IV-2. The annual analysis suggested that the variation from year to year is relatively small compared to differences among the three levels for the period examined.

3. Pittsburgh Data

Hourly surface wind speed and direction data from the Pittsburgh Airport are from the U.S. EPA SCRAM electronic bulletin board for the six year period corresponding to the BVPSMT data. These data are free from the valley effects seen at WTI and BVPSMT. These are processed into a wind rose for comparison to the BVPSMT data (Figure III-12). The Pittsburgh wind rose is very similar to the 500-ft level BVPSMT wind rose, with westerly winds predominating, and northeast winds the least common. There are more southerly winds at Pittsburgh relative to BVPSMT and, perhaps showing the influence of the valley, BVPSMT has more southwest winds. The Pittsburgh pattern is different from that seen at the BVPSMT 35- and 150-ft levels.

Two years of rawinsonde data (1988 and 1989) from the Pittsburgh airport are also examined. These data also reflect the prevailing westerly winds and are similar to the 500-ft tower data. The plots of the rawinsonde observations at both 00 and 12 GMT are presented for several heights in the Appendix IV-2.

4. Use of Meteorological Data in ISC-COMPDEP Modeling of WTI

The discussion of the wind roses indicates that the 500-ft level winds at BVPSMT reflects a different flow regime than the winds at the lower levels of the tower. The 500-ft winds are very similar in behavior to the conditions that are seen at Pittsburgh and thus are representative of the synoptic flow that is more likely to influence the higher elevations surrounding East Liverpool. The 500-ft winds are mostly free of influence from valley topography. The lower level winds at BVPSMT are greatly influenced by valley topography, and show channeling and drainage flow effects. The BVPSMT data include a vertical temperature data set which may give a better picture of stability conditions in the valley at WTI than surface data or default assumptions in the model.

Therefore, a modeling approach that uses wind data from WTI and the 150 ft level of BVPSMT to represent within-valley flow and the 500-ft BVPSMT tower data to represent flow above the valley walls may give a more accurate representation of the impacts of the WTI facility than extrapolation of the 30-meter WTI onsite tower winds to elevations above the top of the valley. The ISC-COMPDEP model has been modified to allow a profile of wind to allow differential transport of plumes at different heights. Although there are several bends of the river valley between the WTI site and the BVPSMT, the direction of the axis of the valley at the locations of the meteorological towers is nearly the same (within approximately 10°). The effect of this small difference is considered negligible, and it is concluded that the BVPSMT

150-ft level probably reflects the in-valley flow at the 150-ft height in the vicinity of the WTI facility reasonably well.

If the 500-ft winds reflect the synoptic flow, and the 150-ft winds reflect the valley flow, there must be a shear zone between these two levels when the flows are different. Through this zone, the wind and temperature change from being valley-dominated to synoptic wind-dominated. The topographical maps of the areas surrounding the WTI site and BVPSMT indicate that the 1000-ft contours generally depict the sides of the valley wall. At 1100 ft, the contour loses much of its relationship to the shape of the lower valley. Therefore, it is likely that the shear zone is around the 1000-1100 levels. With the ground elevation at about 750 ft, the shear zone is assumed to be in the region 265 to 365 ft above the ground. In preparing the wind data for input into ISC-COMPDEP, five levels of winds are used: 30 m (98.4 ft), 45.7 m (150 ft), 80.8 m (265 ft), 111.3 m (365 ft), and 152.4 m (500 ft). The 30 m, 45.7 m, and 152.4 m levels correspond to measurement heights of the BVPSMT or WTI towers. The 80.8 m and 111.3 m levels correspond to the bottom and top of the assumed shear zone. The bottom of the shear zone is assumed to have the same wind as the 45.7 m level of the BVPSMT, and the top of the shear zone is assumed to have the same winds as the 152.4 m level of the BVPSMT. The shear zone concept is necessary to avoid the effects of above-valley winds being interpolated downward into the valley where they do not apply.

Because the main incinerator stack height is 150 ft, the 500-150 ft temperature gradient observations at the BVPSMT are used to improve the characterization of stability conditions at plume height. ISC-COMPDEP was modified to allow hourly values of potential temperature gradient from the BVPSMT for the 150-500 ft layer to replace the default temperature gradients provided in the ISC-COMPDEP model. This provides a more direct measure of the frequency and intensity of temperature inversions within the Ohio River Valley to be represented within the model.

Observations of cloud cover and ceiling height are needed for computation of the stability class. Since these observations are not made onsite, cloud data from the Pittsburgh Airport are used. Morning and afternoon mixing heights for the period are computed using upper air soundings from Pittsburgh, PA and surface temperatures from the same site, in accordance with U.S. EPA modeling guidance. Pittsburgh is the closest available upper air station to East Liverpool.

A modified version of the U.S. EPA meteorological preprocessor RAMMET is used to conduct the meteorological modeling. The program allows the use of different measurements for stability and transport calculations, and will substitute for missing data from user-selected backup measurements. A calm threshold of 1 m/s is

used in the analysis. Thus, wind speeds less than 1 m/s are reset to 1 m/s, in accordance with U.S. EPA guidance, and the hour is treated as a calm hour. RAMMET produces hourly estimates of stability class, wind vector, wind speed, temperature, and also interpolates the twice-daily mixing heights to hourly values.

The dry deposition algorithm in ISC-COMPDEP requires hourly values of the surface friction velocity (u_*) and Monin-Obukhov length (L). The friction velocity is a measure of the momentum flux to the surface, and is a function of the surface roughness length (z_o), wind speed, and atmospheric stability. The Monin-Obukhov length is a measure of the relative importance of mechanical and buoyant production of turbulence in the atmospheric boundary layer. It ranges from small positive values for highly stable conditions to infinity for neutral conditions to small negative values for highly convective conditions.

ISC-COMPDEP requires the computation of u_* and L externally. The DEPMET meteorological processor, described in Section II.L., is used to compute these variables for the ISC-COMPDEP simulations. DEPMET uses standard meteorological observations and surface characteristics to compute u_* and L based on the energy balance method of Holtslag and van Ulden (1983).

Hourly precipitation data is from the National Climatic Data Center (NCDC). The data consists of two types: hourly precipitation amounts (in NCDC's TD-3240 format), and hourly precipitation type codes (in CD-144 format). The precipitation amount is used in determining the magnitude of the scavenging ratio. The precipitation type code (e.g., rain, drizzle, showers, snow, hail, etc.) is used to distinguish liquid from frozen forms of precipitation. The scavenging coefficient has different values for liquid precipitation than frozen precipitation.

D. Receptor Grid

A radial grid of receptors is developed for the air dispersion and deposition modeling. The modeling domain extended out to 50 km from the WTI stack. Receptors are placed in rings at distances of 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0, 1.25, 1.50, 1.75, 2.0, 2.25, 2.5, 3.0, 4.0, 5.0, 7.5, 10.0, 15.0, 20.0, 30.0, 40.0, and 50.0 km from the WTI stack. The polar grid is centered at the WTI stack. Each receptor ring consists of 36 receptors located at 10° intervals. All of the receptors are located at local ground level. The terrain elevation of each receptor is 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.

E. Geophysical Data

1. Terrain Elevations

Two types of geophysical data are used in the dispersion and deposition modeling: terrain elevations and land use/land cover information. Digitized, fine-resolution gridded terrain data of the area surrounding East Liverpool is from the U.S. Geological Survey (USGS) by U.S. EPA and provided for use in the modeling. In addition, 1:24000 scale terrain maps of the area are also used to determine the radial receptor terrain elevations required by the models.

A gridded terrain data base is required by the ISC-COMPDEP model in order to track the cumulative effects of upwind plume depletion resulting from terrain variations. ISC-COMPDEP reads the gridded terrain data and internally calculates the terrain heights that a plume encounters along its trajectory for any wind direction. The appropriate adjustments are made to the vertical term of the Gaussian plume equation for each step in the integration of the modified source depletion equations (see Section II.F.2). For example, the presence of a hill upwind of a receptor may cause enhanced dry deposition onto the hill surface, which will result in a greater degree of plume depletion at the receptor than if the hill did not exist. ISC-COMPDEP includes an option to account for this effect.

2. Land Use

ISC-COMPDEP allows the user to specify domain-average values of land use and surface roughness length, or receptor-specific values. The domain average values represent the average or typical values of the variables over the entire 100 km x 100 km modeling domain. The receptor-specific option allows different values to be specified for each receptor or group of receptors. The base case simulations of ISC-COMPDEP uses domain-average values in order to allow an assessment of the importance of plume depletion effects. However, sensitivity runs are also made using receptor-specific values of land use. For the sensitivity runs, the land use category for each receptor is derived from USGS land use/land cover data for the modeling domain. The data for a 1° latitude by 2° longitude area (40° - 41° N) x (80° - 82° W) are provided in GIRAS format, which uses polygon maps to define areas of equal land use type. The land use category at each of the radial receptors used in the modeling is determined by U.S. EPA using the ARC-INFO GIS software package. Of the 936 receptors in the grid, there are 12 receptors along the 50 km receptor ring which are outside the area covered by the land use data. As a result, the land use

category for those receptors is assigned to be the value at the closest boundary of the land use coverage area.

The use of receptor-specific surface characteristics required multiple runs of DEPMET (one for each land use category). The receptors are split into five groups, based on their land use type (urban/suburban, agricultural, forest land, water, and barren). The geophysical parameters shown in Table III-7 are assigned to each land use type. DEPMET is run for each land use type, and the output meteorological file is used to drive the ISC-COMPDEP model. Only receptors of the same land use type are modeled in a single run of ISC-COMPDEP. After all of the land use categories are considered, the results from all receptors are then merged to reconstruct the original 936-receptor polar grid.

The tradeoff in using receptor-specific land use data is that plume depletion effects due to dry deposition should not be significant, since in receptor-specific land use mode, plume depletion effects due to dry deposition are not included (depletion due to wet removal is included in receptor-specific land use mode). Plume depletion due to dry deposition must be turned off when receptor-specific land use is used because the dry deposition plume depletion scheme assumes a uniform deposition velocity over the trajectory of the plume, which is not the case when the surface characteristics vary. Typically, with combustion sources emitting small particles from elevated stacks (such as the WTI facility), the variation in dry deposition due to land use variations is much more significant than plume depletion effects, especially near the source where the maximum concentration and deposition flux is expected. The receptor-specific land use sensitivity test is designed to quantify this effect.

COMPDEP simulations were performed in a previous phase of the study, and the COMPDEP results are presented in Section IV.B.1 for comparison to the ISC-COMPDEP results. The COMPDEP model uses a domain averaged value of surface roughness in the deposition velocity calculations. A roughness length of 30 cm was estimated (Hjelmfelt 1982) for the domain, based on typical values for suburban residential and agricultural land, which are important land uses for the risk assessment. In the base case ISC-COMPDEP simulations, the same 30 cm roughness length is assumed.

F. Model Options and Switches

ISC-COMPDEP is derived from the ISC2 model code. Unfortunately, one of the limitations of the method used to allocate arrays in ISC2 that exists in ISC-COMPDEP as well, is that only one type of output field may be generated in a single run. That is, it is possible to produce concentrations, wet deposition fluxes, dry deposition fluxes, or total

deposition fluxes, but only one in a single run. The model evaluates the effects of wet and dry deposition and plume depletion simultaneously, but one set of arrays is available for output purposes. Therefore, the two base case particulate runs require a total of four runs each (one for each type of output). The base case vapor simulation, because it does not include deposition effects, required only one additional run.

Each of the base case simulations use the following model options. These options affect only the simple terrain calculations; the complex terrain modeling options are independent and are automatically set to use regulatory default mode.

- Used regulatory default options:
  - final plume rise (except for downwash conditions),
  - stack tip downwash (except with the Schulman-Scire downwash algorithm),
  - buoyancy-induced dispersion,
  - U.S. EPA calm processing algorithm,
  - default wind profile exponents (0.07, 0.07, 0.10, 0.15, 0.35, 0.55 for stability classes A-F, respectively),
  - default potential temperature lapse rates (0.02 °K/m, 0.035 °K/m for stability classes E and F, respectively).
- Used receptor-specific terrain elevations
- Rural dispersion option (PG dispersion curves)
- Multilayer meteorological tower data used:
  - 3 levels of temperature data - 30 m, 45.7 m, 152.4 m
  - 5 levels of wind data - 30 m, 45.7 m, 80.8 m, 111.3 m, 152.4 m (80.8 m and 111.3 m are pseudo-levels defining the bottom and top of the transition zone from valley flow to gradient, above-valley flow).
- Building downwash evaluated
- Unit emission rate (1 g/s) used

For the base case particulate matter runs, the following deposition and depletion inputs are specified.

- Dry deposition and depletion modeled
- Wet deposition and depletion modeled
- Gridded terrain data used for depletion calculations

- Particle density: 1 g/cm^3

- Particle categories: 10

- Particle diameters (μm):

  2.97, 1.89, 0.93, 0.55, 0.40,
  0.27, 0.18, 0.12, 0.062, 0.030

- Size distribution - mass-weighted distribution:

  0.04260, 0.08510, 0.17020, 0.19150, 0.19150,
  0.11910, 0.10000, 0.05000, 0.04000, 0.01000

- Size distribution - surface area-weighted distribution:

  0.00414, 0.01301, 0.05288, 0.10060, 0.13832,
  0.12745, 0.16051, 0.12038, 0.18640, 0.09631

- Wet scavenging coefficients - liquid precipitation:

  $0.21x10^{-3}$, $0.14x10^{-3}$, $0.50x10^{-4}$, $0.50x10^{-4}$, $0.60x10^{-4}$,
  $0.90x10^{-4}$, $0.13x10^{-3}$, $0.15x10^{-3}$, $0.20x10^{-3}$, $0.22x10^{-3}$

- Wet scavenging coefficients - frozen precipitation:

  $0.70x10^{-4}$, $0.47x10^{-4}$, $0.17x10^{-4}$, $0.17x10^{-4}$, $0.20x10^{-4}$,
  $0.30x10^{-4}$, $0.43x10^{-4}$, $0.50x10^{-4}$, $0.67x10^{-4}$, $0.73x10^{-4}$

In the vapor base case runs, the dry deposition, wet deposition, and plume depletion options are all turned off. The multilayer meteorological data are used, as with the particle runs. A listing of the model input parameters is shown in the list file outputs in Appendix IV-3.

Table III-1
Stack Parameters for the WTI Incinerator Stack

Variable	Value	
Stack height	45.7 m	(150 ft)
Stack diameter	1.83 m	(6 ft)
Exit velocity	17.74 m/s	(58.2 ft/s)
Exit gas temperature	367.0 °K	(201°F)
Stack base elevation	212.1 m	(696 ft)
UTM Zone 17 coordinates:		
X	538,460 m	—
Y	4,497,750 m	—

Table III-2
Particle Weight Fractions Observed During Run 2 of the WTI Trial Burn Particle Distribution Study
March 17, 1993

(From A.T. Kearney, 1993)

Median Diameter (μm)	Weight Fraction
8.88	0.00
6.48	0.00
4.38	0.00
2.97	4.26
1.89	8.51
0.93	17.02
0.55	19.15
0.40	19.15
< 0.40	31.91

Table III-3
Size Distributions of the Pollutant Mass Assumed in the WTI Modeling

Pollutant Mass Fraction (%)

Base Particle Size Distribution		
Diameter (μm)	Mass-Weighted Pollutant Distribution	Surface Area-Weighted Pollutant Distribution
2.970	4.26	0.4144
1.890	8.51	1.3009
0.930	17.02	5.2876
0.550	19.15	10.0597
0.400	19.15	13.8321
0.270	11.91	12.7447
0.180	10.00	16.0512
0.120	5.00	12.0384
0.062	4.00	18.6401
0.030	1.00	9.6307

Table III-4
Source Characteristics for Fugitive Emission Sources

Point Sources						
Description	X^* (m)	Y^* (m)	Stack Height (m)	Temperature (deg. K)	Exit Velocity (m/s)	Diameter (m)
Ash Handling	23.89	48.98	6.706	310.	0.1	0.1
Organic Wastetank Farm						
Vent #1	173.47	108.45	18.9	310.	0.1	0.1
Vent #2	193.12	116.90	18.9	310.	0.1	0.1
Vent #3	199.30	102.31	18.9	310.	0.1	0.1
Vent #4	179.65	93.99	18.9	310.	0.1	0.1
Carbon Adsorption Bed	61.02	42.83	28.04	250.	31.05	0.762

Volume Sources					
Description	X^* (m)	Y^* (m)	Height (m)	Initial σ_y	Initial σ_z
Open Wastewater Tank	177.06	204.76	5.3	2.35	4.96
Truck Wash	100.16	170.91	3.048	1.77	2.84

* Coordinates are relative to the origin (0.0, 0.0) located at main incinerator stack. Coordinates are oriented relative to true north.

Table III-5
WTI Building Information

(From A.T. Kearney, 1992)

No.	Description	Building Height (H_B)
1	Maintenance	15.24 m (50 ft)
2	Administration	8.84 m (29 ft)
3	Truck Holding	6.10 m (20 ft)
4	Steam Plant	6.71 m (22 ft)
5	Container Hold	6.10 m (20 ft)
6	Incinerator Feed	25.76 m (84.5 ft)
7	Container Processing	14.94 m (49 ft)
8	Waste Tank Farm	15.24 m (50 ft)
9	Truck Unloading	6.10 m (20 ft)
10	Water Treatment	7.62 m (25 ft)
11	Scrubber	29.08 m (95.4 ft)
12	Precipitator	24.38 m (80 ft)
13	Spray Dryer	32.31 m (106 ft)
14	Boiler	21.34 m (70 ft)

Table III-6
Direction-Specific Building Dimensions
for the WTI Main Stack
Produced by the BPIP Program

Direction (degrees)	Building Height (m)	Building Width (m)	Direction (degrees)	Building Height (m)	Building Width (m)
10	29.08	26.88	190	29.08	26.88
20	29.08	24.72	200	29.08	24.72
30	29.08	21.81	210	29.08	21.81
40	25.76	27.61	220	25.76	27.61
50	24.38	27.01	230	25.76	26.08
60	24.38	24.64	240	25.76	23.77
70	24.38	25.97	250	24.38	25.97
80	29.08	22.57	260	25.76	24.81
90	29.08	25.75	270	29.08	25.75
100	29.08	28.77	280	29.08	28.77
110	29.08	30.90	290	29.08	30.90
120	29.08	32.10	300	29.08	32.10
130	29.08	32.33	310	29.08	32.33
140	29.08	31.85	320	29.08	31.85
150	29.08	30.86	330	29.08	30.86
160	29.08	29.63	340	29.08	29.63
170	29.08	29.30	350	29.08	29.30
180	29.08	28.21	360	29.08	28.21

Table III-7
Geophysical Parameters Assigned to Each Land Use Type in the Sensitivity Runs of ISC-COMPDEP

Land Use Category	Number of Receptors	Surface Roughness (m)	Albedo	Minimum Value of L (m)	Soil Moisture Parameter
Urban/suburban	371	1.00	0.20	25	0.8
Agricultural	147	0.25	0.20	2	1.0
Forest land	275	1.00	0.14	25	0.8
Water	141	0.0001	0.10	2	1.2
Barren	2	0.002	0.30	2	0.3

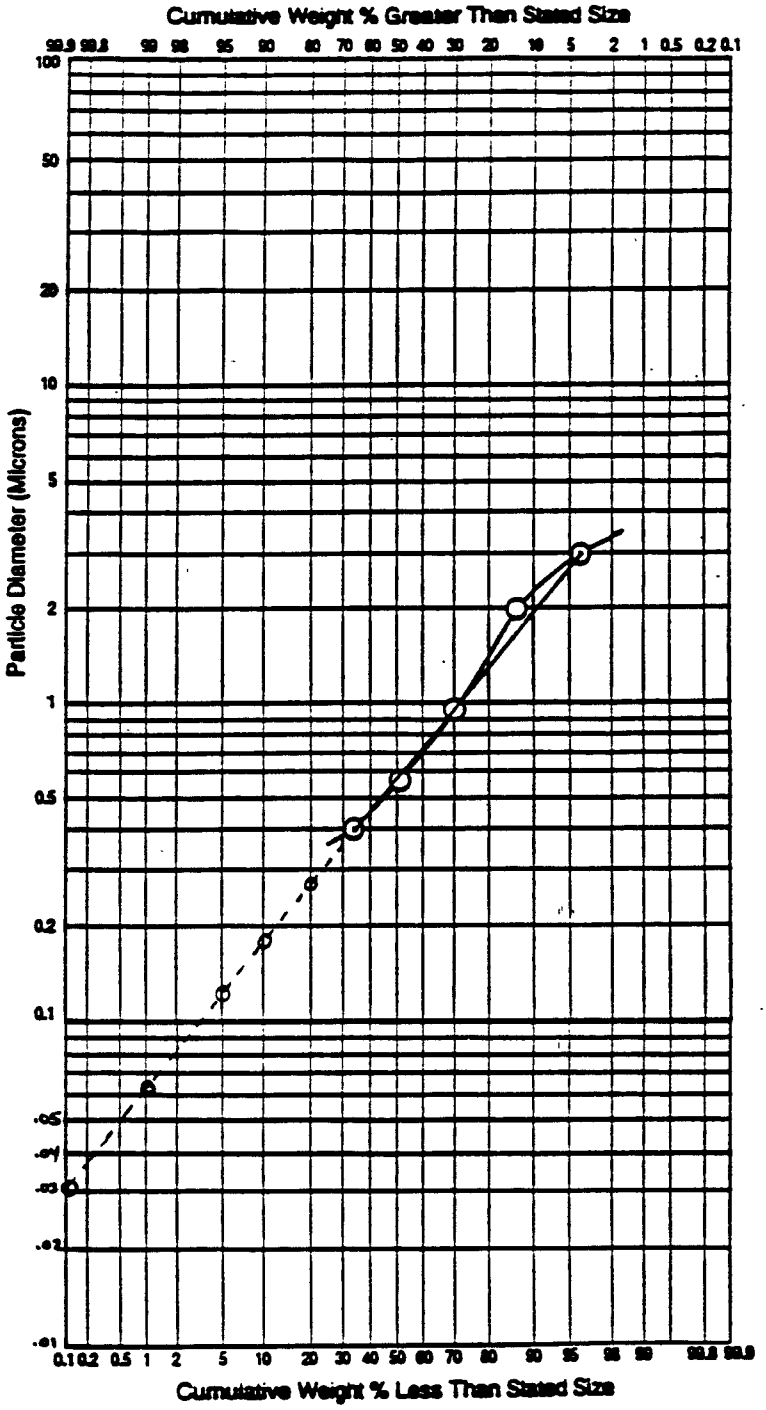

Figure III-1. Plot of particle mass as a function of particle diameter. Data for particle sizes greater than 0.4-μm diameter are from the Trial Burn test results of March 17, 1993 (U.S. EPA, 1993f). The points below 0.4-μm diameter are based on an extrapolation of a best-fit line through the observed data points.

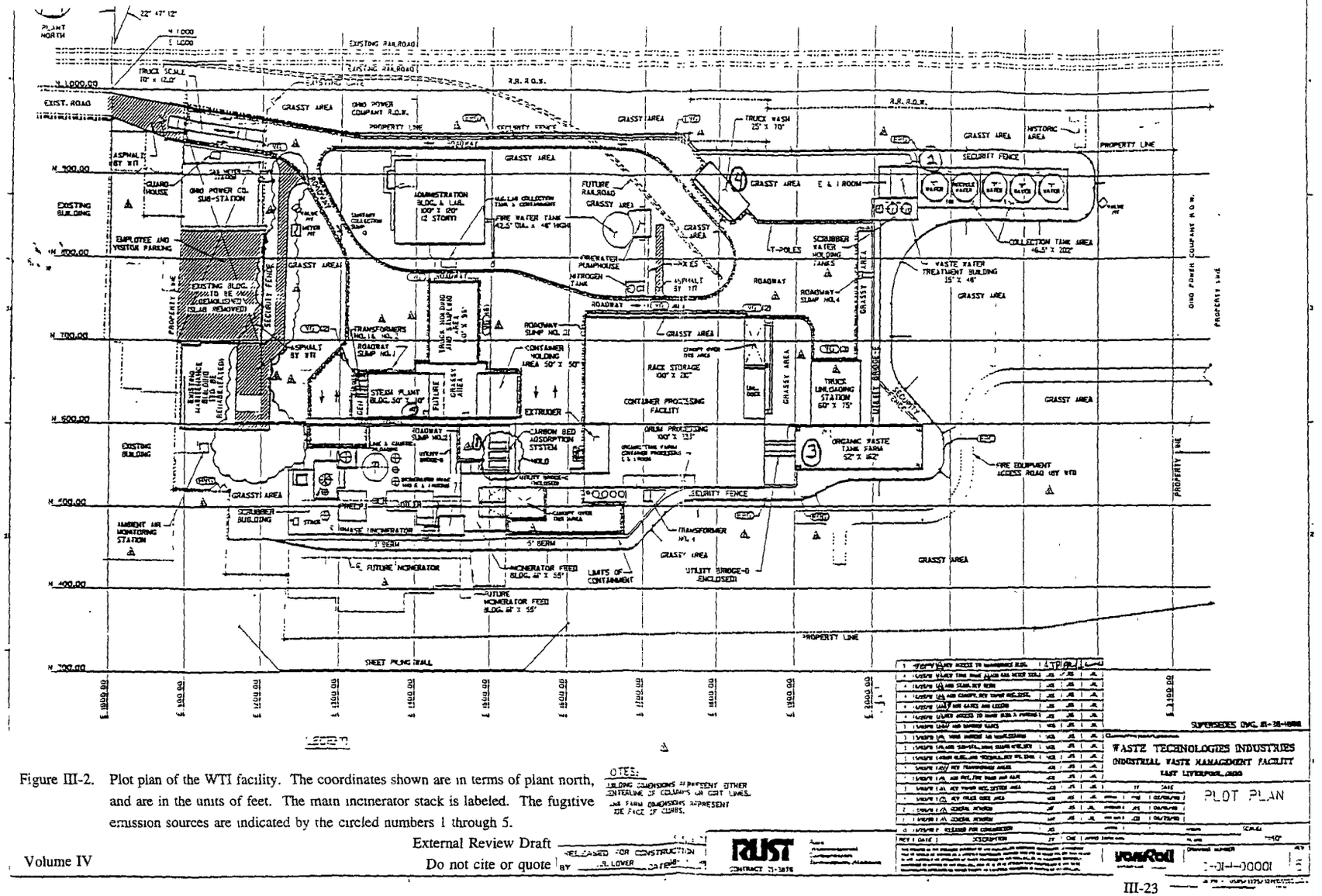

Figure III-2. Plot plan of the WTI facility. The coordinates shown are in terms of plant north, and are in the units of feet. The main incinerator stack is labeled. The fugitive emission sources are indicated by the circled numbers 1 through 5.

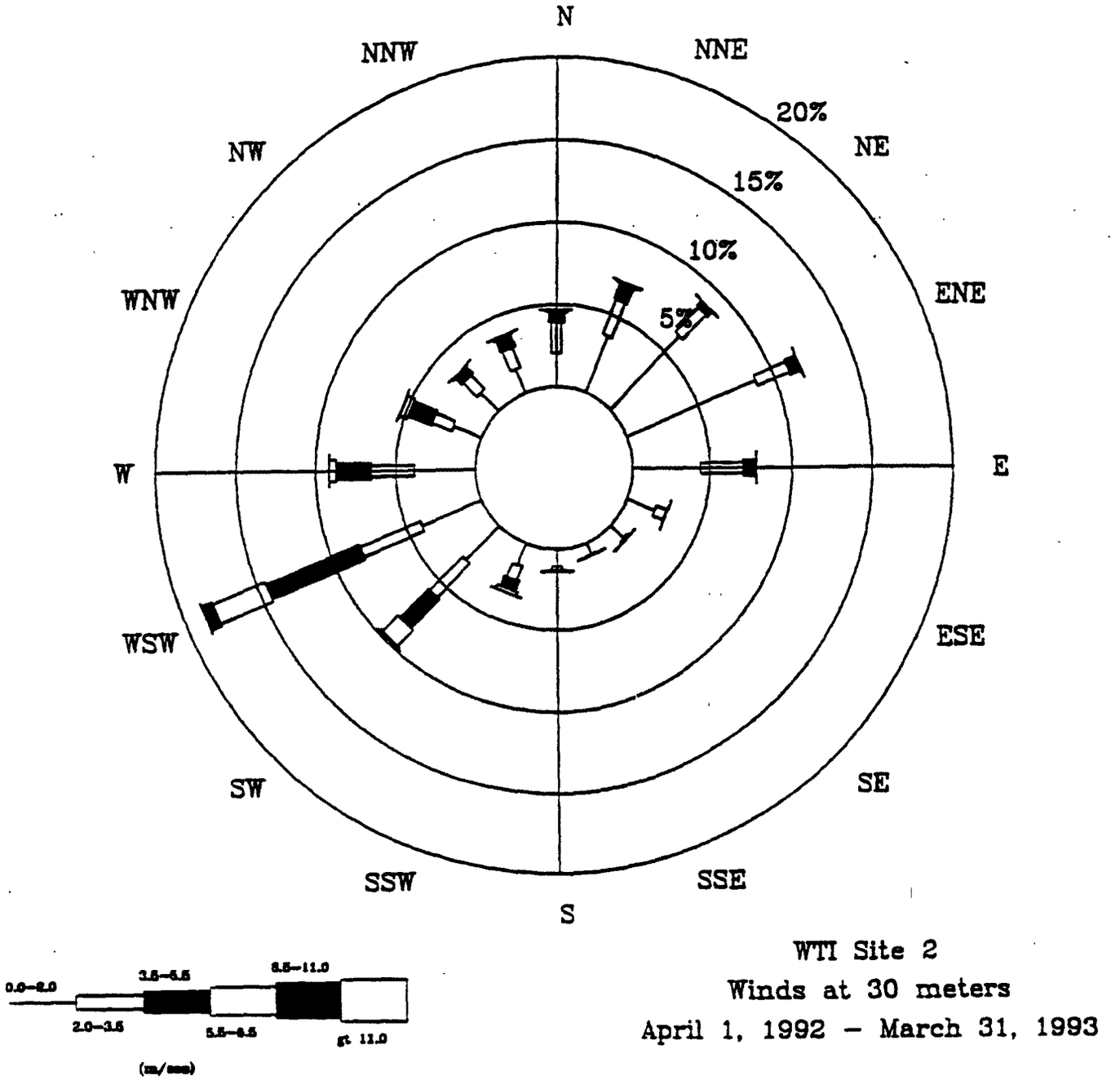

Figure III-3. Hourly wind rose for WTI Site 2, 30-m data, located on-site.

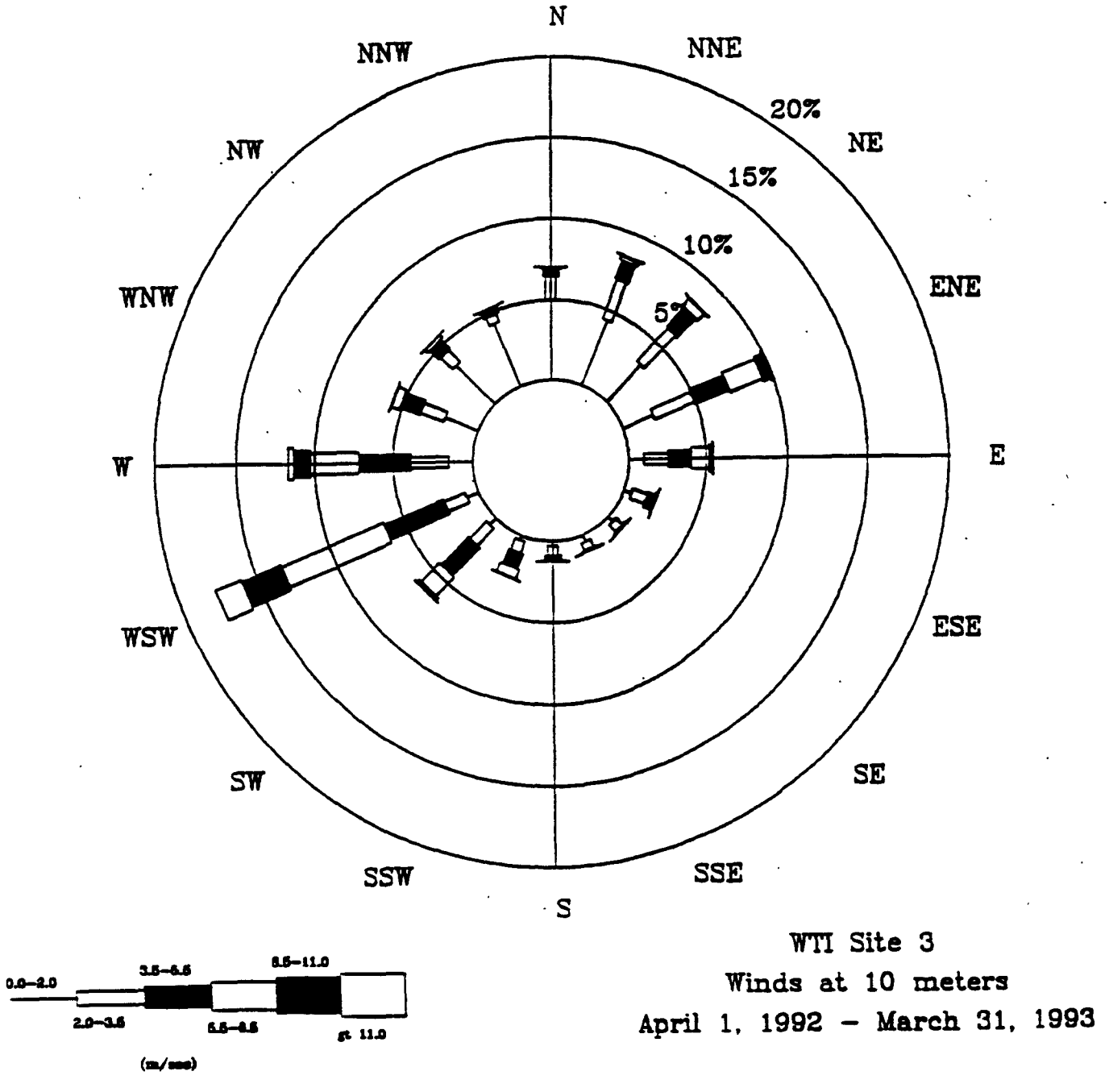

Figure III-4. Hourly wind rose for WTI Site 3, located at the eastern edge of the property.

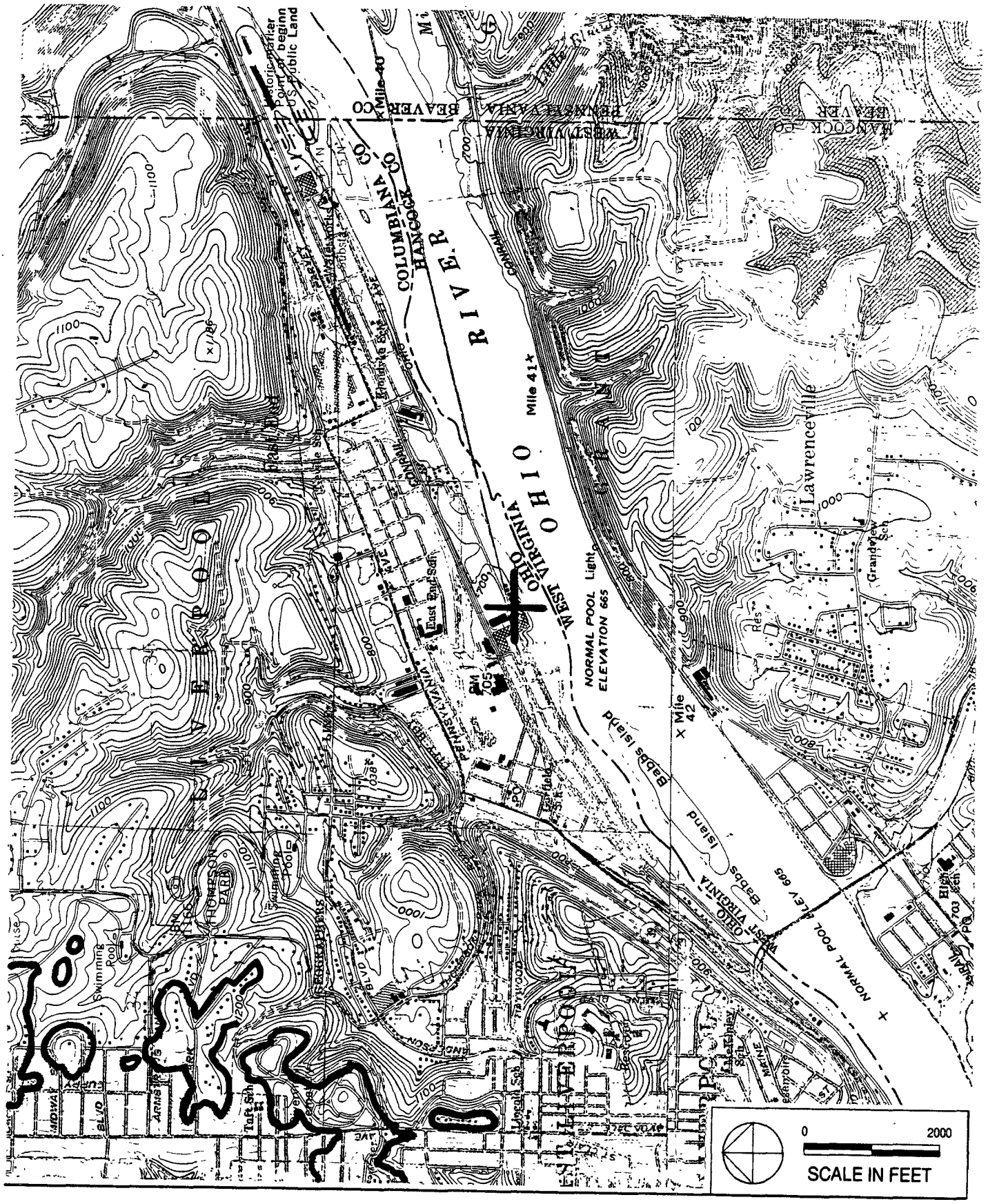

Figure III-5. Section from a USGS map that depicts the topography of the area surrounding the WTI site. The cross indicates the location of the facility and the wind measurements. The 1200-ft contour line is highlighted. The BVPSMT 500-ft level is at 1235 ft ASL.

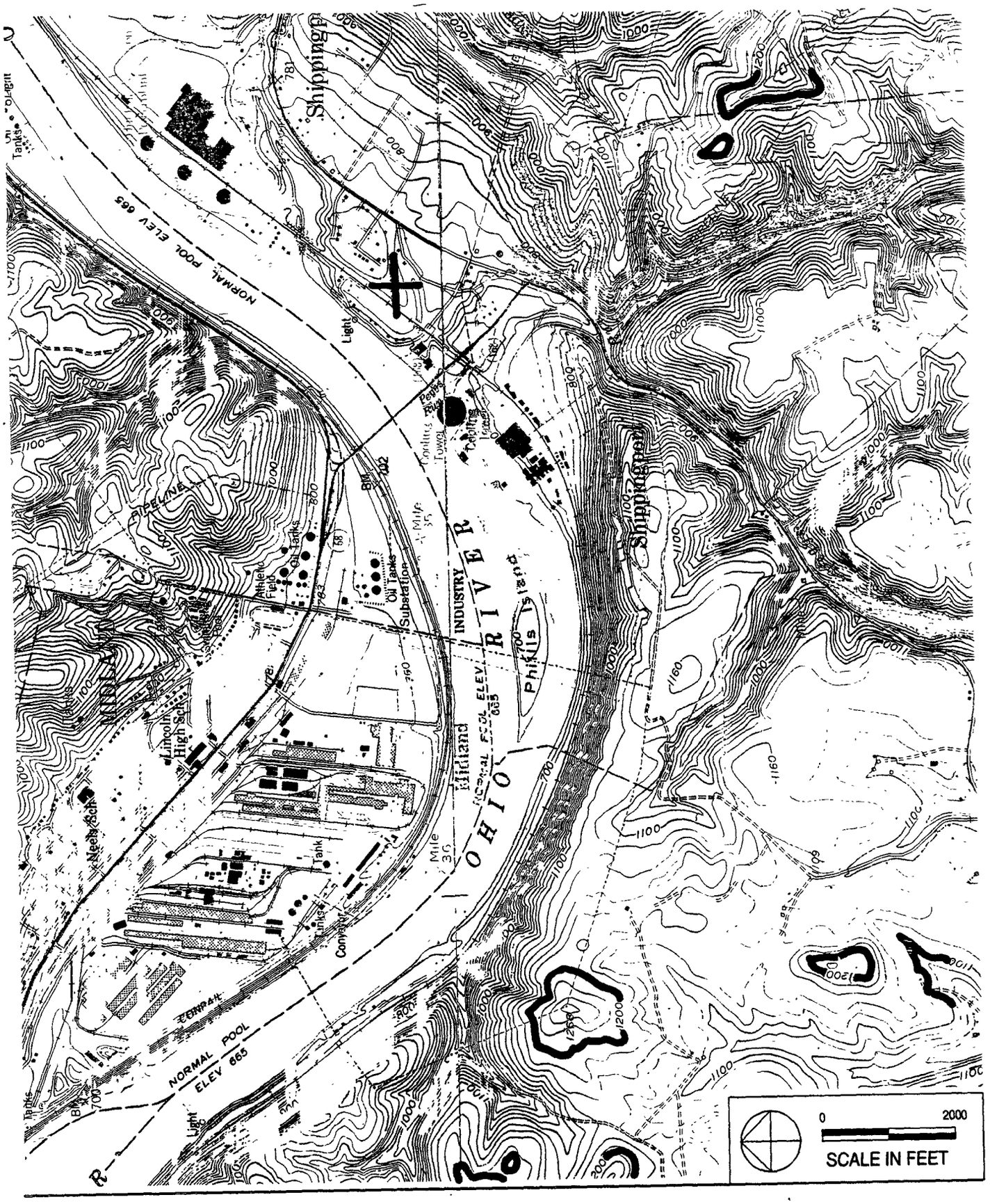

Figure III-6. Section from a USGS map that depicts the topography of the area surrounding the Beaver Valley Power Station meteorological tower. The cross indicates the location of the tower. The 1200-ft contour line is highlighted. The BVPSMT 500-ft level is at 1235 feet ASL.

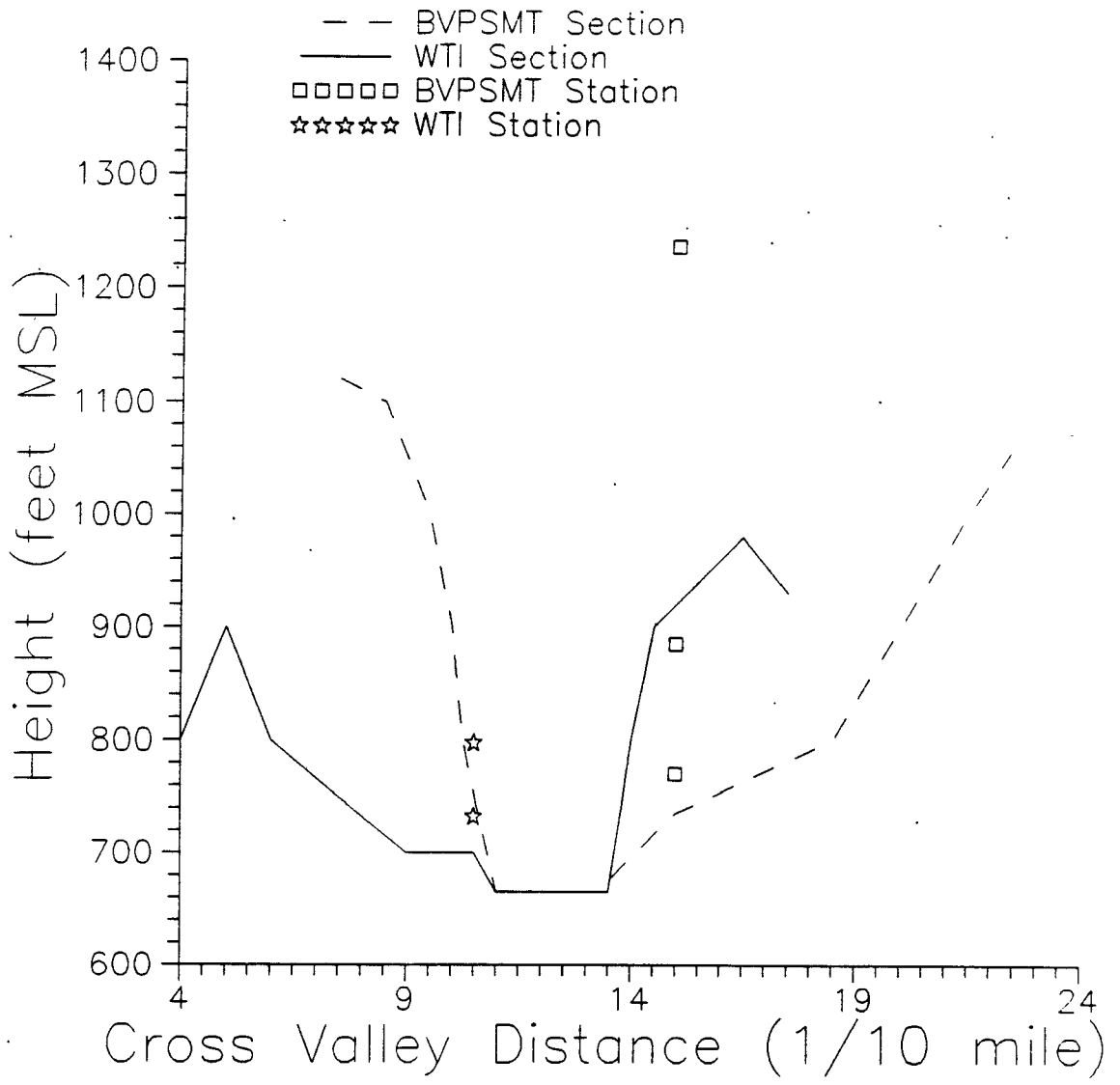

Figure III-7. Cross-section of terrain (MSL) at the sites of the BVPSMT and WTI meteorological towers. Also shown are the elevations of the various levels of the meteorological towers.

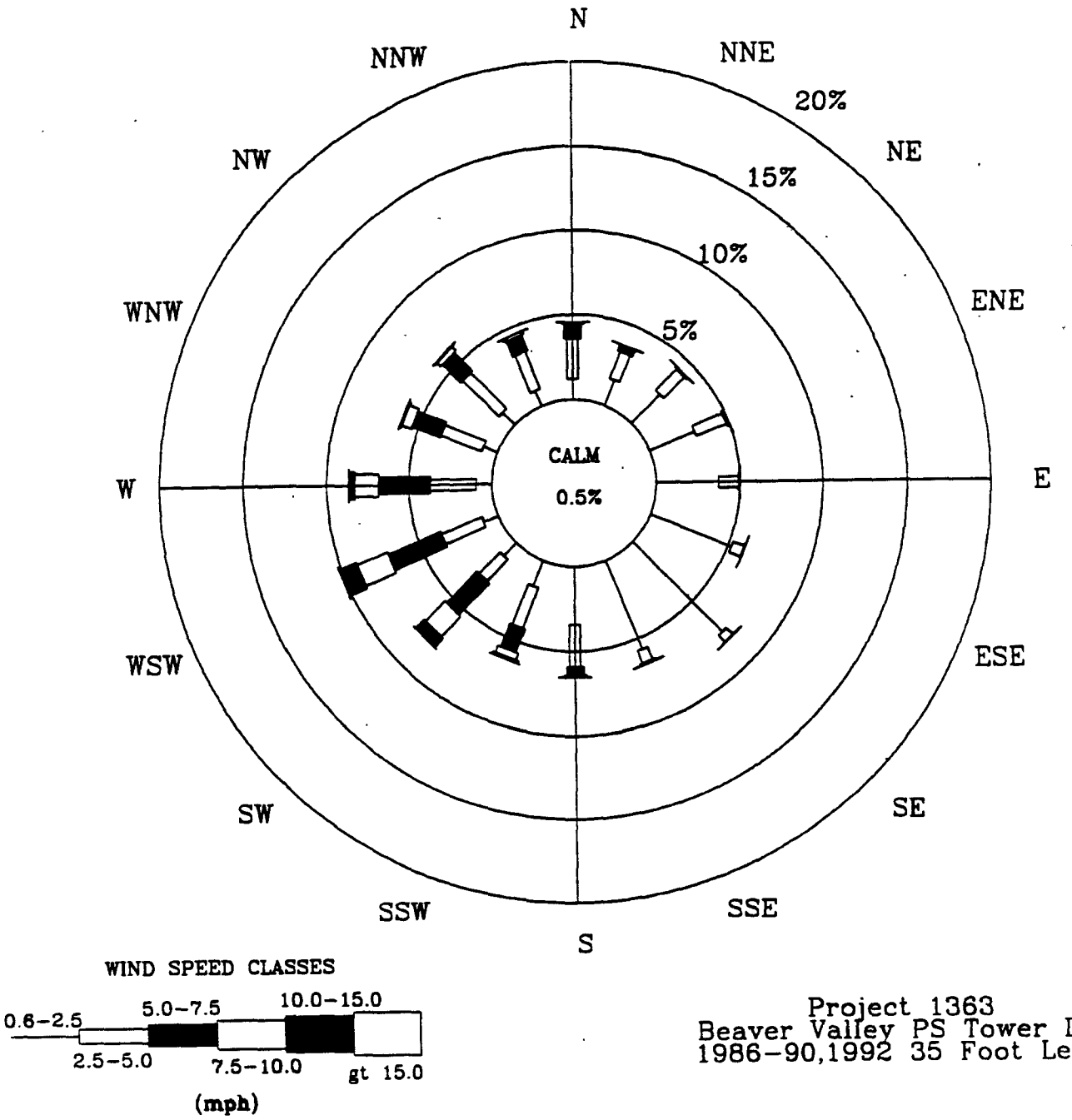

Figure III-8. Hourly wind rose at Beaver Valley Power Station meteorological tower 35-ft level for 1986–1990, 1992 (six years).

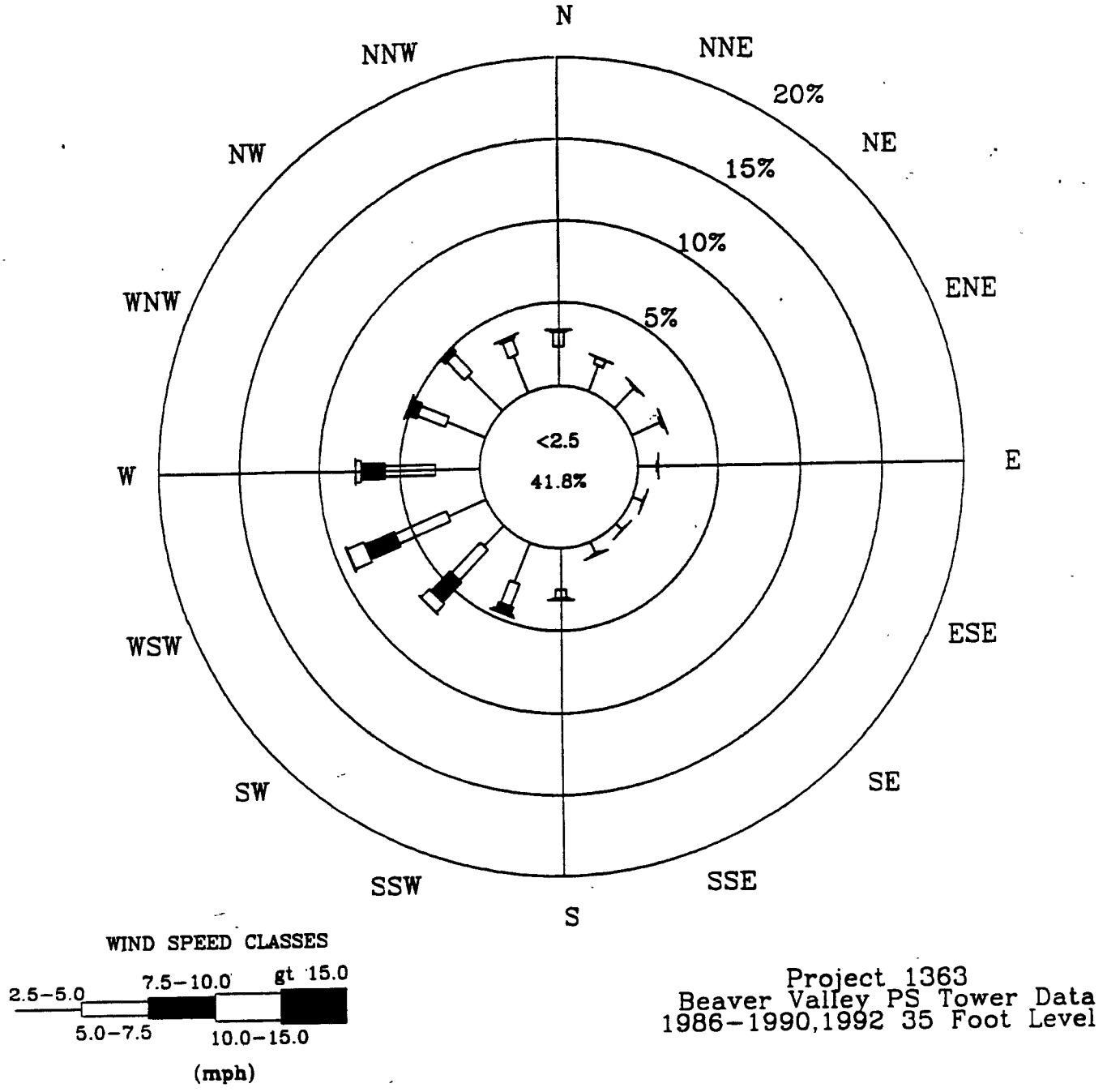

Figure III-9. As in Figure III-8, except that winds less than 2.5 miles per hour are not included in the wind rose.

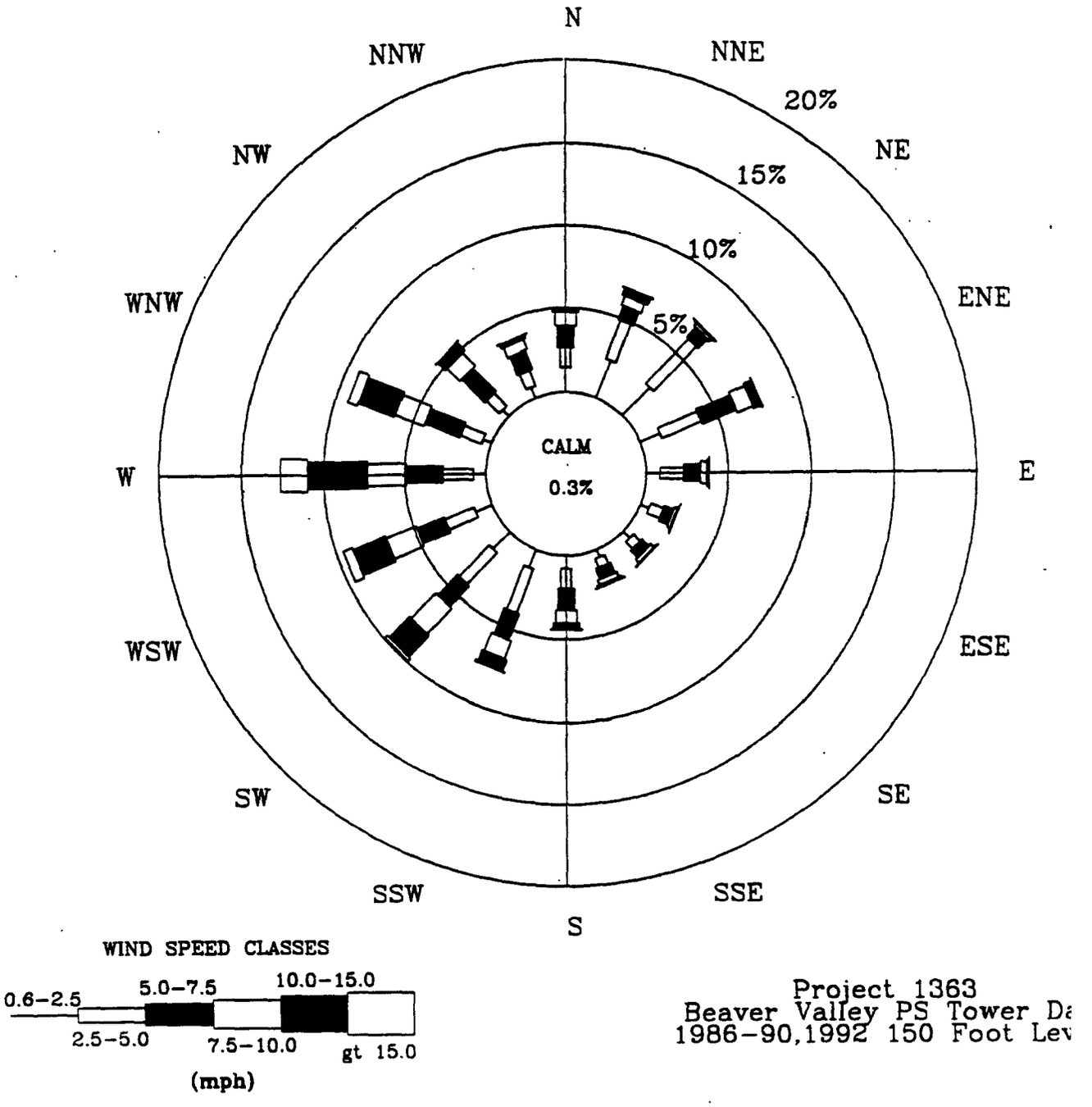

Figure III-10. Hourly wind rose at Beaver Valley Power Station meteorological tower 150-ft level for 1986–1990, 1992 (six years).

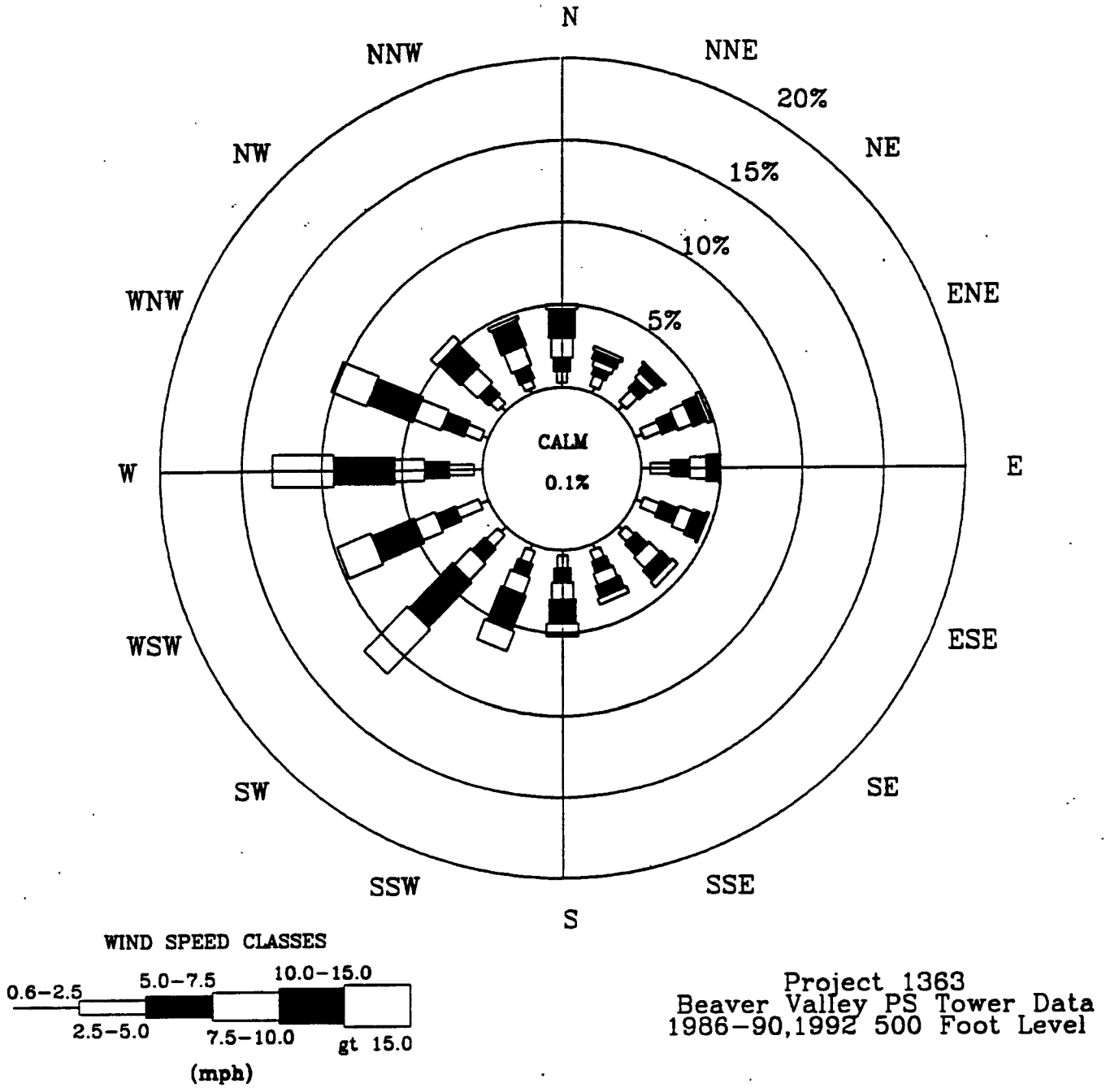

Figure III-11. Hourly wind rose at Beaver Valley Power Station meteorological tower 500-ft level for 1986–1990, 1992 (six years).

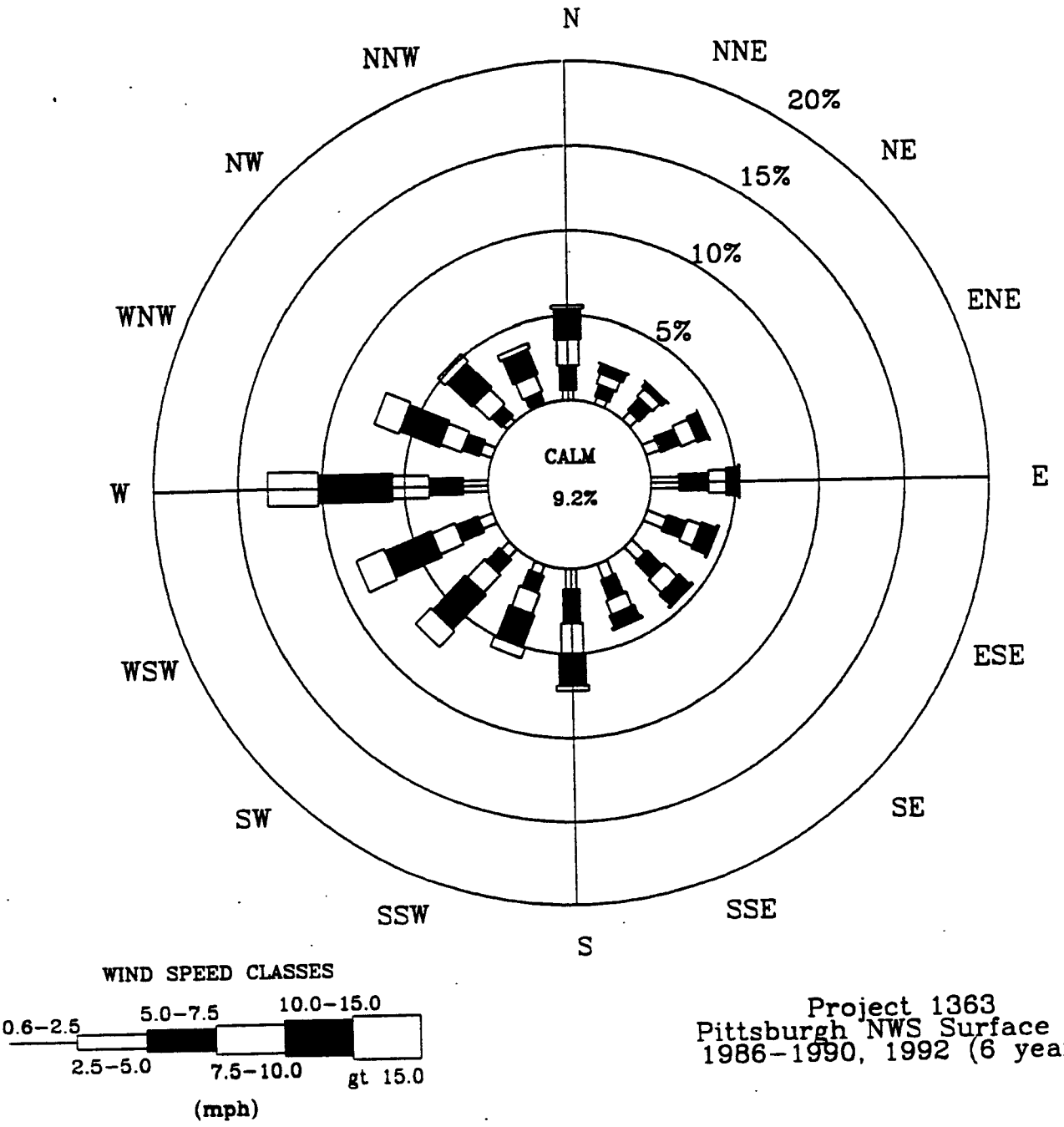

Figure III-12. Wind rose at Greater Pittsburgh International Airport, based on hourly observations at the surface, covering 1986–1990 plus 1992.

IV. DISCUSSION OF MODELING RESULTS

Modeling simulations are conducted with the ISC-COMPDEP model, as described in Chapter II, to predict the peak and spatially-averaged concentrations and deposition fluxes due to the emissions from the WTI incinerator. A set of "base case" simulations are used to predict the impacts of the different forms that the pollutants may take. For example, the base case simulations include the following runs: (1) pollutants assumed to be distributed throughout the particulate matter leaving the stack (i.e., the "mass" pollutant distribution), which is appropriate for non-volatile metals; (2) pollutants assumed to be distributed on the outside surface of the particulate matter (i.e., the "surface area" pollutant distribution, which is appropriate for semi-volatile organics; and (3) pollutants emitted as a vapor.

The base case simulations constitute the best estimate of the actual impacts from the facility. The base case results are described in Section IV.A. In addition, however, a set of sensitivity simulations (see Section IV.B) are conducted to determine the variation in the predicted results to various types of data inputs, and to assess the impact of alternative source configurations (e.g., a Good Engineering Practice (GEP) height stack rather than the present sub-GEP height stack). The model input sensitivity tests that are conducted include simulations using nine-year high and low annual precipitation amounts, and the use of turbulence-based horizontal dispersion coefficients utilizing the BVPSMT measurements of horizontal wind fluctuations (σ_θ).

Additional model sensitivity tests are conducted with an earlier version of the ISC-COMPDEP model and the COMPDEP model, prior to the peer review. The results of these simulations are also presented, because they offer insight into the model's sensitivity (or lack thereof) to alternative assumptions regarding the particle size distribution, the effects of plume depletion, and the sensitivity to assumptions regarding land use. The COMPDEP simulations, with its different deposition and dispersion (i.e., building downwash) algorithms, provide a reference point for assessing the ISC-COMPDEP results that is useful in the uncertainty analysis.

Because the steady-state plume model is ill-suited to evaluate impacts during calm wind conditions and during fumigation events, modeling is conducted with the CALPUFF non-steady-state dispersion model (Section IV.B.5). The CALPUFF simulations are designed to isolate the effects of the calm wind and fumigation conditions to the extent possible. Other than taking advantage of the inherent features of the non-steady-state approach, the CALPUFF is run in a mode that otherwise was similar to the ISC-COMPDEP run. Additional simulations with the INPUFF non-steady-state model, conducted by the

U.S. EPA are also summarized. The INPUFF simulations assess the effects of calm wind conditions for a WTI-like stack in a hypothetical flat terrain setting.

The effects of terrain-induced downwash cannot be adequately modeled with the current generation of regulatory models. Therefore, in order to evaluate the effects of terrain downwash, the U.S. EPA conducted a set of wind tunnel simulations of the WTI site and the surrounding terrain. In Section IV.B.6, the results of the physical modeling performed in the wind tunnel study are summarized along with mathematical modeling with ISC-COMPDEP for the conditions studied in the wind tunnel.

The impacts of routine fugitive emission sources are also evaluated (Section IV.C). The fugitive sources modeled include the carbon bed adsorption system, ash handling activities, the open wastewater tank, the organic waste tank farm, and the truck wash.

An analysis of the uncertainty in the modeling is also conducted (see Section IV.D). The uncertainty analysis is categorized into two types: limitations of the technical algorithms in the models, and limitations in the amount and quality of the data available to the model.

A. Base Case Simulations of Incinerator Emissions

A total of thirteen sets of simulations of the main incinerator stack are conducted with a version of the ISC-COMPDEP model modified to address the peer reviewer comments. Three base case sets of runs are conducted, corresponding to the three different pollutant distributions: mass-weighted (particle), surface area-weighted (particle), and vapor distributions. Wet and dry deposition effects are computed for the distributions involving particulate matter. The vapor simulations are conducted assuming no deposition. Ten sets of sensitivity tests are conducted to evaluate the response of the model to various input assumptions and model options. Each simulation involving particulate matter requires four runs of the model: one to generate predicted concentrations, and three to output wet deposition fluxes, dry deposition fluxes, and total deposition. This is required due to the structure of ISC-COMPDEP's parent model, ISC2, which allows the output of only one field per run.

The matrix of simulations and a summary of the model output statistics are shown in Table IV-1. Contour plots for the base case simulations are presented in Appendix IV-4. In general, the model is executed in a regulatory mode, i.e., using those options and switches which are recommended for regulatory use in the *Guideline on Air Quality Models* for ISCST2 and COMPLEX I (see Section III.F). However, enhanced features of ISC-COMPDEP, which are not part of the ISCST2 and COMPLEX I models, are also used in the simulations. These enhancements include the use of multi-layer meteorological data, a scavenging coefficient model for wet deposition, a resistance-based model for dry

deposition, and multi-layer plume rise. A partial listing of the model output files generated by ISC-COMPDEP for the base case simulations is shown in Appendix IV-3. Version 94227 of ISC-COMPDEP is used in all of the simulations.

Table IV-1 shows the maximum annual concentration and total deposition flux predicted by the model for any of the 936 receptors. The total deposition flux is the sum of the wet and dry fluxes. In addition, the following spatially-averaged variables are shown:

- Receptor average concentration, $\overline{\chi}$:

$$\overline{\chi} = \frac{1}{N} \sum_{i=1}^{N} \chi_i \qquad \text{(IV-1)}$$

where χ_i is the concentration at receptor i, and
N is the number of receptors (i.e., 936).

- Receptor average total deposition flux, $\overline{F_t}$:

$$\overline{F_t} = \frac{1}{N} \sum_{i=1}^{N} (F_t)_i \qquad \text{(IV-2)}$$

where $(F_t)_i$ is the total (wet + dry) deposition flux at receptor i, and

$\overline{F_t}$ is the receptor average deposition flux

- "Total" average deposition velocity, $\overline{(v_d)_t}$:

$$\overline{(v_d)_t} = \overline{F_t} / \overline{\chi} \qquad \text{(IV-3)}$$

Note that the "total" deposition velocity, as it is defined here, includes the effects of both wet and dry deposition. It is useful as a convenient reference point for comparing the bulk removal rates for the base application with those from the other sensitivity runs as well as those in other studies. However, this variable should be applied only on a bulk basis, and not on a receptor-by-receptor basis because it is not necessarily well-behaved at all receptors. For example, in the near-field where the plume is elevated and not interacting with the ground, the ground-level concentration will approach zero, but the total flux (due to wet removal) will be non-zero. Thus, the "total" deposition velocity can approach infinity. However, as applied here, the "total" deposition velocity is a useful bulk measure of the average rate of deposition per unit of concentration.

As shown in Table IV-1, the base case simulations show relatively little sensitivity of the concentration to the pollutant distribution. The maximum concentrations are within 1% for all three pollutant distributions, and are predicted to occur at the same receptor (1 km from the stack, to the east (100°)) on the West Virginia side of the Ohio River. The terrain height at this receptor is 1,080 ft (329.2 m), or 234 ft above the elevation of the top of the stack. Thus, complex terrain effects are involved in producing the peak concentration, as well as a relatively high frequency of winds from the west and west-northwest directions. The concentration averaged over all receptors is also insensitive to the pollutant distribution. The predicted deposition fluxes show a 40% increase with the surface area-weighted distribution over the mass-weighted distribution.

The spatial patterns of the predicted concentrations, wet fluxes, dry fluxes, and total fluxes are shown in Figures IV-1 through IV-4. The effects of terrain channeling of the wind flow can be seen in the orientation of the concentration and deposition isopleths. The dominance of wet deposition over dry deposition is also evident from the contour plots. Additional detailed plots of near-field concentrations and deposition isopleths are provided in Appendix IV-4.

The peak base case deposition fluxes are predicted to occur at a receptor 100 m from the stack to the east (80°). Detailed plots of the wet and dry deposition fluxes for the base case run 1a are provided on Pages IV-4-5 and IV-4-7, respectively, of Appendix IV-4. Note the similarity of the dry deposition flux pattern with the ground-level concentration pattern (Page IV-4-3). This is due to the direct proportionality of the dry fluxes with ground-level concentrations (i.e., dry flux is the product of the concentration and the deposition velocity). The same factors that contribute to elevated concentration predictions will also produce higher dry deposition fluxes. However, also note the large differences between the wet deposition pattern and the dry deposition/concentration patterns. Wet removal is modeled as being proportional to the vertically integrated concentration, so its peak occurs at the closest receptor ring where the plume depth is the smallest. (As discussed in Section D.1.a, this formulation may tend to overestimate wet fluxes in the near field). The wet flux peak is in an area where the ground-level concentrations are small. Because the model assumes that the precipitation falls through the plume, even if the plume is elevated, it is not necessary for the plume to have dispersed down to the ground for wet removal to occur. A comparison of the wet and dry deposition values in the plots shows the dominance of wet removal at the point of peak predicted total deposition flux.

B. Sensitivity Simulations of Incinerator Emissions

1. Overview of Previous Modeling Results

Based on the initial work plan and a version of ISC-COMPDEP developed before the peer review workshop, some initial simulations were conducted with the WTI incinerator stack. Although the ISC-COMPDEP model has been revised, as discussed in Section II.A, the sensitivity results of the previous modeling offers some insight into the model's response to certain input variables. An overview of the previous modeling results is presented here.

A total of sixteen simulations are conducted with the COMPDEP and ISC-COMPDEP models to evaluate a set of base case assumptions and to test the sensitivity of the model to various input assumptions and model options. The matrix of simulations are shown in Table IV-2 along with a summary of model output statistics. Version 93340 of COMPDEP and Version 93349 of ISC-COMPDEP are used in the simulations discussed in this subsection.

Table IV-2 contains the maximum annual concentration and total (wet + dry) deposition flux predicted by each model for any receptor, as well as the receptor-average concentration and total deposition flux averaged over all 936 receptors, and the effective total (wet + dry) "deposition velocity."

In comparing the base case COMPDEP simulations with the base case ISC-COMPDEP simulations, it is apparent that the models produce similar results. The ISC-COMPDEP produces receptor-averaged deposition fluxes which are 30-40% higher than COMPDEP. The corresponding receptor-averaged concentrations are approximately 15-17% lower with ISC-COMPDEP than COMPDEP. The rate of removal, with the new dry deposition scheme in ISC-COMPDEP and the differences in the wet removal technique, is about 50%-70% higher than in COMPDEP, based on the magnitude of the total deposition velocities. In the vapor base case simulations, which does not include any deposition or depletion effects, ISC-COMPDEP predicts a receptor-averaged concentration about 15% lower than that with COMPDEP. However, the predicted *peak* concentration is slightly higher with ISC-COMPDEP. These differences can be attributed to the differences in the treatment of building downwash in the models. As discussed in Section II.M, COMPDEP uses the Huber-Snyder algorithm for all sub-GEP stack heights, and uses a single set of worst-case building dimensions for all wind directions. ISC-COMPDEP has both the Huber-Snyder and Schulman-Scire algorithms implemented as in ISCST2, and uses direction-specific building dimensions with both algorithms. The building height used in the initial runs of ISC-COMPDEP have since been

revised based on new information so that the stack will use the Huber-Snyder downwash model. In the results presented here, about half of the directions (16 out of 36) use the Huber-Snyder model, and the others use the Schulman-Scire model.

The results suggest that the use of a single worst-case set of building dimensions in COMPDEP is contributing to the higher receptor-average values predicted with the model. Therefore, it appears that the lack of the Schulman-Scire algorithm in COMPDEP tends to result in lower concentrations in COMPDEP, but a compensating factor (and in the case of the receptor-average concentrations, a dominating factor) is the use of conservative building dimensions for all direction, which tends to overestimate the impacts with COMPDEP for those directions where the controlling building dimensions are less favorable for downwash than the worst-case dimensions. These conclusions are strongly dependent on the specific source and building configuration input into the model.

Both ISC-COMPDEP and COMPDEP show only a weak sensitivity of area-averaged concentrations and deposition fluxes to the assumption of mass-weighted or surface area weighted pollutant distributions. For COMPDEP, the receptor-averaged deposition fluxes are only about 1% higher for the surface area-weighted distribution, and for ISC-COMPDEP, the deposition flux for surface area distribution is less than 10% higher than for the mass-weighted distribution. Even in the sensitivity runs with all of the pollutant mass on particles less than 0.4 μm diameter assigned to very small 0.03 μm diameter particles (i.e., sensitivity runs C-2a, C-2b, I-2a, and I-2b), the receptor-average deposition flux is within 30% of the base case values. The receptor-average concentrations are within 5% of the base case values for both models. The average concentrations are also insensitive (within 7% of the base case values) to the assumption of the vapor pollutant depositing at the same rate as 0.03 μm diameter particles. These results suggest that plume depletion is not a large factor in determining the ambient air concentrations. It should be noted, however, that the receptor-average statistics are weighted more heavily to the near-field impacts because the density of receptors decreases as the distance from the stack increases. The peak deposition flux is somewhat more sensitive to the pollutant size distribution. The maximum deposition flux with the small particles is about 30% higher than the base case for the mass-weighted distribution (Run I-2a) and about 60% higher for the surface area distribution (Run I-2b). Again, these conclusions are likely to be a strong function of the particular WTI particle size distributions used in the tests, and may not be universally applicable.

The final set of sensitivity tests involves the application of ISC-COMPDEP with receptor-specific land use and surface characteristics. Runs are made for both

the mass-weighted and surface area-weighted pollutant distributions. The deposition fluxes show more sensitivity to assumptions about land use than some of the other variables. The receptor-specific land use runs with ISC-COMPDEP produce receptor-average deposition fluxes about twice as high for the mass-weighted distribution and about 50% higher for the surface area-weighted distribution than the base case simulations with a constant, area-wide average land use characterization.

The general lack of sensitivity to many of the assumptions regarding the pollutant distribution from the WTI incinerator suggests that the uncertainties associated with the emission variables are not likely to dominate the results of the modeling analysis, at least for the specific particle distribution identified at the WTI facility. The sensitivity results also suggest that efforts to characterize the geophysical variables (e.g., land use) as well as possible are worth the effort, since the model is more sensitive to these variables.

2. GEP Stack Height Tests

A set of ISC-COMPDEP simulations is conducted to evaluate the effect of a GEP height stack on predicted concentration and deposition fluxes. The actual WTI incinerator stack, at 45.7 meters, is less than GEP height of 72.7 meters (see Section III.B). The peak and average ground-level concentrations decrease by approximately 11-13% and 19%, respectively, with the higher GEP height stack. This is due to the effects of a higher plume and the absence of enhanced dispersion due to building downwash with the GEP height stack. The deposition fluxes, on the average, are insensitive to the stack height. This is due to the dominance of wet deposition over dry deposition in the model for the WTI pollutant distribution. Because wet deposition is a function of the vertically integrated concentration and is nearly independent of plume height, the wet flux patterns do not show much variation with stack height.

3. Precipitation Tests

The effect of the year-to-year variability in precipitation is evaluated in a series of sensitivity tests with ISC-COMPDEP. In the base simulations, precipitation data observed at the Pittsburgh Airport and obtained from the National Climatic Data Center (NCDC) are used in the calculation of wet fluxes. For the annual period modeled, April 1992 through March 1993, the Pittsburgh precipitation was 39.3 inches, as compared to a 30-year climatological average at the Pittsburgh Airport of 36.3 inches (NOAA 1983). Precipitation data from the BVPSMT for the period 1986 through May 1994 are analyzed. The average annual precipitation at the

BVPSMT is 33.7 inches for this period, with a low of 27.1 inches (1991) and a high of 47.34 inches (1990). The annual amounts at the BVPSMT for 1986 through 1994 are 26.51, 39.79, 27.41, 30.50, 47.34, 27.10, 33.62, 34.55, and 36.22 (annualized).

In the precipitation sensitivity tests, the base precipitation file (from the Pittsburgh Airport), is scaled by the ratio of the highest annual BVPSMT precipitation to the base amount (i.e., 47.34/39.3 = 1.20) and the ratio of the lowest annual BVPSMT precipitation to the base amount (i.e., 27.1/39.3 = 0.69). All of the other meteorological variables are kept unchanged. This allows the effect of precipitation amounts to be isolated from other factors.

The results, presented in Table IV-1, show that the peak and average concentrations are insensitive to the precipitation amount. This is due to the fact that only a very small fraction of the mass emitted is actually depleted from the plume within the modeling domain. Therefore, a change in precipitation will only weakly influence the concentrations (other factors being equal) through the small change in the amount of mass depleted from the plume. The average deposition shows a roughly proportional relationship with the precipitation amount. The percentage change in total deposition flux is only slightly less than the change in the precipitation amount. Although wet deposition is predicted to dominate the deposition flux for the WTI pollutant distribution, the effect of dry deposition, which is insensitive to precipitation amount, results in a slightly lower percentage change in deposition than a direct proportionality with the precipitation amount.

4. Dispersion Coefficient Tests

A special version of ISC-COMPDEP was developed to allow the use of measured turbulence data from the BVPSMT in the calculation of the dispersion rates used in the model. Measured values of σ_θ are available from the BVPSMT at the 150-ft and 500-ft levels of the tower. The model computes σ_y from the measured wind fluctuations, rather than on surface stability class. The relationship between σ_y and σ_θ can be written as:

$$\sigma_y = \frac{\sigma_\theta x}{f_y} \quad , \qquad \text{(IV-4)}$$

where σ_y is in meters,

σ_θ is in radians,

x is the downwind distance (m), and

the function, f_y, is given by Draxler (1976):

$$f_y(x) = 1 + 0.9(0.001x/u)^{0.5} \quad \text{(IV-5)}$$

where u is the wind speed (m/s).

In the first equation above, the approximate equivalence of the turbulence intensity i_y and σ_θ is used (i.e., $i_y = \sigma_\theta$, for small values of σ_θ, expressed in radians). Missing values of σ_θ are filled by taking the slope of the initial (small x) portion of the rural Briggs curves for σ_y (as reported by Gifford, 1976). For small x, the growth in σ_y is nearly linear, so that $\sigma_\theta = \sigma_y/x$. These values vary by stability class:

Stability class:	A	B	C	D	E	F
σ_θ (radians):	0.22	0.16	0.11	0.08	0.06	0.04

The influence of using measured wind fluctuation data on the size of σ_θ, relative to the base case runs which use the PG sigmas, can be seen by comparing the distribution of the measured turbulence intensity with the values in the table above inferred from the Briggs curves. Figure IV-1 shows that the median turbulence intensities observed at 45.7 m (150 ft) exceed the corresponding "Briggs" values by about 0.2 radians for stability classes 2 through 7, while median values measured at 152.4 m (500 ft) exceed the "Briggs" values by about 0.1 radians for classes 4 through 7, and 0.2 radians for classes 2 and 3 (the observed median is roughly twice the size of the "Briggs" value at 500 ft). For the rare occurrences of stability class 1 (highly convective), the observed turbulence intensity exceeds the "Briggs" value by a substantially larger margin. In the sensitivity tests, σ_θ from the 150-ft level of the BVPSMT is used in the calculation of σ_y because this level is closest to the plume height under most conditions.

The modeling results, presented earlier, show little sensitivity of the average concentrations and deposition fluxes to the use of the turbulence-based dispersion coefficients. The average concentrations and deposition fluxes are both nearly the same as the base case simulations (within 3%). The maximum annual deposition fluxes are about 22% lower using the turbulence-based dispersion coefficients. The maximum annual concentrations are insensitive to the use of the turbulence-based dispersion coefficients.

Much of this lack of sensitivity to fluctuations in the wind direction is related to the treatment of receptors at elevations greater than stack-height. These receptors comprise about 2/3 of all receptors used in the simulation. The lateral plume parameter σ_y is only used in the ISC module of ISC-COMPDEP, because the COMPLEX I module uses a 22.5° sector-average description for the lateral

distribution. For receptors between stack-top and the plume centerline height at final rise, concentrations are computed by both modules, and the larger concentration determines the module used to simulate concentrations and deposition at that receptor. If σ_y is larger when the σ_θ data are used, peak concentrations from the ISC module are smaller, which would foster the selection of the COMPLEX I module results. Therefore, it is expected that modeling results at receptors already "controlled" by the COMPLEX I module do not change.

The reduction in the peak annual deposition flux may be related to the joint occurrence of precipitation events and larger values of σ_θ. Wet deposition dominates the annual deposition rate and is greatest near the source where the lateral plume distribution is smallest. This is also the region where most receptors lie below the top of the stack, so that the ISC module determines the distribution. With larger values of σ_y calculated from the turbulence data, the wet flux decreases. Hence the reduction in the peak annual deposition flux is expected.

5. Calm Wind and Fumigation Simulations

The peer reviewers identified the need to improve the treatment of transport and dispersion during low wind speed conditions and plume fumigation events in the modeling of the WTI facility. Because COMPDEP and ISC-COMPDEP are both steady-state Gaussian plume models, they are not well-suited to handle non-steady-state phenomena such as light wind speed dispersion and plume fumigation in valley situations. The steady-state plume equation breaks down as the wind speed approaches zero (i.e., they predict infinite concentrations), because it contains an inverse wind speed dependency. For this reason, COMPDEP and ISC-COMPDEP use the U.S. EPA calm wind procedures for light wind speed events. In these procedures, winds below the instrument detection limit are considered calm. Hours with calm winds are ignored in the calculation of multi-hour average concentrations and deposition fluxes. For example, annual average concentrations are computed as the sum of concentrations during non-calm hours divided by the number of non-calm hours. Short-term average concentrations are computed as the sum of concentrations during non-calm hours during the averaging period divided by the *greater* of the number of non-calm hours or 75% of the number of hours in the averaging time (i.e., 18 for a 24-hour average). For hours with winds less than 1 m/s but greater than the instrument detection threshold, the U.S. EPA procedure is to reset the wind speed to 1 m/s for modeling purposes, but to include the hour in the modeling as a non-calm hour.

At the WTI facility, a large number of hours (~22%) during the one year period from April 1, 1992 through March 31, 1993 are determined to be calm for modeling purposes. In this analysis, a threshold wind speed of 1 m/s is assumed. The location of the WTI facility within a well-defined river valley is conducive to the development of strong nocturnal temperature inversions with light winds and stable temperature lapse rates within the valley. A typical diurnal pattern involves the accumulation of pollutants in the stable layer during nighttime hours with poor dispersion conditions, followed by the breakup of the inversion during the following morning. The breakup of the inversion results in a situation where the elevated emissions of the previous night may mix rapidly down to the ground (fumigating), resulting in elevated ground-level concentrations and deposition fluxes within the valley. The comments of the Peer Review Panel ask that a more realistic treatment of both the calm wind conditions and plume fumigation events be considered in the WTI modeling.

Straight-line Gaussian plume models are fundamentally ill-suited to treat such non-steady phenomena. A basic assumption of the plume approach is that along-wind diffusion is negligible in comparison to plume advection. This is clearly not the case for calm wind conditions. Additionally, the plume model ignores plume history and causality effects. Each hour in the simulation is assumed to have reached a steady-state situation, which requires that the source-receptor distances be small relative to the transport wind speed, and that the winds and other meteorological conditions are constant during the period. These conditions are not satisfied during light wind speed events. Also, the plume model cannot easily accumulate emissions from nighttime hours for later impact during the morning inversion breakup period. Although a plume model can be manipulated (through the use of virtual sources) to simulate a quasi-steady fumigation situation such as encountered in coastal fumigation, valley fumigation is quite different and impractical to treat properly within the framework of a steady-state plume model. Modification of the steady-state model to treat calm wind conditions is difficult as well.

For these reasons, a non-steady-state puff model (CALPUFF) is used to simulate a typical calm wind and plume fumigation event in order to assess the impact of these conditions on long term concentrations at WTI. The puff model, unlike plume models, can easily handle light or calm wind conditions, along-wind diffusion, accumulation of emissions in an elevated stable layer, and the eventual fumigation of the emissions during the morning inversion breakup period. Prior to this analysis, U.S. EPA's Applied Modeling Research Branch also performed a study (Petersen and Schwede 1994) to help quantify model uncertainty on annual

concentrations and peak 24-hour average concentrations due to low-wind-speed conditions. They applied the INPUFF model using two versions of the full year of meteorological data, one with the calm periods removed, and one with the calm periods replaced with wind speeds less than 1 m/s.

Because CALPUFF uses a method different than that used in ISC-COMPDEP for characterizing the particle size distribution (i.e., using a geometric mean and standard deviation rather than discrete size bins), a direct comparison of deposition fluxes between the CALPUFF and ISC-COMPDEP is difficult. Therefore, this analysis was restricted to ground-level concentrations.

The remaining sections describe the methods used in this study and the results obtained. An analysis of the type, frequency, and length of low wind speed and potential fumigation conditions in the river valley near WTI is described in Section IV.B.5.a. In Section IV.B.5.b, the frequency and type of events occurring during an historical annual period are addressed by applying CALPUFF to the full year of meteorological data. Information gained from the application of INPUFF by the U.S. EPA (Petersen and Schwede, 1994) is also reviewed and incorporated.

a. Meteorological Data Analysis (April 1992 - March 1993)

Meteorological data from the tower located on-site, and from the Beaver Valley Power Station meteorological tower (BVPSMT) are used to identify days in which "calm" conditions, coupled with a strong temperature inversion aloft (air temperature increases with height), would likely allow emissions to build over the valley during the night, only to mix rapidly to the surface (fumigate) during the following morning. In the morning, solar heating of the ground warms the air, causing the atmospheric surface layer to overturn, entrain air from above, and grow in depth. During this period, any pollutants emitted earlier above the surface layer would be entrained into the surface layer, and mix to the ground.

Calm conditions (wind speed less than or equal to 1.0 m/s) are determined from the wind speed measurements made 30 m above the ground at the on-site meteorological tower. These data are listed in the file of processed meteorological data (DEPBIN.MET) used in the ISC-COMPDEP model. The RAMMET meteorological processor is used to prepare the initial data file from on-site data. The DEPMET processor revises this file to include surface layer parameters required by the ISC-COMPDEP dispersion model. All hours in which wind speeds are less than 1.0 m/s are defined as calm, and RAMMET assigns a wind speed of 1.0 m/s to these while

persisting the wind direction from the previous hour. In the DEPMET stage of processing, the format of the meteorological data file is changed from the RAMMET "binary" form to the ISCST2 "ASCII" form. Calm hours in the latter case are denoted by a wind speed of 0.0 m/s. As a result, no measured speeds between 0.0 and 1.0 m/s are passed to the dispersion model.

Temperature inversions are determined from temperature difference ("delta-T") measurements made between 45.7 m (150 ft) and 10.7 m (35 ft) at the BVPSMT. The temperature difference between 152.4 m (500 ft) and 10.7 m (35 ft) is also available from the BVPSMT, but is less representative of conditions within the valley, as the upper temperature measurements sample the flow well above the top of the valley. Duplicate delta-T measurements are reported — a primary and a backup. However, no distinction is made in the instrumentation or in their calibration and service schedules, so they are considered equivalent. Recognizing this, the average delta-T is used in this analysis whenever both systems report valid data.

Wind speed data are also available from the 45.7 m (150 ft) level of the BVPSMT. These are reported as "calm" whenever the indicated speed is less than 0.27 m/s (0.6 mph). Duplicate anemometers are used, so the average speed is computed here when both report valid data, as with the temperatures. Only 4 hours in the year-long period are characterized as "calm" using the 0.27 m/s cut-off. Also note that all data received from the BVPSMT are 15-minute averages, reported once per hour.

Figure IV-2 illustrates the frequency of occurrence (number of days per year) of calm periods of a given number of hours per day, as determined from these data. Three definitions of "calm" are used:

- Delta-T greater than or equal to 1.0 °C, with wind speed at the WTI tower less than 1.0 m/s (model wind speed equal to 0.0 m/s) or wind speed at 45.7 m (150 ft) less than or equal to 1.0 m/s.

- Delta-T greater than or equal to 1.5 °C, with wind speed at the WTI tower less than 1.0 m/s (model wind speed equal to 0.0 m/s) or wind speed at 45.7 m (150 ft) less than or equal to 1.0 m/s.

- Wind speed at the WTI tower less than 1.0 m/s (model wind speed equal to 0.0 m/s).

The first definition combines the occurrence of a "modeling" calm hour with a substantial temperature inversion in the valley, while the second definition applies a more stringent measure of the temperature inversion. The

third definition removes the temperature inversion requirement altogether. With definition 3, we see that as many as 18 calm hours occur within a single day (midnight-to-midnight). A total of 44 days during the year have 12 or more calm hours. With definitions 1 and 2, as many as 15 hours in one day are found to be associated with calm winds and a strong temperature inversion, but it is far more common to find fewer than 8 such hours in one day. The total number of hours found to be calm are:

Definition 1 — 866
Definition 2 — 479
Definition 3 — 1942

Within a day, the distribution of calm hours has a strong diurnal pattern, being largely associated with stable nighttime periods. Figure IV-3, the frequency of occurrence (number of days per year) of calm hours at a particular time of day, shows this. On the basis of wind speed alone (definition 3) we see that comparatively few calms are found between 1000 and 1700 (133 out of 1942 calm hours, or less than 7%). The most likely period for calms is between 2000 and 0800. When the delta-T measure is added to signal the presence of an inversion (definitions 1 and 2), calms between 1100 and 1600 are dropped, and few remain between 0800 and 1800. The separation between the curve for definition 3 and those for definitions 1 and 2 for the morning hours just after sunrise defines a period in which fumigation is likely to produce the largest ground-level concentrations. The worst such events are expected to be those in which the overnight hours are calm and stably-stratified, with calm conditions persisting into the morning as the convective mixing reaches and exceeds the plume height.

b. Full Year Application of CALPUFF

In order to evaluate the effects of calm wind conditions and fumigation events, CALPUFF is applied to the full year of meteorological data. CALPUFF is applied using a unit emission rate of a gas-phase pollutant from the stack. Concentrations are simulated at all receptors located at elevations below 260 m (MSL), which is approximately the elevation of the top of the WTI stack. These receptors, numbering 320, are confined to the river basin. Their distribution is plotted in Figure IV-4. CALPUFF employs the ISC terrain treatment, transitional rise, and included stack-tip downwash and

buoyancy enhancement of the sigmas. Pasquill-Gifford dispersion coefficients are used during non-calm wind hours. During calm wind conditions (wind speed < 1.0 m/s), the plume growth rates are based on an application of the turbulence-based dispersion coefficients with minimum values of σ_w of 0.16 m/s and σ_v of 0.5 m/s. Wet and dry deposition are not modeled. Meteorological data from the 30-meter level of the WTI tower is used in the simulations to characterize the flow field. This is not a preferred method for applying CALPUFF because it does not take advantage of the full three-dimensional wind field capabilities of the model. However, using CALPUFF in an ISC mode will serve the intended purpose of this sensitivity analysis, which is to isolate, to the extent possible, the effects of calm winds and fumigation conditions. Also note that in this application, CALPUFF employs the ISCST2 terrain adjustment procedures that are most relevant to receptors below stack-top. (The ISCST2 terrain method holds the plume at a constant elevation, while limiting receptor elevation to be at or below the stack top elevation). To facilitate comparisons, ISC-COMPDEP is run with the NOCMPL option specified, so that it too uses the ISCST2 terrain adjustment for all receptors. Hence, results from these simulations are only relevant to this sensitivity analysis. Peak concentrations are summarized in Table IV-3.

The peak 1-hour, 24-hour, and annual average concentrations predicted by CALPUFF in this ISC2 mode sensitivity test are similar in magnitude to the values predicted by ISC-COMPDEP (see Table IV-3). This suggests that the inclusion of calm wind dispersion and fumigation does not have a significant effect on the peak predicted concentrations from the elevated WTI stack. Although CALPUFF is run in a mode as close as possible to ISC-COMPDEP, some of the inherent features of the puff model (e.g., causality effects, time-variability to the fields, curved trajectories over multiple hours, etc.) also play a role in the concentration predictions by CALPUFF.

Figure IV-5 shows the annual average concentrations simulated by ISC-COMPDEP. This has the characteristic distribution found in the regular ISC-COMPDEP results presented earlier. There is some along-river channeling, but the peak value lies on the hillside to the east of the stack. Concentrations at the receptors nearest to the stack are less than the first isopleth (.05 $\mu g/m^3$). In contrast, the CALPUFF results shown in Figure IV-6 shows larger concentrations just down-river from the stack, and also at greater distances to the east-northeast and west-southwest. Clearly, those concentrations nearest the stack result from some pooling of emissions near

the release during calm conditions. The elongation of the pattern "along" the river's axis is probably due to a combination of the sole use of wind directions from the 30-m level of the tower at WTI in these CALPUFF simulations, and completely accounting for all of the mass released. Note that winds above the valley measured at the Beaver Valley tower are available to ISC-COMPDEP for use when the plume height is well above the WTI stack. Without this supplementary wind information, puffs in CALPUFF are expected to follow a more channeled flow, even when they rise out of the valley.

The INPUFF simulation (Petersen and Schwede 1994) is derived from the same meteorological file as CALPUFF, so that it too produces the "channeled flow" concentration distribution, even though no terrain is specified in INPUFF. Unlike the CALPUFF simulations, the wind directions during the lightest wind speed hours (less than 1.0 m/s) were randomized in the INPUFF simulations. U.S. EPA's comparison of INPUFF with COMPDEP (no terrain, no calms) indicated that peak annual average concentrations were similar in magnitude and location, but the areal coverage of the isopleths from INPUFF was broader, leading to a factor of 3-5 increase in concentration at receptors in the lower impact areas. Perhaps the random assignment of "low" wind speeds and directions during calm hours spread out the puffs, thereby increasing the cross-valley impacts as well as the along-valley impacts.

The results of both the INPUFF and CALPUFF simulations suggest that calm wind conditions will not produce the controlling concentrations for the WTI stack emissions. The inclusion of plume fumigation effects in CALPUFF does not result in significantly different peak ground-level concentrations in the valley. The purpose of the sensitivity tests with CALPUFF run in ISC2 mode is to isolate and thereby assess the importance of calm wind conditions and fumigation events rather than to exercise the full three-dimensional transport and dispersion features in CALPUFF.

6. Terrain Downwash Simulations

The peer reviewers also identified the need to consider terrain-induced downwash, which they considered a potentially serious problem at the site, at least for moderate-to-high wind speeds. In response to this concern, the U.S. EPA Fluid Modeling Facility conducted a series of wind-tunnel simulations to investigate the potential for terrain downwash at the site, and to characterize the resulting peak

ground-level concentrations (Snyder 1994). A copy of this report is included as Appendix IV-6. To provide a context for their findings relative to the dispersion modeling program, ISC-COMPDEP simulations are performed that parallel the configurations studied in the wind tunnel. These are discussed in the following section.

In the wind tunnel study, a 1:480 scale model was constructed which represented a full-scale region approximately 1 mile wide by 3 miles long. The wind tunnel simulations explored three terrain configurations: flat terrain (a base case), wind flow from the east-southeast (125 degrees), and wind from the west-northwest (305 degrees). The most prominent nearby terrain feature that may promote downwash is located about 1 km to the east-southeast of the WTI stack. Therefore, wind directions of 125/305 place this terrain upwind/downwind of the facility, respectively. Following the naming conventions used by Snyder (1994), the 125 degree simulations are referred to as "SE", and the 305 degree simulations as "NW". Three stack heights were used in the simulations: 45.7 m (existing stack), 72.7 m (GEP stack), and 120 m. The stated findings include:

- A small recirculation region is found at the base of the SE hill (for SE winds). The stack lies beyond this region, but is itself in an area of downward-directed mean flow.

- All terrain configurations employ the same set of free-stream wind speeds (at 500 ft, or 152 m). Because of the terrain, however, the wind speed at stack-top is considerably smaller in the presence of the actual terrain, when compared to the corresponding flat terrain simulation.

- Maximum ground-level concentrations clearly decrease as the stack-height is increased for all three terrain configurations. Furthermore, differences due to changes in the stack-height are much more significant than changes in the terrain configuration.

- High intensity, large-scale turbulence is generated by the presence of the terrain in concert with the changes in the mean streamline patterns.

These findings do indeed indicate that terrain-induced perturbations to the flow are expected to occur at the WTI site..

Are these perturbations likely to lead to concentrations larger than those estimated with ISC-COMPDEP? The configurations studied in the wind tunnel are simulated with ISC-COMPDEP to find out. The terrain and receptor data used in the base case ISC-COMPDEP simulations discussed in Section IV.A are used here as well, but only those receptors that coincide with the wind tunnel configuration are included. Furthermore, since the receptor radials are spaced at even increments of 10 degrees, wind directions of 130/310 degrees replace the 125/305 pair used in the wind tunnel simulation. Anemometer height is set at 152.4 m, and a wind profile exponent of 0.21 is specified to match that reported for the wind tunnel boundary layer with flat terrain. The results are compared in Figures IV-7 through IV-9.

Figure IV-7 compares the modeled peak concentrations as a function of wind speed with the corresponding peak concentrations from the wind tunnel simulations. For each stack-height, the wind tunnel simulations produce larger concentrations, generally by at least a factor of two. Over the range of wind speeds modeled, concentrations resulting from emissions from the lowest stack increase with wind speed. With the presence of actual terrain, however, Figures IV-8 and IV-9 demonstrate significantly different behavior. Even though terrain downwash effects are not modeled in ISC-COMPDEP, the treatment of terrain in the model produces concentrations that exceed those obtained in the wind tunnel simulations. The structure of the curves is also different in that concentrations do not always decrease as the stack is raised. This is particularly the case in Figure IV-9 in which winds from the "NW" are simulated. The re-ordering of peak concentration and stack-height for the 9 m/s wind speed is probably related to the use of two dissimilar models in implementing the intermediate terrain procedure. Under certain circumstances, the ISC and COMPLEX I treatments can produce markedly different concentration estimates. Because the larger estimate is chosen within the intermediate terrain regime, and an abrupt switch to the Complex I result is made in the complex terrain regime (i.e., receptors above stack top) and because the regime is itself a function of stack height, plume height, and receptor height, concentration predictions from the model do not always show a decrease with increasing stack height. This behavior is a result of the intermediate/complex terrain procedures rather than any physical process.

These comparisons suggest that concentrations produced by the methods used to treat terrain in ISC-COMPDEP are sufficiently conservative, and that the changes in peak concentrations attributed to terrain downwash on the basis of the wind tunnel simulations are sufficiently minor, that the ISC-COMPDEP modeling performed for the WTI facility does not need any modifications related to terrain downwash.

C. Routine Fugitive Emissions Modeling

The fugitive source of emissions include the carbon bed adsorption system, ash handling activities, the open wastewater tank, the organic waste tank farm, and the truck wash. The ash handling, organic waste farm, and carbon bed adsorption system emissions are vented through stacks, and therefore are modeled as point sources. (The organic waste farm emissions are vented through four stacks). The other two sources (the open wastewater tank and truck wash) are treated as volume sources. (See Section III.A.2 for a discussion of the sources and emission parameters).

Each of the fugitive emission sources is modeled with a unit emission factor. For both the point and volume sources, the unit emission rate is 1 g/s in the modeling. Pollutant-specific modeling results can be obtained by multiplying the unit-emission rate results by the pollutant's emission rate. Note that *each* of the four stacks in the organic waste farm emission run has an emission rate of 1 g/s, for a total emission rate of 4 g/s. Therefore, pollutant-specific scaling of these results must be based on an average, *per stack*, emission rate. The emissions for these sources is assumed to be in the vapor form, except for the ash handling facility, which is assumed to include both vapor and particulate matter emissions. It is not possible to obtain specific size distribution data for the particulate matter emissions from the ash handling facility, so the same size distribution used in the base case simulations of the incinerator stack are used for the ash handling facility.

Table IV-4 summarizes the results of the fugitive emission modeling. Because of the very small pollutant emission rates expected from these sources, the large unit emission-based concentrations will actually produce relatively small, localized concentrations. Therefore, the summary lists only the maximum concentrations rather than the domain average concentrations over all receptors. Contour plots of the spatial distributions of the concentration fields, and in the case of the ash handling facility, the wet, dry, and total deposition fluxes, are presented in Appendix IV-4.

The contour plots of the fugitive emission concentrations all show peak concentrations in the immediate vicinity of the source, except for the carbon adsorption bed stack. This reflects the low release heights and the lack of significant buoyancy or momentum of the emissions. The carbon adsorption bed emissions have significant momentum (although no buoyancy) and are released at a height of 28 m. The resulting concentration isopleths show a near-field peak a few hundred meters from the stack. The general shape of the contour of concentrations show these strong channeling effects of the terrain on the low-level winds used for advecting the fugitive emissions. This pattern is in contrast to that of the incinerator stack, which reflects the influence of upper level winds during the periods when the plume rises out of the valley.

D. Uncertainty Analysis

1. Limitations of the Technical Formulations

Recognition of the uncertainties of dispersion and deposition model predictions is important in conducting a health risk assessment. In this analysis, the uncertainties are categorized into two types: limitations of the technical algorithms in the model, and limitations in the amount and type of data available for the modeling (discussed in Section IV.D.2). The principal areas of uncertainty in the model are discussed below.

a. Wet Deposition

The wet deposition algorithm used in ISC-COMPDEP is a simple, empirically-based scavenging coefficient scheme. The scavenging coefficients are used by the model to determine the amount of pollutant removed from the plume. The scavenging coefficients are specified as a function of the particle size categories and precipitation type. The scavenging coefficients are derived from limited observational studies with a relatively small number of data points. The data in these studies do not allow the identification and parameterization of individual wet removal processes, such as in-cloud nucleation and below cloud interception. Instead, all wet removal mechanisms are included implicitly in the empirical scavenging coefficients. Non-steady-state effects and saturation effects are not included in the model. ISC-COMPDEP assumes that no changes in the size distribution of the particles occurs, as can happen due to aerosol growth in high humidity environments.

The scavenging coefficient scheme predicts deposition fluxes that depend on the vertically-integrated pollutant concentration, which increases rapidly as one approaches the source. It is likely that the wet deposition algorithm is biased to overpredict rather than underpredict near-field wet deposition fluxes because certain processes such as nucleation, which are important in enhancing the rate of wet removal, are probably not active near the stack. (Near the stack, only below cloud processes are active, whereas the empirical scavenging coefficients include the effects of all (below cloud and within-cloud) processes). Because wet deposition is a dominant component of the total deposition and because the peak predicted wet deposition fluxes occur near the stack, it is likely that this uncertainty results in the model overestimating the peak wet deposition flux (and therefore overestimating the estimated risk) of the facility.

b. Complex Terrain

The location of the WTI site in the steep-walled Ohio River valley presents challenges for the dispersion and deposition modeling. The meteorological data measured in the valley indicate that there is strong channeling of the flow at lower heights in the valley. At higher elevations above the valley walls, the channeling is not present. This indicates that there is the potential for significant wind shear just above stack top. In fact, the flow in the two zones can be completely decoupled in some circumstances. Thus, depending on exactly where the plume is predicted to be (i.e., within or above the valley), different plume trajectories can result. Although the ISC-COMPDEP model has been modified to allow for a characterization of the flow at different levels, the modeling approach still represents a simple approximation to the actual flow fields that are likely to be quite complex. In addition, the COMPLEX I terrain algorithm in ISC-COMPDEP is considered a simple screening approach for evaluating complex terrain effects.

Another limitation is that the steady-state plume modeling approach does not allow the plume trajectory to deviate from a straight line. Especially in complex terrain such as near the WTI facility, this assumption is questionable, and is likely to lead to errors in plume trajectories. However, over long averaging times such as the annual averages presented in Section IV, some of the errors will likely average out. However, the model is not expected to be able to accurately predict an individual plume's behavior well for an individual hour.

As noted by the peer reviewers, the model does not contain algorithms for treating terrain-induced downwash effects. However, a comparison of wind tunnel simulations of the WTI area with the ISC-COMPDEP model suggest that there is sufficient conservatism in the formulation of the complex terrain treatment in the model, so that the lack of terrain downwash will not lead to underpredictions of the predicted concentrations. In contrast, the comparison suggests that the model will overpredict concentrations at higher elevations in the domain (see Section IV.B.6).

c. Calm Winds and Fumigation

The meteorological observations in the valley indicate a high frequency of occurrence of low wind speed conditions and inversion conditions. The steady-state plume approach used in the ISC-COMPDEP model cannot treat calm conditions or fumigation associated with inversion break-up events.

Therefore, the ISC-COMPDEP predictions are likely to be very uncertain during these types of conditions. However, a limited application of a non-steady-state model has been applied to the WTI incinerator stack to help quantify the effects of calm winds and fumigation events (see Section IV.B.5). The results suggest that for the main WTI stack emissions, calm wind and fumigation conditions are not likely to significantly affect the peak concentration impacts.

d. Dry Deposition

Comparisons of dry deposition velocity observations and predictions generally show a significant amount of scatter (e.g., U.S. EPA 1993). The prediction of deposition velocities is a strong function of meteorological variables and the size characteristics of the pollutant, both of which represent sources of uncertainty, even with a perfect deposition model. The split of pollutants between the vapor and particle phases is also an area of uncertainty. As pointed out by the peer reviewers, the significance of transformations between the vapor and particle phases during plume transport is unknown. In this study, wet deposition fluxes are found to dominate the total deposition from the WTI incinerator. Therefore, it is believed that the wet removal algorithms represent a larger source of uncertainty than the dry deposition model in the current study. For example, the sensitivity tests discussed in Section IV.B do not show significant variability of the total deposition flux for the particular size distributions tested. This conclusion may not be transferable to other sites or other pollutant distributions, but appears to be accurate for the WTI situation.

2. Data Limitations

a. Meteorological Data

The wind fields and turbulence fields in the Ohio River valley are likely to have a great deal of fine scale structure. As a result of the peer reviewer's comments, improvements were made in the model's ability to handle wind variations in the vertical, local temperature gradient data were used in the calculation of inversion strengths, and tests were conducted using local measures of the horizontal wind direction fluctuations (σ_θ). Even with these improvements, the steady-state plume modeling approach, necessarily results in a significant simplification of the meteorological conditions in the valley. However, with the focus on long-term average concentrations and

deposition fluxes, the errors associated with the use of simplified meteorological approximations is likely to be mitigated somewhat.

The results of using local precipitation data from the Beaver Valley meteorological station rather than Pittsburgh precipitation data are discussed in Section IV.B.3. It was found that year-to-year variability in precipitation amounts can produce a nearly linear response in the deposition flux estimates, but that concentration predictions were only a very weak function of the precipitation data. The precipitation amounts for the base period modeled are close to the longer term average precipitation amounts recorded at the Beaver Valley station.

b. Particle Size Distribution

The rate of removal of particulate matter from the atmosphere (and therefore, the magnitude of the predicted pollutant dry deposition fluxes from the model) is a strong function of the size distribution of the particulate matter. For example, Sehmel (1980) shows curves of deposition velocities as a function of particle size which vary over several orders of magnitude. Dry deposition velocities tend to show a minimum for particles with diameters near 0.1 μm to 1.0 μm. Particles smaller than this range tend to exhibit larger deposition velocities due to the Brownian motion effects. Because particles in the 0.1-1.0 μm diameter size range are not transported across the quasi-laminar layer in the vicinity of the surface very effectively by any of these processes, they have the smallest dry deposition velocities. In the stacks tests conducted at the WTI facility about one-third of the particulate matter was found to be less than 0.4 μm in diameter. Due to limitations of the testing equipment, the shape of the size distribution below 0.4 μm diameter is not known. Because of the potential sensitivity of dry deposition rates on particle size, sensitivity tests of the model are made with different assumptions of the distribution (see Section IV.B.1). Probably because the wet deposition fluxes are predicted to dominate the deposition flux estimates, the model did not show significant variability as a function of the size distribution used. Although wet deposition also depends on the particle size, it does not appear to be as strong a function as the dry deposition (at least as modeled).

Table IV-1
Summary of ISC-COMPDEP Modeling Results for the WTI Main Incinerator Stack
Annual Simulation (April 1, 1992 to March 31, 1993)
All Results Are Based on Unit Emission Rate (1 g/s)

Run No.	Model	Run Description	Pollutant Distribution	Maximum Concentration ($\mu g/m^3$)	Maximum Deposition Flux ($g/m^2/yr$)	Receptor Average Concentration ($\mu g/m^3$)	Receptor Average Deposition Flux ($g/m^2/yr$)	Total (Wet and Dry) Average Deposition Velocity (cm/s)
1a	ISC-COMPDEP	Base Case	Mass	.9128 (1 km, 100°)	.2213 (0.1 km, 80°)	.1018	.0123	.38
1b	ISC-COMPDEP	Base Case	Surface Area	.9111 (1 km, 100°)	.3052 (0.1 km, 80°)	.1013	.0168	.53
1c	ISC-COMPDEP	Base Case	Vapor	.9144 (1 km, 100°)	--	.1024	--	--
2a	ISC-COMPDEP	GEP Ht. Stack	Mass	.8077 (1 km, 100°)	.1655 (0.1 km, 80°)	.0830	.0121	.46
2b	ISC-COMPDEP	GEP Ht. Stack	Surface Area	.8057 (1 km, 100°)	.2254 (0.1 km, 80°)	.0826	.0164	.63
2c	ISC-COMPDEP	GEP Ht. Stack	Vapor	.8098 (1 km, 100°)	--	.0836	--	--
3a	ISC-COMPDEP	9-yr High	Mass	.9126 (1 km, 100°)	.2653 (0.1 km, 80°)	.1017	.0145	.45
3b	ISC-COMPDEP	Precipitation	Surface Area	.9108 (1 km, 100°)	.3653 (0.1 km, 80°)	.1012	.0196	.62
4a	ISC-COMPDEP	9-yr Low	Mass	.9131 (1 km, 100°)	.1505 (0.1 km, 80°)	.1019	.0087	.27
4b	ISC-COMPDEP	Precipitation	Surface Area	.9115 (1 km, 100°)	.2080 (0.1 km, 80°)	.1014	.0120	.38
5a	ISC-COMPDEP	Turbulence-based	Mass	.9207 (1 km, 100°)	.1733 (0.1 km,100°)	.1018	.0121	.38
5b	ISC-COMPDEP	Sigmas	Surface Area	.9190 (1 km, 100°)	.2394 (0.1 km, 90°)	.1014	.0164	.51
5c	ISC-COMPDEP		Vapor	.9223 (1 km, 100°)	--	.1024	--	--

Table IV-2
Summary of WTI Modeling Results with COMPDEP and ISC-COMPDEP
(Before Peer Review to ISC-COMPDEP)
Annual Simulation (April 1, 1992 to March 31, 1993)
All Results Are Based on Unit Emission Rate (1 g/s)

Run No.	Model	Run Description	Pollutant Distribution	Maximum Concentration ($\mu g/m^3$)	Maximum Deposition Flux ($g/m^2/yr$)	Domain Average Concentration ($\mu g/m^3$)	Domain Average Deposition Flux ($g/m^2/yr$)	Total (Wet and Dry) Average Deposition Velocity (cm/s)
C-1a	COMPDEP	Base Case	Mass	.9174 (1.25 km, 250°)	.3377 (0.1 km, 60°)	.0978	.0178	.58
C-1b	COMPDEP	Base Case	Surface Area	.9144 (1.25 km, 250°)	.3372 (0.1 km, 60°)	.0976	.0180	.58
C-1c	COMPDEP	Base Case	Vapor	.9454 (1.25 km, 250°)	--	.1002	--	--
C-2a	COMPDEP	Mass < .4 μm	Mass	.9012 (1.25 km, 250°)	.3539 (0.1 km, 60°)	.0965	.0193	.63
C-2b	COMPDEP	At 0.03 μm	Surface Area	.8752 (1.25 km, 250°)	.3774 (0.1 km, 60°)	.0944	.0216	.73
C-3	COMPDEP	Vapor Modeled as 0.03 μm particle	Vapor/Particle	.8705 (1.25 km, 250°)	.3820 (0.1 km, 60°)	.0941	.0220	.74
I-1a	ISC-COMPDEP	Base Case	Mass	.9404 (1.25 km, 250°)	.4205 (0.1 km, 70°)	.0813	.0229	.89
I-1b	ISC-COMPDEP	Base Case	Surface Area	.9443 (1.25 km, 250°)	.5762 (0.1 km, 70°)	.0830	.0250	.96
I-1c	ISC-COMPDEP	Base Case	Vapor	.9534 (1.25 km, 250°)	--	.0852	--	--
I-2a	ISC-COMPDEP	Mass < .4 μm	Mass	.9381 (1.25 km, 250°)	.5444 (0.1 km, 70°)	.0810	.0273	1.07
I-2b	ISC-COMPDEP	At 0.03 μm	Surface Area	.9392 (1.25 km, 250°)	.9128 (0.1 km, 70°)	.0824	.0317	1.22
I-3	ISC-COMPDEP	Vapor Modeled as 0.03 μm particle	Vapor/Particle	.9388 (1.25 km, 250°)	.9764 (0.1 km, 70°)	.0825	.0381	1.46
I-4a	ISC-COMPDEP	No Depletion	Mass	.9534 (1.25 km, 250°)	.4344 (0.1 km, 70°)	.0852	.0285	1.06
I-4b	ISC-COMPDEP	No Depletion	Surface Area	.9534 (1.25 km, 250°)	.6004 (0.1 km, 70°)	.0852	.0309	1.15
I-5a	ISC-COMPDEP	Receptor-Specific	Mass	.9534 (1.25 km, 250°)	.5840 (1.0 km, 60°)	.0852	.0462	1.72
I-5b	ISC-COMPDEP	Land Use	Surface Area	.9534 (1.25 km, 250°)	.6029 (0.1 km, 70°)	.0852	.0366	1.36

Table IV-3
Comparison of CALPUFF and ISC-COMPDEP
Modeling Results

	Concentration ($\mu g/m^3$)		
	Largest 1-hr Average	Largest 24-hr Average	Largest Annual
ISC-COMPDEP	18.67	6.62	0.37
CALPUFF	19.46	4.48	0.38

Table IV-4
Summary of WTI Modeling Results with ISC-COMPDEP
Fugitive Emission Sources
Annual Simulation (April 1, 1992 to March 31, 1993)
All Results Are Based on Unit Emission Rate (1 g/s or 1 g/m^2/s)

Run No.	Fugitive Emission Source	Pollutant Distribution	Maximum Annual Concentration ($\mu g/m^3$)
8c	Carbon Bed Adsorption System (one stack)	Vapor	3.801[a] (0.8 km, 200°)
9c	Ash Handling (one stack)	Vapor	148.97[a] (0.1 km, 50°)
		PM — Mass	148.71 (0.1 km, 50°)
		PM — Surface Area	148.32 (0.1 km, 50°)
10c	Open Wastewater Tank (volume source)	Vapor	298.68[a] (0.3 km, 40°)
11c	Organic Wastetank Farm (four stacks)	Vapor	143.56[b] (0.1 km, 40°)
12c	Truck Wash	Vapor	288.70[a] (0.2 km, 40°)

[a] Based on an emission rate of 1 g/s.

[b] Based on an emission rate of 1 g/s *per stack* (four stacks in run)

Annual Concentrations ($\mu g/m^3$)
WTI Stack (Surface Distribution)

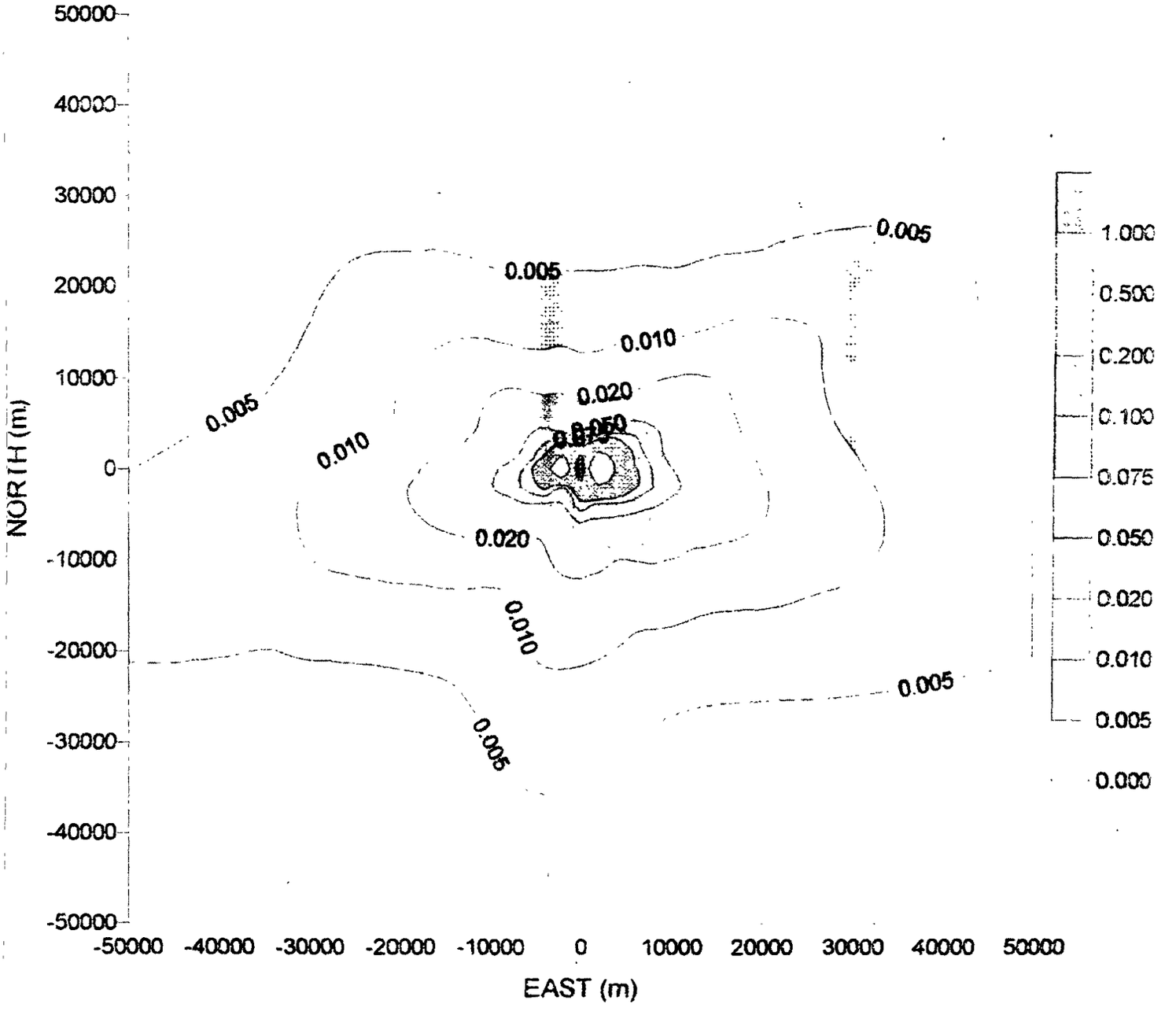

Figure IV-1. Annual average concentrations ($\mu g/m^3$) for the incinerator stack - Run 1b (ISC-COMPDEP, base case, surface area-weighted pollutant distribution). Modeling domain out to 50 km is displayed.

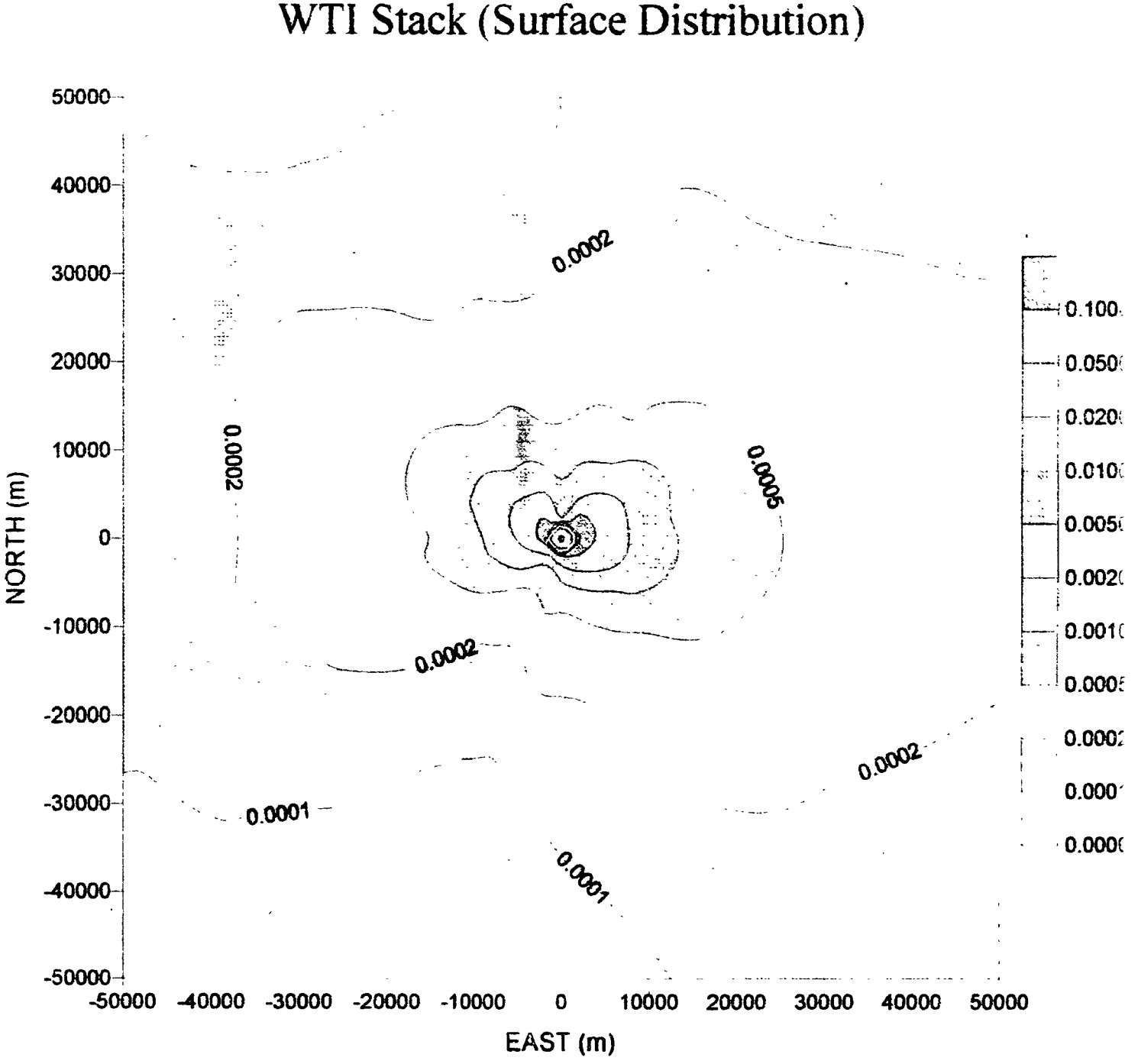

Figure IV-2. Annual wet deposition fluxes (g/m^2) for the incinerator stack - Run 1b (ISC-COMPDEP, base case, surface area-weighted pollutant distribution). Modeling domain out to 50 km is displayed.

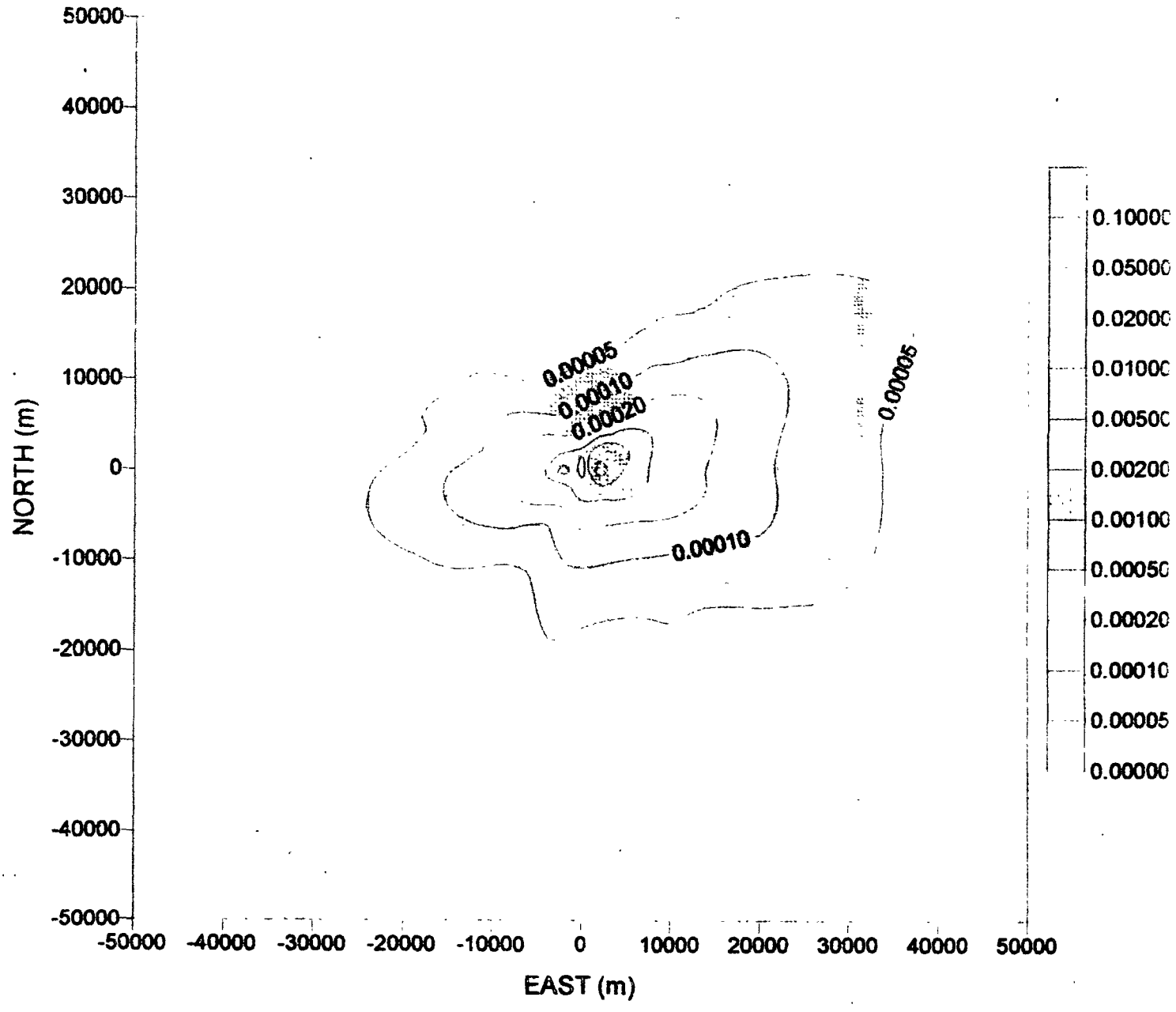

Figure IV-3. Annual dry deposition fluxes (g/m^3) for the incinerator stack - Run 1b (ISC-COMPDEP, base case, surface area-weighted pollutant distribution). Modeling domain out to 50 km is displayed.

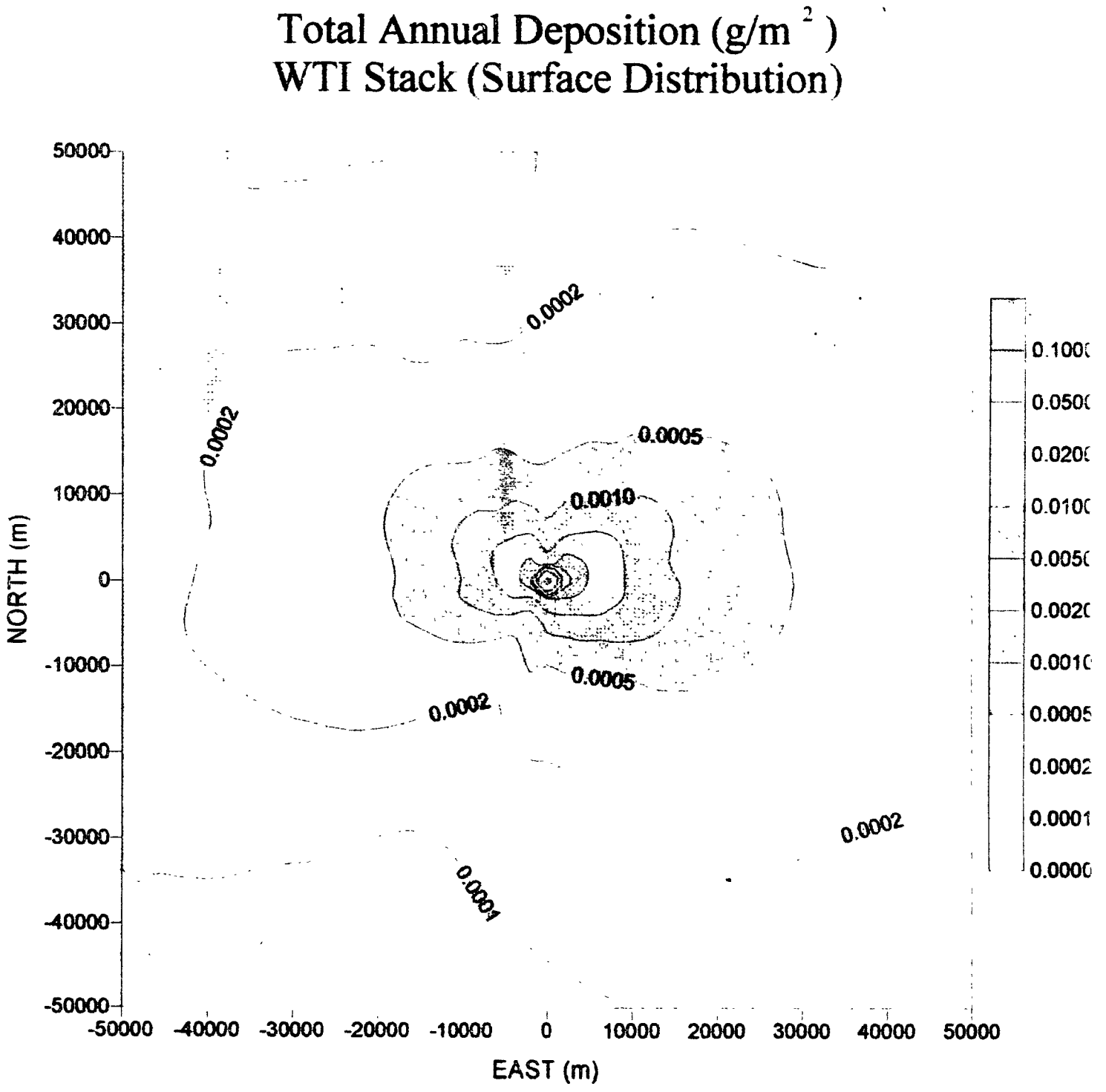

Figure IV-4. Annual total deposition fluxes (g/m^2) for the incinerator stack - Run 1b (ISC-COMPDEP, base case, surface area-weighted pollutant distribution). Modeling domain out to 50 km is displayed.

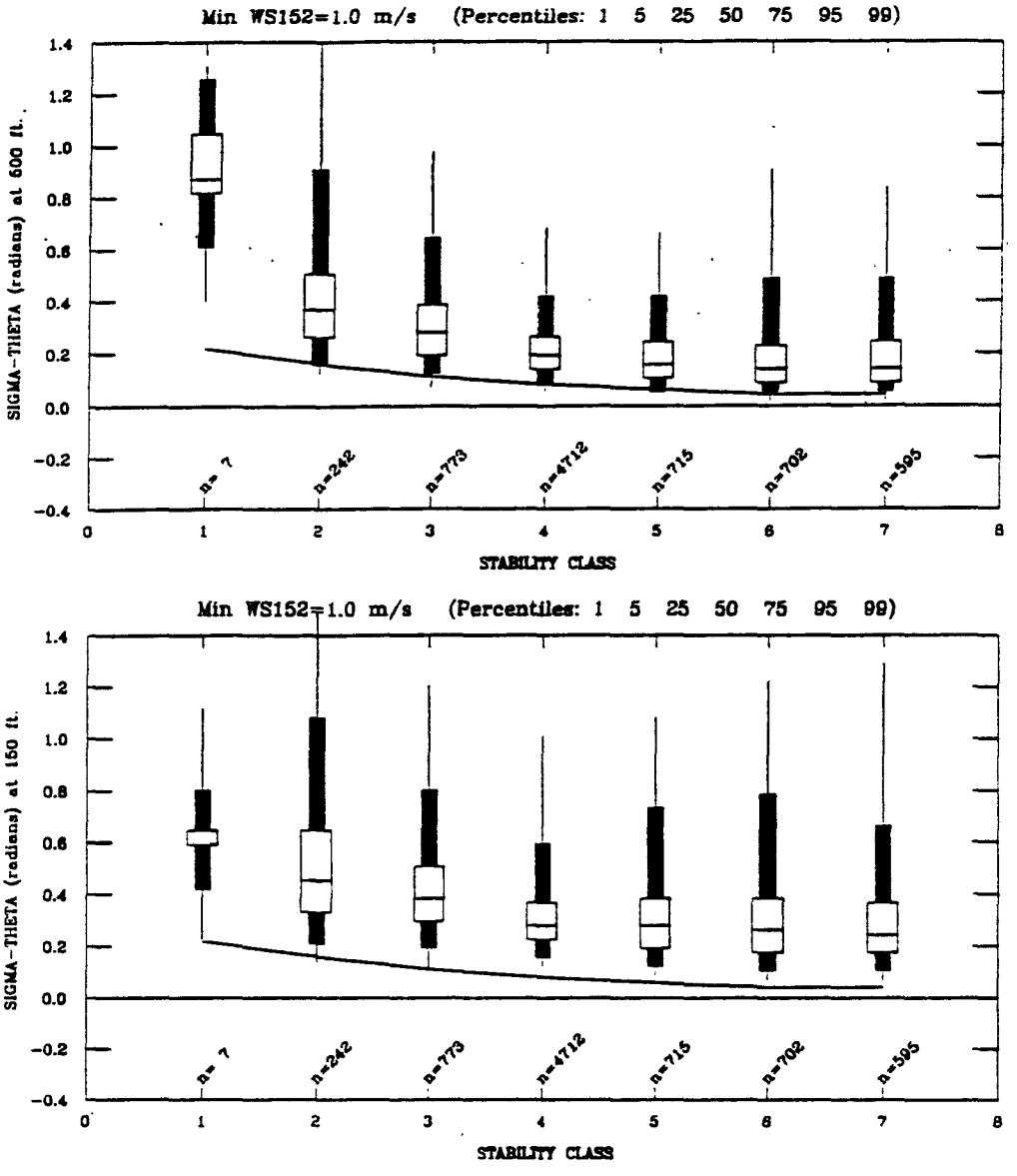

Figure IV-5. Distribution of lateral turbulence intensity measured at the Beaver Valley tower. The solid line identifies the corresponding turbulence intensity inferred from σ_y functions developed by Briggs.

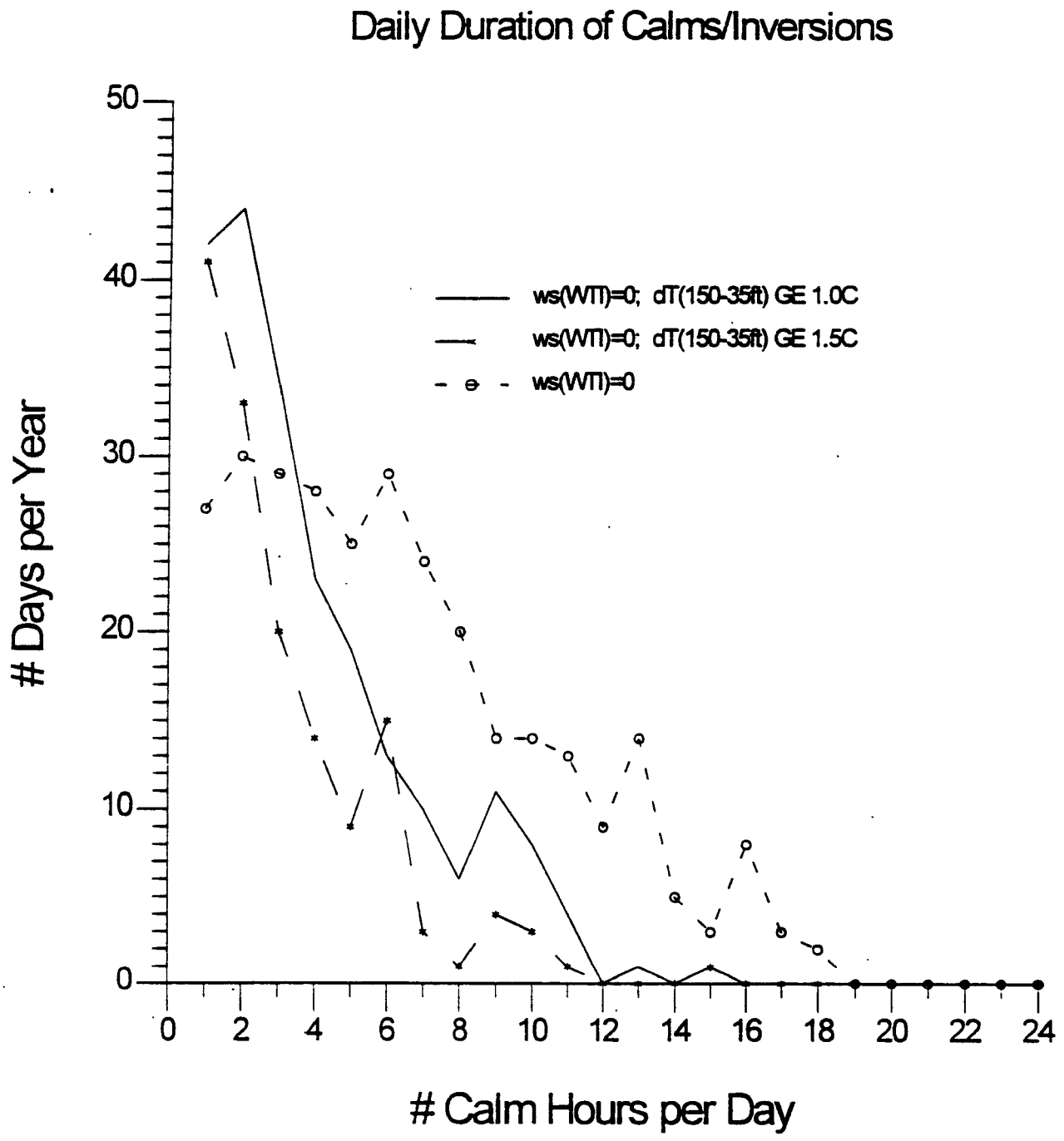

Figure IV-6. Frequency of occurrence of calm periods of a given number of hours per day. Calm hours are determined from the measured wind speed at the WTI tower (30 m), and inversion conditions are determined from temperatures measured at the Beaver Valley tower.

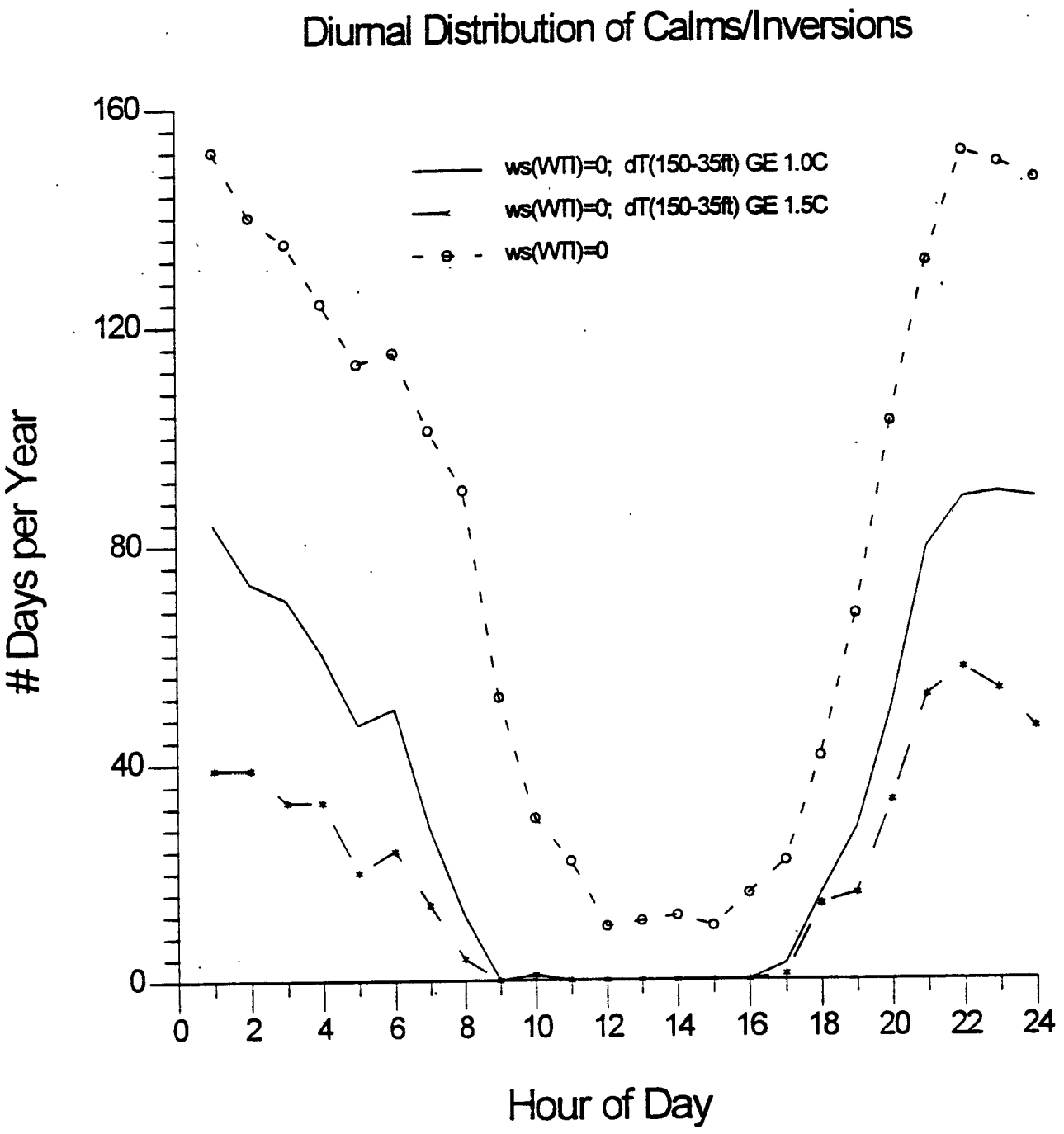

Figure IV-7. Frequency of occurrence of calm conditions by time-of-day. Calm hours are determined from the measured wind speed at the WTI tower (30 m), and inversion conditions are determined from temperatures measured at the Beaver Valley tower.

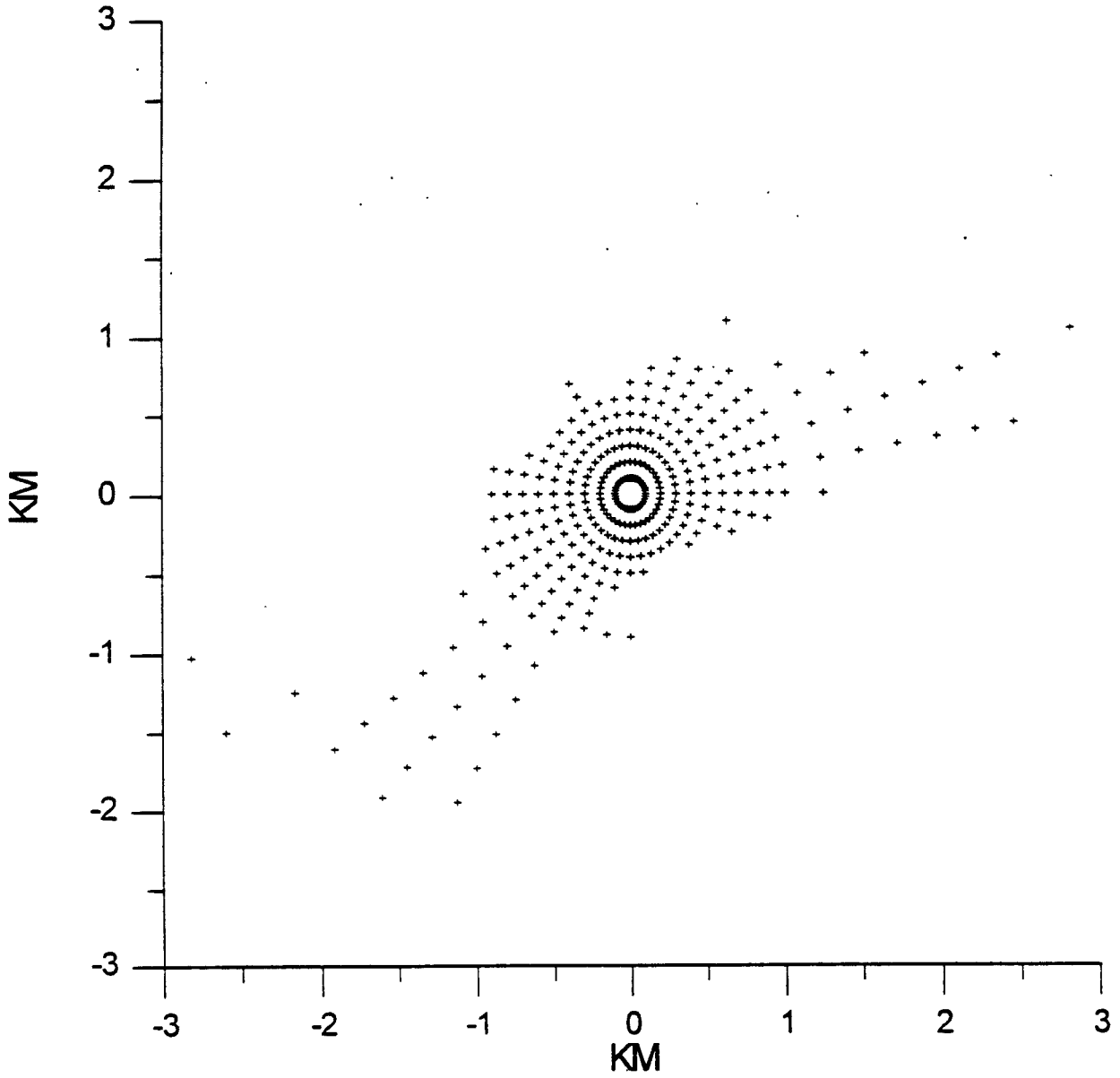

Figure IV-8. Distribution of receptors, centered on the WTI stack, used in simulating concentrations with ISC-COMPDEP and CALPUFF during May 11 to May 12. These 320 receptors lie at or below the elevation of the top of the stack.

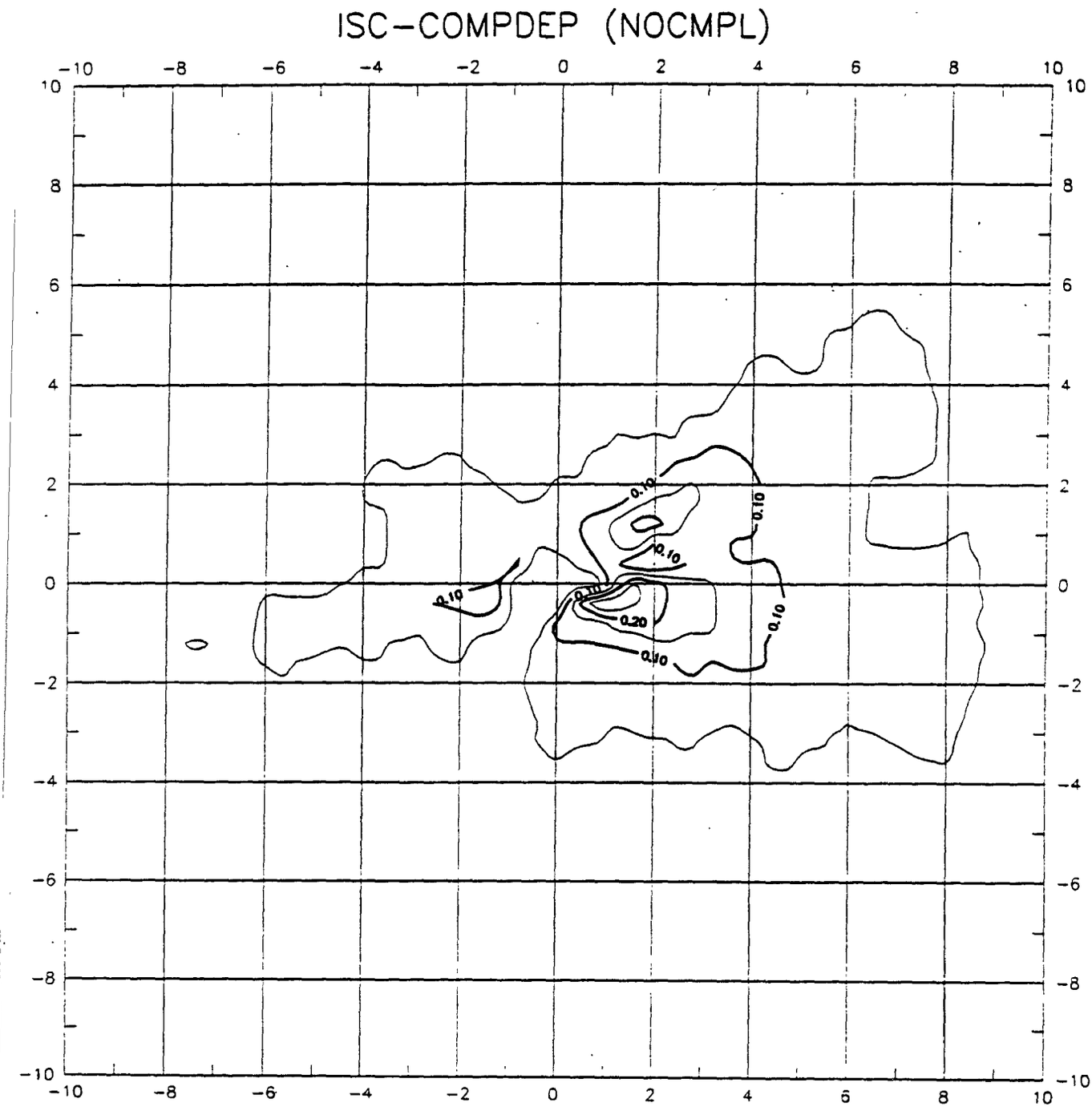

Figure IV-9. Annual concentrations ($\mu g/m^3$) for a unit emission rate (1 g/s) predicted by applying ISC-COMPDEP with ISC terrain adjustments for all receptors. The WTI stack is located at (0,0) and distances marked are in kilometers.

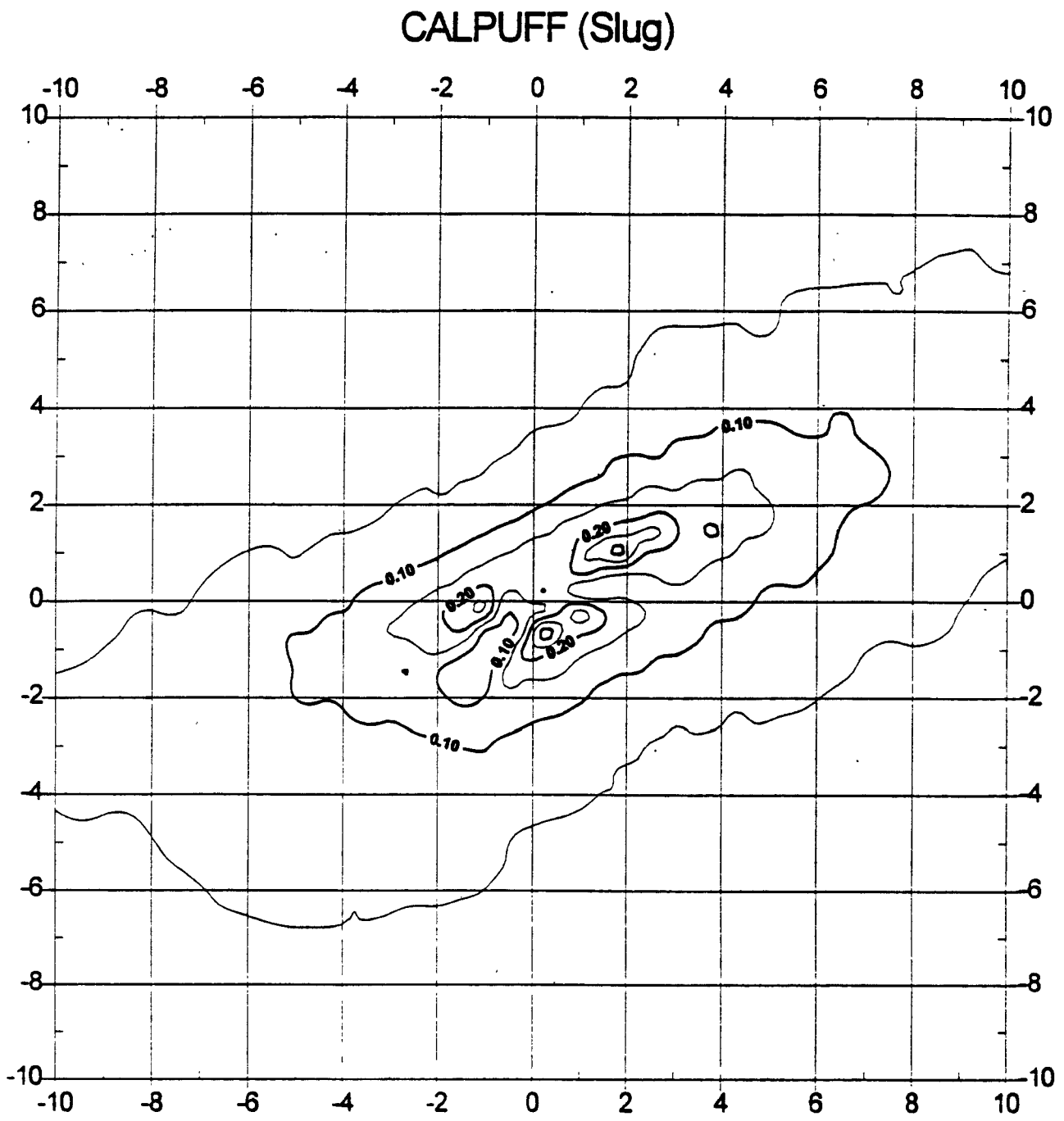

Figure IV-10. Annual concentrations ($\mu g/m^3$) for a unit emission rate (1 g/s) predicted by applying CALPUFF. The WTI stack is located at (0,0) and distances are in kilometers.

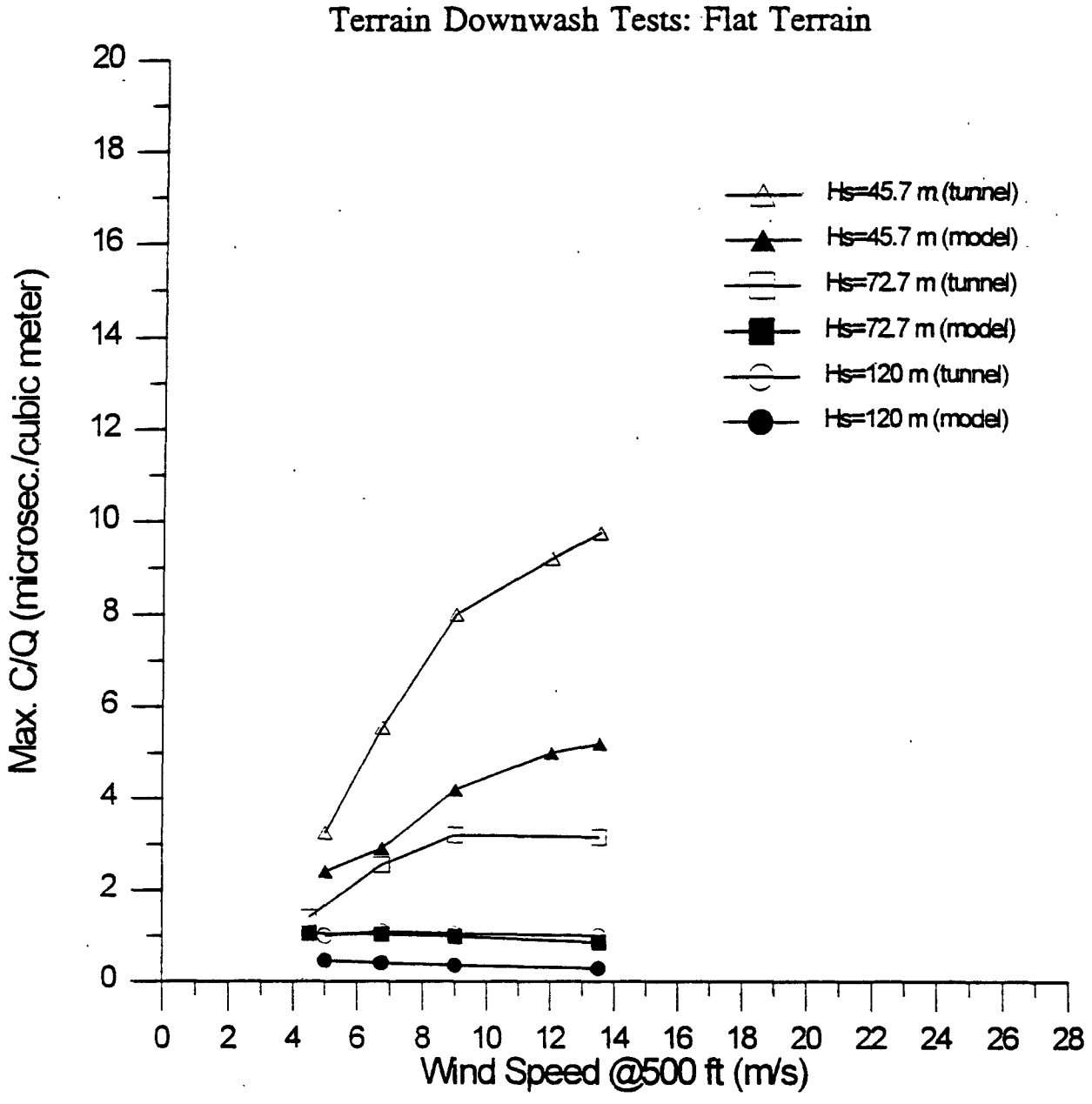

Figure IV-11. **Comparison of ISC-COMPDEP results with U.S. EPA FMF wind tunnel results for the flat terrain configuration.**

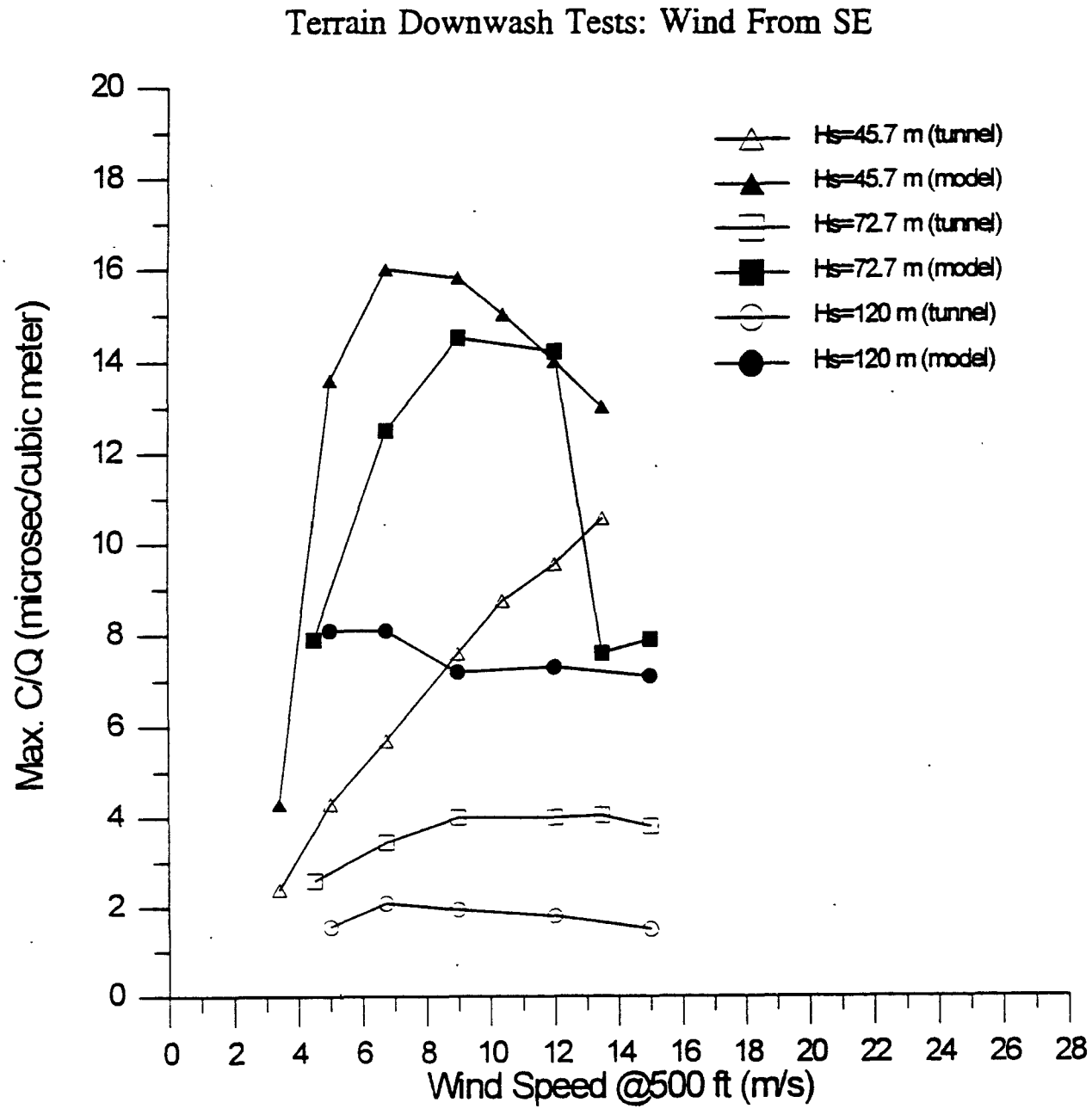

Figure IV-12. Comparison of ISC-COMPDEP results with U.S. EPA FMF wind tunnel results for "SE" winds.

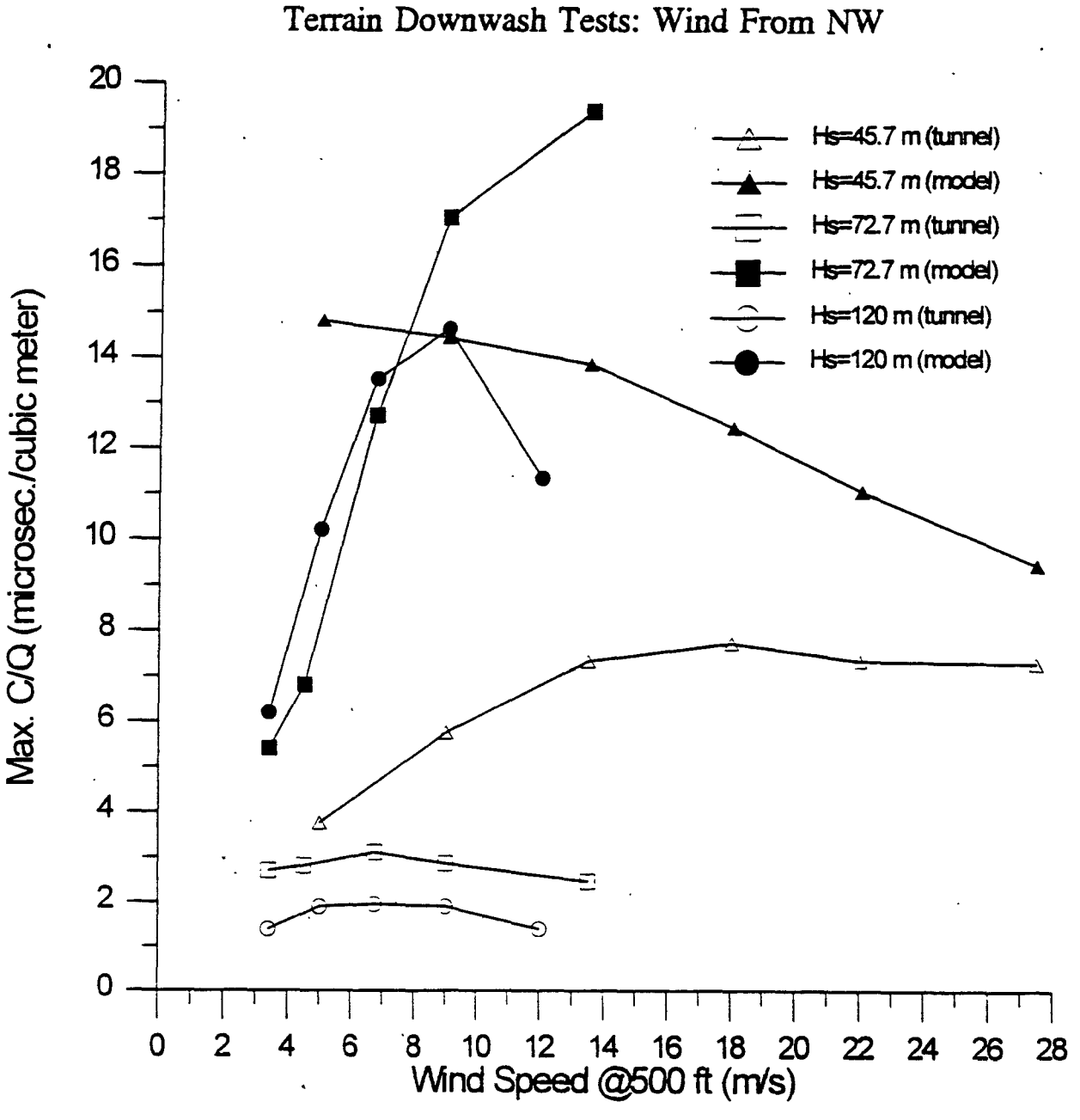

Figure IV-13. Comparison of ISC-COMPDEP results with U.S. EPA FMF wind tunnel results for "NW" winds.

V. SUMMARY AND MAJOR ASSUMPTIONS

A revised dispersion and deposition modeling study of stack emissions and fugitive emissions from the WTI hazardous waste facility is conducted as part of the WTI Risk Assessment of the facility. Modifications and enhancements were made to the Project Plan to reflect the comments of a peer review group convened in Washington, D.C. on December 8 and 9, 1993. The Meteorology/Air Dispersion Work Group of the Peer Reviewer Panel made a set of short-term recommendations to refine and improve the air modeling for the WTI Risk Assessment Study and several long-term recommendations for future studies. Among the comments were recommendations to use additional meteorological data from a nearby meteorological tower and local precipitation and turbulence data, evaluation of calm wind conditions and fumigation in the valley, evaluation of terrain-induced downwash effects, modeling of fugitive emission sources, inclusion of short-term average concentration estimates for use in evaluating concentration increases from upset conditions, and an analysis of the sources of uncertainty in the study.

Concurrent with the development of the original Project Plan, a new model (ISC-COMPDEP) was developed to provide a more refined analysis of dispersion and deposition from a source in complex terrain such as the WTI facility. The model has been peer reviewed and is applied to the WTI Risk Assessment. It is described in detail in Section II of this report. Many of the peer review panel concerns are addressed by the use of ISC-COMPDEP; in fact additional refinements were made to the model in response to specific peer review comments. Specifically, ISC-COMPDEP was modified to allow the use of meteorological data (wind and temperature) measured at various heights in the atmosphere, and it was executed using both on-site data from WTI and data from the Beaver Valley meteorological tower. A version of the model was developed that replaced Pasquill-Gifford horizontal dispersion coefficients (σ_y) with values based on observed measurements of turbulence (σ_θ). ISC-COMPDEP simulations are conducted using local precipitation data, short-term concentration estimates are produced for evaluating upset or accident-related increases in emissions, fugitive sources of emissions are modeled, and a series of sensitivity tests are conducted and uncertainty evaluated. In addition, a separate wind tunnel study (Snyder 1994) is conducted of the WTI site, and the results compared to ISC-COMPDEP modeling predictions. Associated modeling work of the wind tunnel scenarios suggested that the ISC-COMPDEP model, although not capable of describing terrain downwash conditions, does appear to produce conservative estimates of the concentrations during these conditions.

For the case of calm wind and fumigation conditions, the basic steady-state assumption used in ISC-COMPDEP is invalid. Therefore, for assessing the impact of these conditions, a limited application of the CALPUFF non-steady-state model (Scire et al. 1995) is conducted. A second non-steady-state model, INPUFF (Petersen and Lavdas 1986), is applied in a separate study to examine the effects of calm wind conditions in flat terrain. The results indicated that for the elevated emissions from the main WTI stack, simulation of calm wind and fumigation conditions with the puff models does not lead to significantly higher predicted peak concentrations. This conclusion may not apply to other source configurations, especially short-stack emissions and fugitive releases.

The model output files are partially reproduced in the Appendices to this volume. A set of tables, plots and files of predicted concentrations and deposition fluxes are presented. Three base case simulations of the WTI incinerator stack are prepared for use in the risk assessment analysis. These consist of runs with mass-weighted pollutant distributions (for use with matrix pollutants bound to the particle material), pollutant area-weighted pollutant distribution (for pollutants that may adsorb onto the outside surface of the particle), and vapor-phase pollutants. Wet and dry deposition effects are modeled for the particulate matter. Pollutants in the vapor phase are assumed not to be subject to deposition processes, but rather part of the inhalation exposure route only.

Five different sources of fugitive emissions are evaluated as part of the WTI Risk Assessment. These include emissions from the carbon adsorption bed, ash handling operations, the open wastewater tank, the organic waste tank farm, and truck washing operations. The impacts from these sources are localized, and given the expected emission rates associated with these sources are much smaller than those from the incinerator. (All of the modeling conducted in this volume are presented based on an unit (1 g/s) emission rate).

A discussion of the key assumptions and limitations of the modeling approach is provided in Section IV.D, and is summarized in Table V-1. The formulation of the wet deposition algorithm is viewed as one of the most significant limitations of the model. It is likely that the wet flux estimates are overpredicted in the near field of the stack because of the inability of the technique to distinguish between in-cloud and below-cloud scavenging processes. Another limitation is the inability of the steady-state ISC-COMPDEP model to simulate the spatially-variable plume trajectories that are expected in the valley. Ideally, it would be desirable to have additional meteorological data, including turbulence measurements at plume height to use in the modeling. However, the modeling results appear to be reasonably robust estimators of the long term average concentration and deposition fluxes expected from the facility.

TABLE V-1
Key Assumptions

Assumption	Basis	Magnitude of Effect	Direction of Effect
Pollutants are distributed according to a steady-state, straight-line Gaussian distribution.	Straight-line Gaussian plume dispersion models are the most widely-used type of model in regulatory applications such as risk assessments. Although they cannot reproduce the effects of complex flow fields and non-steady-state behavior, they are generally considered to provide robust, reasonably conservative estimates of plume impacts.	medium	probably overestimate
Low-wind speed stagnation events and plume fumigation are neglected.	The steady-state plume model cannot treat calm conditions or plume fumigation during inversion break-up conditions. Sensitivity tests with two non-steady-state puff models (INPUFF and CALPUFF) were conducted that indicate these conditions do not have a significant effect on the peak impacts from the WTI incinerator.	low	underestimate
Wet removal is a linear process proportional to the vertically-integrated plume concentration.	The scavenging coefficient wet removal algorithm is a widely-used approach in regulatory modeling. More sophisticated techniques would require a significantly more complex base model than the Gaussian plume model. The use of the scavenging coefficient method is likely to overestimate rather than underestimate peak near-field wet deposition.	medium to high	overestimate (in near-field) underestimate (in far-field)
Terrain downwash effects are neglected .	A wind tunnel study has been conducted that quantifies terrain downwash effects on emissions from the WTI incinerator stack. A comparison of modeling predictions with the wind tunnel results suggests that the model contains sufficient conservatism to compensate for the lack of an explicit terrain downwash algorithm in evaluating the peak impacts from the WTI stack.	low	underestimate

TABLE V-1
Key Assumptions

Assumption	Basis	Magnitude of Effect	Direction of Effect
Meteorological conditions and flows within the valley can be characterized by the available meteorological measurements.	The use of the Beaver Valley Power Station meteorological data to supplement meteorological measurements made by WTI was recommended by the Peer Peview Panel. These data sources represent the best available meteorological observations within the valley.	low to medium	unknown
Terrain effects are adequately represented by the ISC2 and COMPLEX I terrain algorithms.	The intermediate terrain and complex terrain algorithms and procedures in ISC2 and COMPLEX I are considered screening techniques that are likely to provide conservative estimates of plume concentrations.	medium	overestimate

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APPENDIX IV-1

Building Dimension Analysis

Building Profile Input Program (BPIP) Output Files

WTIBPIP3.OUT -	BPIP summary output file containing wind direction-specific building heights and widths for the main incinerator stack, organic waste tank farm stacks, and the ash handling stack.
WTIBPIP3.SUM -	Detailed BPIP output file, including building input information for the main incinerator stack, organic waste tank farm stacks, and the ash handling stack.
CADBPIP.OUT -	BPIP summary output file containing wind direction-specific building heights and widths for the carbon bed adsorption stack.
CADBPIP.SUM -	Detailed BPIP output file, containing building input and output information for the carbon adsorption bed stack.

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BPIP PROCESSING INFORMATION:
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The ST flag has been set for processing for an ISCST2 run.

Inputs entered in FEET will be converted to meters using a conversion factor of 0.3048. Output will be in meters.

UTMP is set to UTMN. The input is assumed to be in a local X-Y coordinate system as opposed to a UTM coordinate system. True North is in the positive Y direction.

Plant north is set to 337.21 degrees with respect to True North.

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PRELIMINARY* GEP STACK HEIGHT RESULTS TABLE
(Output Units: meters)

Stack Name	Stack Height	Stack-Building Base Elevation Differences	GEP** EQN1	Preliminary* GEP Stack Height Value
WTI1	45.72	0.00	72.69	72.69
waste1	16.76	0.00	38.10	65.00
waste2	16.76	0.00	38.10	65.00
waste3	16.76	0.00	38.10	65.00
waste4	16.76	0.00	38.10	65.00
steam	6.71	0.00	68.00	68.00

* Results are based on Determinants 1 & 2 on pages 1 & 2 of the GEP Technical Support Document. Determinant 3 may be investigated for additional stack height credit. Final values result after Determinant 3 has been taken into consideration.

** Results were derived from Equation 1 on page 6 of GEP Technical Support Document. Values have been adjusted for any stack-building base elevation differences.

Note: Criteria for determining stack heights for modeling emission limitations for a source can be found in Table 3.1 of the GEP Technical Support Document.

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BPIP output is in meters

SO BUILDHGT WTI1	29.08	29.08	29.08	25.76	24.38	24.38
SO BUILDHGT WTI1	24.38	29.08	29.08	29.08	29.08	29.08
SO BUILDHGT WTI1	29.08	29.08	29.08	29.08	29.08	29.08
SO BUILDHGT WTI1	29.08	29.08	29.08	25.76	25.76	25.76
SO BUILDHGT WTI1	24.38	25.76	29.08	29.08	29.08	29.08
SO BUILDHGT WTI1	29.08	29.08	29.08	29.08	29.08	29.08
SO BUILDWID WTI1	26.88	24.72	21.81	27.61	27.01	24.64
SO BUILDWID WTI1	25.97	22.57	25.75	28.77	30.90	32.10
SO BUILDWID WTI1	32.33	31.85	30.86	29.63	29.30	28.21
SO BUILDWID WTI1	26.88	24.72	21.81	27.61	26.08	23.77
SO BUILDWID WTI1	25.97	24.81	25.75	28.77	30.90	32.10
SO BUILDWID WTI1	32.33	31.85	30.86	29.63	29.30	28.21
SO BUILDHGT waste1	15.24	15.24	15.24	15.24	15.24	15.24
SO BUILDHGT waste1	15.24	15.24	15.24	15.24	15.24	15.24
SO BUILDHGT waste1	15.24	15.24	15.24	15.24	15.24	15.24
SO BUILDHGT waste1	15.24	15.24	15.24	15.24	15.24	15.24
SO BUILDHGT waste1	15.24	15.24	15.24	15.24	15.24	15.24
SO BUILDHGT waste1	15.24	15.24	15.24	15.24	15.24	15.24
SO BUILDWID waste1	50.09	47.00	42.49	36.68	29.75	21.92
SO BUILDWID waste1	18.23	26.39	33.74	40.06	45.17	48.91
SO BUILDWID waste1	51.16	51.86	50.98	50.09	51.66	51.66
SO BUILDWID waste1	50.09	47.00	42.49	36.68	29.75	21.92
SO BUILDWID waste1	18.23	26.39	33.74	40.06	45.17	48.91
SO BUILDWID waste1	51.16	51.86	50.98	50.09	51.66	51.66

SO BUILDHGT waste2	15.24	15.24	15.24	15.24	15.24	15.24
SO BUILDHGT waste2	15.24	15.24	15.24	15.24	15.24	15.24
SO BUILDHGT waste2	15.24	15.24	15.24	15.24	15.24	15.24
SO BUILDHGT waste2	15.24	15.24	15.24	15.24	15.24	15.24
SO BUILDHGT waste2	15.24	15.24	15.24	15.24	15.24	15.24
SO BUILDHGT waste2	15.24	15.24	15.24	15.24	15.24	15.24
SO BUILDWID waste2	50.09	47.00	42.49	36.68	29.75	21.92
SO BUILDWID waste2	18.23	26.39	33.74	40.06	45.17	48.91
SO BUILDWID waste2	51.16	51.86	50.98	50.09	51.66	51.66
SO BUILDWID waste2	50.09	47.00	42.49	36.68	29.75	21.92
SO BUILDWID waste2	18.23	26.39	33.74	40.06	45.17	48.91
SO BUILDWID waste2	51.16	51.86	50.98	50.09	51.66	51.66
SO BUILDHGT waste3	15.24	15.24	15.24	15.24	15.24	15.24
SO BUILDHGT waste3	15.24	15.24	15.24	15.24	15.24	15.24
SO BUILDHGT waste3	15.24	15.24	15.24	15.24	15.24	15.24
SO BUILDHGT waste3	15.24	15.24	15.24	15.24	15.24	15.24
SO BUILDHGT waste3	15.24	15.24	15.24	15.24	15.24	15.24
SO BUILDHGT waste3	15.24	15.24	15.24	15.24	15.24	15.24
SO BUILDWID waste3	50.09	47.00	42.49	36.68	29.75	21.92
SO BUILDWID waste3	18.23	26.39	33.74	40.06	45.17	48.91
SO BUILDWID waste3	51.16	51.86	50.98	50.09	51.66	51.66
SO BUILDWID waste3	50.09	47.00	42.49	36.68	29.75	21.92
SO BUILDWID waste3	18.23	26.39	33.74	40.06	45.17	48.91
SO BUILDWID waste3	51.16	51.86	50.98	50.09	51.66	51.66
SO BUILDHGT waste4	15.24	15.24	15.24	15.24	15.24	15.24
SO BUILDHGT waste4	15.24	15.24	15.24	15.24	15.24	15.24
SO BUILDHGT waste4	15.24	15.24	15.24	15.24	15.24	15.24
SO BUILDHGT waste4	15.24	15.24	15.24	15.24	15.24	15.24
SO BUILDHGT waste4	15.24	15.24	15.24	15.24	15.24	15.24
SO BUILDHGT waste4	15.24	15.24	15.24	15.24	15.24	15.24
SO BUILDWID waste4	50.09	47.00	42.49	36.68	29.75	21.92
SO BUILDWID waste4	18.23	26.39	33.74	40.06	45.17	48.91
SO BUILDWID waste4	51.16	51.86	50.98	50.09	51.66	51.66
SO BUILDWID waste4	50.09	47.00	42.49	36.68	29.75	21.92
SO BUILDWID waste4	18.23	26.39	33.74	40.06	45.17	48.91
SO BUILDWID waste4	51.16	51.86	50.98	50.09	51.66	51.66
SO BUILDHGT steam	29.08	29.08	29.08	24.38	24.38	24.38
SO BUILDHGT steam	6.71	25.76	25.76	25.76	25.76	25.76
SO BUILDHGT steam	25.76	25.76	25.76	29.08	29.08	29.08
SO BUILDHGT steam	29.08	29.08	29.08	24.38	24.38	24.38

SO BUILDHGT steam	14.94	25.76	25.76	25.76	25.76	25.76
SO BUILDHGT steam	25.76	25.76	25.76	29.08	29.08	29.08
SO BUILDWID steam	25.95	24.72	21.81	28.86	27.01	24.64
SO BUILDWID steam	16.41	24.81	26.44	27.27	27.27	26.44
SO BUILDWID steam	24.80	22.42	20.13	25.95	25.95	25.95
SO BUILDWID steam	25.95	24.72	21.81	28.86	27.01	24.64
SO BUILDWID steam	65.31	24.81	26.44	27.27	27.27	26.44
SO BUILDWID steam	24.80	22.42	20.13	25.95	25.95	25.95

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 DATE : 12/23/94
 TIME : 16:56:52.99
 A363 - WTI Downwash Analysis


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BPIP PROCESSING INFORMATION:
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   The ST flag has been set for processing for an ISCST2 run.

   Inputs entered in FEET       will be converted to meters using
    a conversion factor of    0.3048.  Output will be in meters.

   UTMP is set to UTMN.  The input is assumed to be in a local
    X-Y coordinate system as opposed to a UTM coordinate system.
    True North is in the positive Y direction.

   Plant north is set to 337.21 degrees with respect to True North.


    The plant coordinates will appear as entered in the Summary output
    file and they will be adjusted to True North prior to processing.
    The True North oriented coordinates appear below between
    the square brackets.



==============
INPUT SUMMARY:
==============


 Number of buildings to be processed :   8


 SCRUBBER has 1 tier(s) with a base elevation of    0.00 FEET
                                                 (    0.00) meters

 BUILDING   TIER  BLDG-TIER  TIER   NO. OF      CORNER   COORDINATES
   NAME    NUMBER   NUMBER  HEIGHT  CORNERS       X           Y

 SCRUBBER    1        1     95.40     8
                           29.08 meters
                                              -15.00       19.00 FEET
                                               -4.57        5.79 meters
```

```
                                    [       -6.46         3.57] meters
                                           -15.00        66.00 FEET
                                            -4.57        20.12 meters
                                    [      -12.01        16.78] meters
                                            14.00        66.00 FEET
                                             4.27        20.12 meters
                                    [       -3.86        20.20] meters
                                            14.00        57.00 FEET
                                             4.27        17.37 meters
                                    [       -2.79        17.67] meters
                                            24.00        57.00 FEET
                                             7.32        17.37 meters
                                    [        0.02        18.85] meters
                                            24.00        33.00 FEET
                                             7.32        10.06 meters
                                    [        2.85        12.11] meters
                                            14.00        33.00 FEET
                                             4.27        10.06 meters
                                    [        0.04        10.93] meters
                                            14.00        19.00 FEET
                                             4.27         5.79 meters
                                    [        1.69         6.99] meters

PRECIP   has 1 tier(s) with a base elevation of     0.00 FEET
                                                (     0.00) meters

BUILDING  TIER  BLDG-TIER  TIER   NO. OF      CORNER   COORDINATES
  NAME   NUMBER   NUMBER  HEIGHT  CORNERS       X           Y

PRECIP      1        5     80.00     4
                          24.38 meters
                                            17.00        29.00 FEET
                                             5.18         8.84 meters
                                    [        1.35        10.16] meters
                                            52.00        29.00 FEET
                                            15.85         8.84 meters
                                    [       11.19        14.29] meters
                                            52.00        -6.00 FEET
                                            15.85        -1.83 meters
                                    [       15.32         4.45] meters
                                            17.00        -6.00 FEET
                                             5.18        -1.83 meters
                                    [        5.49         0.32] meters

SPRAY D  has 1 tier(s) with a base elevation of     0.00 FEET
```

(0.00) meters

BUILDING NAME	TIER NUMBER	BLDG-TIER NUMBER	TIER HEIGHT	NO. OF CORNERS	CORNER	COORDINATES X	Y
SPRAY D	1	9	106.00	8			
			32.31 meters				
						64.00	77.00 FEET
						19.51	23.47 meters
					[	8.89	29.19] meters
						77.00	72.00 FEET
						23.47	21.95 meters
					[	13.14	29.32] meters
						82.00	59.00 FEET
						24.99	17.98 meters
					[	16.08	26.26] meters
						77.00	46.00 FEET
						23.47	14.02 meters
					[	16.21	22.02] meters
						64.00	41.00 FEET
						19.51	12.50 meters
					[	13.14	19.08] meters
						51.00	46.00 FEET
						15.54	14.02 meters
					[	8.90	18.95] meters
						46.00	59.00 FEET
						14.02	17.98 meters
					[	5.96	22.01] meters
						51.00	72.00 FEET
						15.54	21.95 meters
					[	5.83	26.25] meters

BOILER has 1 tier(s) with a base elevation of 0.00 FEET
(0.00) meters

BUILDING NAME	TIER NUMBER	BLDG-TIER NUMBER	TIER HEIGHT	NO. OF CORNERS	CORNER	COORDINATES X	Y
BOILER	1	13	70.00	6			
			21.34 meters				
						80.00	30.00 FEET
						24.38	9.14 meters
					[	18.94	17.87] meters
						143.00	30.00 FEET
						43.59	9.14 meters
					[	36.64	25.31] meters

```
                                        143.00      -11.00 FEET
                                         43.59       -3.35 meters
                                    [    41.48       13.79] meters
                                        121.00      -11.00 FEET
                                         36.88       -3.35 meters
                                    [    35.30       11.19] meters
                                        121.00        7.00 FEET
                                         36.88        2.13 meters
                                    [    33.18       16.25] meters
                                         80.00        7.00 FEET
                                         24.38        2.13 meters
                                    [    21.65       11.41] meters

INCIN FD has 1 tier(s) with a base elevation of    0.00 FEET
                                                (    0.00) meters

BUILDING   TIER  BLDG-TIER  TIER    NO. OF      CORNER   COORDINATES
  NAME     NUMBER  NUMBER  HEIGHT  CORNERS       X           Y

INCIN FD    1       17     84.50     6
                           25.76 meters
                                        179.00       52.00 FEET
                                         54.56       15.85 meters
                                    [    44.16       35.74] meters
                                        239.00       52.00 FEET
                                         72.85       15.85 meters
                                    [    61.02       42.83] meters
                                        239.00      -19.00 FEET
                                         72.85       -5.79 meters
                                    [    69.40       22.87] meters
                                        184.00      -19.00 FEET
                                         56.08       -5.79 meters
                                    [    53.95       16.38] meters
                                        184.00        0.00 FEET
                                         56.08        0.00 meters
                                    [    51.71       21.72] meters
                                        179.00        0.00 FEET
                                         54.56        0.00 meters
                                    [    50.30       21.13] meters

steamplt has 1 tier(s) with a base elevation of    0.00 FEET
                                                (    0.00) meters

BUILDING   TIER  BLDG-TIER  TIER    NO. OF      CORNER   COORDINATES
  NAME     NUMBER  NUMBER  HEIGHT  CORNERS       X           Y
```

BUILDING NAME	TIER NUMBER	BLDG-TIER NUMBER	TIER HEIGHT	NO. OF CORNERS	CORNER	COORDINATES X	Y
steamplt	1	21	22.00	4			
			6.71 meters				
						52.00	168.00 FEET
						15.85	51.21 meters
					[	-5.22	53.35] meters
						132.00	168.00 FEET
						40.23	51.21 meters
					[	17.26	62.79] meters
						132.00	118.00 FEET
						40.23	35.97 meters
					[	23.16	48.74] meters
						52.00	118.00 FEET
						15.85	35.97 meters
					[	0.68	39.30] meters

contain has 1 tier(s) with a base elevation of 0.00 FEET
(0.00) meters

BUILDING NAME	TIER NUMBER	BLDG-TIER NUMBER	TIER HEIGHT	NO. OF CORNERS	CORNER	COORDINATES X	Y
contain	1	25	49.00	4			
			14.94 meters				
						338.00	237.00 FEET
						103.02	72.24 meters
					[	67.00	106.50] meters
						575.00	237.00 FEET
						175.26	72.24 meters
					[	133.60	134.48] meters
						575.00	34.00 FEET
						175.26	10.36 meters
					[	157.57	77.43] meters
						338.00	34.00 FEET
						103.02	10.36 meters
					[	90.97	49.46] meters

wastefrm has 1 tier(s) with a base elevation of 0.00 FEET
(0.00) meters

BUILDING NAME	TIER NUMBER	BLDG-TIER NUMBER	TIER HEIGHT	NO. OF CORNERS	CORNER	COORDINATES X	Y
wastefrm	1	29	50.00	4			
			15.24 meters				
						617.00	106.00 FEET

```
                                    188.06        32.31 meters
                                [   160.87       102.62] meters
                                    779.00       106.00 FEET
                                    237.44        32.31 meters
                                [   206.39       121.75] meters
                                    779.00        54.00 FEET
                                    237.44        16.46 meters
                                [   212.53       107.14] meters
                                    617.00        54.00 FEET
                                    188.06        16.46 meters
                                [   167.01        88.01] meters

Number of stacks to be processed :   6

                    STACK              STACK    COORDINATES
 STACK NAME      BASE  HEIGHT            X          Y

 WTI1            0.00  150.00 FEET
           (     0.00   45.72) meters
                                         0.00        0.00 FEET
                                (        0.00        0.00) meters
                                [        0.00        0.00] meters
 waste1          0.00   55.00 FEET
           (     0.00   16.76) meters
                                       663.00      106.00 FEET
                                (      202.08       32.31) meters
                                [      173.80      108.05] meters
 waste2          0.00   55.00 FEET
           (     0.00   16.76) meters
                                       733.00      106.00 FEET
                                (      223.42       32.31) meters
                                [      193.47      116.32] meters
 waste3          0.00   55.00 FEET
           (     0.00   16.76) meters
                                       733.00       54.00 FEET
                                (      223.42       16.46) meters
                                [      199.61      101.71] meters
 waste4          0.00   55.00 FEET
           (     0.00   16.76) meters
                                       663.00       54.00 FEET
                                (      202.08       16.46) meters
                                [      179.94       93.44] meters
 steam           0.00   22.00 FEET
           (     0.00    6.71) meters
                                       132.00      118.00 FEET
                                (       40.23       35.97) meters
                                [       23.16       48.74] meters
```

```
 The number of stack-tier combinations entered, where each stack is at least
5L
 in from at least one of the edges of their respective tier roofs, is:    0


                    Overall GEP Summary Table
                         (Units: meters)


 StkNo:  1  Stk Name:WTI1     Stk Ht:  45.72 Prelim. GEP Stk.Ht:   72.69
            GEP:  BH:  29.08  PBW:   29.08            *Eqn1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
  No. of Tiers affecting Stk:  2  Direction occurred:  172.50
   Bldg-Tier nos. contributing to GEP:   1   9


 StkNo:  2  Stk Name:waste1   Stk Ht:  16.76 Prelim. GEP Stk.Ht:   65.00
            GEP:  BH:  15.24  PBW:   15.88            *Eqn1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
  No. of Tiers affecting Stk:  1  Direction occurred:   67.25
   Bldg-Tier nos. contributing to GEP:  29


 StkNo:  3  Stk Name:waste2   Stk Ht:  16.76 Prelim. GEP Stk.Ht:   65.00
            GEP:  BH:  15.24  PBW:   15.88            *Eqn1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
  No. of Tiers affecting Stk:  1  Direction occurred:   67.25
   Bldg-Tier nos. contributing to GEP:  29


 StkNo:  4  Stk Name:waste3   Stk Ht:  16.76 Prelim. GEP Stk.Ht:   65.00
            GEP:  BH:  15.24  PBW:   15.88            *Eqn1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
  No. of Tiers affecting Stk:  1  Direction occurred:   67.25
   Bldg-Tier nos. contributing to GEP:  29


 StkNo:  5  Stk Name:waste4   Stk Ht:  16.76 Prelim. GEP Stk.Ht:   65.00
            GEP:  BH:  15.24  PBW:   15.88            *Eqn1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
  No. of Tiers affecting Stk:  1  Direction occurred:   67.25
   Bldg-Tier nos. contributing to GEP:  29


 StkNo:  6  Stk Name:steam    Stk Ht:   6.71 Prelim. GEP Stk.Ht:   68.00
```

```
          GEP:  BH:  29.08  PBW:   25.95              *Eqn1 Ht:   68.00
        *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2  Direction occurred:   14.75
  Bldg-Tier nos. contributing to GEP:   1   9
```

Summary By Direction Table
(Units: meters)

Dominate stand alone tiers:

Drtcn: 10.00

```
StkNo:  1  Stk Name:WTI1                                  Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  15.44  *Wake Effect Ht:   52.24
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
        *adjusted for a Stack-Building elevation difference of    0.00
             BldNo:  1  Bld Name:SCRUBBER  TierNo:  1
StkNo:  2  Stk Name:waste1                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.09  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
        *adjusted for a Stack-Building elevation difference of    0.00
             BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.09  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
        *adjusted for a Stack-Building elevation difference of    0.00
             BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.09  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
        *adjusted for a Stack-Building elevation difference of    0.00
             BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.09  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
        *adjusted for a Stack-Building elevation difference of    0.00
             BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  6  Stk Name:steam                                 Stack Ht:    6.71
    Directional MAX:  BH:  21.34  PBW:  22.91  *Wake Effect Ht:   53.34
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
        *adjusted for a Stack-Building elevation difference of    0.00
             BldNo:  4  Bld Name:BOILER    TierNo:  1
```

```
Drtcn:  20.00

StkNo:  1  Stk Name:WTI1                                    Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  16.22  *Wake Effect Ht:   53.40
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  1  Bld Name:SCRUBBER  TierNo:  1
StkNo:  2  Stk Name:waste1                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  47.00  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  3  Stk Name:waste2                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  47.00  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  4  Stk Name:waste3                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  47.00  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  5  Stk Name:waste4                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  47.00  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  6  Stk Name:steam                                   Stack Ht:    6.71
    Directional MAX:  BH:  29.08  PBW:  16.22  *Wake Effect Ht:   53.40
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  1  Bld Name:SCRUBBER  TierNo:  1

Drtcn:  30.00

StkNo:  1  Stk Name:WTI1                                    Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  16.75  *Wake Effect Ht:   54.21
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  1  Bld Name:SCRUBBER  TierNo:  1
StkNo:  2  Stk Name:waste1                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  42.49  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  3  Stk Name:waste2                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  42.49  *Wake Effect Ht:   38.10
```

```
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  42.49  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  42.49  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  6  Stk Name:steam                                 Stack Ht:    6.71
    Directional MAX:  BH:  29.08  PBW:  16.75  *Wake Effect Ht:   54.21
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  1  Bld Name:SCRUBBER  TierNo:  1

Drtcn:  40.00

StkNo:  1  Stk Name:WTI1                                  Stack Ht:   45.72
    Directional MAX:  BH:  25.76  PBW:  27.61  *Wake Effect Ht:   64.39
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  5  Bld Name:INCIN FD  TierNo:  1
StkNo:  2  Stk Name:waste1                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  36.68  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  36.68  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  36.68  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  36.68  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  6  Stk Name:steam                                 Stack Ht:    6.71
```

```
    Directional MAX:  BH:  29.08  PBW:  16.78  *Wake Effect Ht:   54.25
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  1  Bld Name:SCRUBBER  TierNo:  1

 Drtcn:  50.00

 StkNo:  1  Stk Name:WTI1                                Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  16.30  *Wake Effect Ht:   53.53
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  1  Bld Name:SCRUBBER  TierNo:  1
 StkNo:  2  Stk Name:waste1                              Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  29.75  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
 StkNo:  3  Stk Name:waste2                              Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  29.75  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
 StkNo:  4  Stk Name:waste3                              Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  29.75  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
 StkNo:  5  Stk Name:waste4                              Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  29.75  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
 StkNo:  6  Stk Name:steam                               Stack Ht:    6.71
    Directional MAX:  BH:  29.08  PBW:  16.30  *Wake Effect Ht:   53.53
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  1  Bld Name:SCRUBBER  TierNo:  1

 Drtcn:  60.00

 StkNo:  1  Stk Name:WTI1                                Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  15.32  *Wake Effect Ht:   52.06
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  1  Bld Name:SCRUBBER  TierNo:  1
 StkNo:  2  Stk Name:waste1                              Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  21.92  *Wake Effect Ht:   38.10
```

```
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  21.92  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  21.92  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  21.92  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  6  Stk Name:steam                                 Stack Ht:    6.71
    Directional MAX:  BH:   6.71  PBW:  18.18  *Wake Effect Ht:   16.76
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
         *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  6  Bld Name:steamplt  TierNo:  1

Drtcn:  70.00

StkNo:  1  Stk Name:WTI1                                  Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  14.74  *Wake Effect Ht:   51.19
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
         *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  1  Bld Name:SCRUBBER  TierNo:  1
StkNo:  2  Stk Name:waste1                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  18.23  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  18.23  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  18.23  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
```

```
    Directional MAX:  BH:  15.24  PBW:  18.23  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  6  Stk Name:steam                              Stack Ht:    6.71
    Directional MAX:  BH:   6.71  PBW:  16.41  *Wake Effect Ht:   16.76
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  6  Bld Name:steamplt  TierNo:  1

Drtcn:  80.00

StkNo:  1  Stk Name:WTI1                               Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  15.93  *Wake Effect Ht:   52.97
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  1  Bld Name:SCRUBBER  TierNo:  1
StkNo:  2  Stk Name:waste1                             Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  26.39  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  3  Stk Name:waste2                             Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  26.39  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  4  Stk Name:waste3                             Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  26.39  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  5  Stk Name:waste4                             Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  26.39  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  6  Stk Name:steam                              Stack Ht:    6.71
    Directional MAX:  BH:  25.76  PBW:  24.81  *Wake Effect Ht:   62.98
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn:  90.00

StkNo:  1  Stk Name:WTI1                               Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  16.63  *Wake Effect Ht:   54.02
```

```
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  1  Bld Name:SCRUBBER  TierNo:  1
StkNo:  2  Stk Name:waste1                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  33.74  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  33.74  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  33.74  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  33.74  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  6  Stk Name:steam                                 Stack Ht:    6.71
    Directional MAX:  BH:  25.76  PBW:  26.44  *Wake Effect Ht:   64.39
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn: 100.00

StkNo:  1  Stk Name:WTI1                                  Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  16.83  *Wake Effect Ht:   54.32
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  1  Bld Name:SCRUBBER  TierNo:  1
StkNo:  2  Stk Name:waste1                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  40.06  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  40.06  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
```

```
    Directional MAX:  BH:  15.24  PBW:  40.06  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  5  Stk Name:waste4                              Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  40.06  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  6  Stk Name:steam                               Stack Ht:    6.71
    Directional MAX:  BH:  25.76  PBW:  27.27  *Wake Effect Ht:   64.39
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn: 110.00

StkNo:  1  Stk Name:WTI1                                Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  16.57  *Wake Effect Ht:   53.94
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  1  Bld Name:SCRUBBER  TierNo:  1
StkNo:  2  Stk Name:waste1                              Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  45.17  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  3  Stk Name:waste2                              Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  45.17  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  4  Stk Name:waste3                              Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  45.17  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  5  Stk Name:waste4                              Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  45.17  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  6  Stk Name:steam                               Stack Ht:    6.71
    Directional MAX:  BH:  25.76  PBW:  27.27  *Wake Effect Ht:   64.39
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  5  Bld Name:INCIN FD  TierNo:  1
```

```
Drtcn: 120.00

StkNo:  1  Stk Name:WTI1                                    Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  16.47  *Wake Effect Ht:   53.79
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  1  Bld Name:SCRUBBER  TierNo:  1
StkNo:  2  Stk Name:waste1                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  48.91  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  3  Stk Name:waste2                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  48.91  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  4  Stk Name:waste3                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  48.91  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  5  Stk Name:waste4                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  48.91  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  6  Stk Name:steam                                   Stack Ht:    6.71
    Directional MAX:  BH:  25.76  PBW:  26.44  *Wake Effect Ht:   64.39
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn: 130.00

StkNo:  1  Stk Name:WTI1                                    Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  15.87  *Wake Effect Ht:   52.88
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  1  Bld Name:SCRUBBER  TierNo:  1
StkNo:  2  Stk Name:waste1                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.16  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  3  Stk Name:waste2                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.16  *Wake Effect Ht:   38.10
```

```
                GEP:  BH:  15.24  PBW:  15.88  *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.16  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88  *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.16  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88  *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  6  Stk Name:steam                                 Stack Ht:    6.71
    Directional MAX:  BH:  25.76  PBW:  24.80  *Wake Effect Ht:   62.96
                GEP:  BH:  29.08  PBW:  25.95  *Equation 1 Ht:   68.00
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn: 140.00

StkNo:  1  Stk Name:WTI1                                  Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  14.78  *Wake Effect Ht:   51.25
                GEP:  BH:  29.08  PBW:  29.08  *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  1  Bld Name:SCRUBBER  TierNo:  1
StkNo:  2  Stk Name:waste1                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.86  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88  *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.86  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88  *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.86  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88  *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.86  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88  *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  6  Stk Name:steam                                 Stack Ht:    6.71
```

```
    Directional MAX:  BH:  25.76  PBW:  22.42  *Wake Effect Ht:   59.38
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn: 150.00

StkNo:  1  Stk Name:WTI1                                 Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  13.25  *Wake Effect Ht:   48.95
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  1  Bld Name:SCRUBBER  TierNo:  1
StkNo:  2  Stk Name:waste1                               Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.98  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  3  Stk Name:waste2                               Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.98  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  4  Stk Name:waste3                               Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.98  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  5  Stk Name:waste4                               Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.98  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  6  Stk Name:steam                                Stack Ht:    6.71
    Directional MAX:  BH:  25.76  PBW:  20.13  *Wake Effect Ht:   55.96
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn: 160.00

StkNo:  1  Stk Name:WTI1                                 Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  12.36  *Wake Effect Ht:   47.62
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  1  Bld Name:SCRUBBER  TierNo:  1
StkNo:  2  Stk Name:waste1                               Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.09  *Wake Effect Ht:   38.10
```

```
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.09  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.09  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.09  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  6  Stk Name:steam                                 Stack Ht:    6.71
    Directional MAX:  BH:  21.34  PBW:  19.79  *Wake Effect Ht:   51.02
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  4  Bld Name:BOILER    TierNo:  1

Drtcn: 170.00

StkNo:  1  Stk Name:WTI1                                  Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  13.82  *Wake Effect Ht:   49.81
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  1  Bld Name:SCRUBBER  TierNo:  1
StkNo:  2  Stk Name:waste1                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.66  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.66  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.66  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
```

```
    Directional MAX:  BH:  15.24  PBW:  51.66  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  6  Stk Name:steam                                Stack Ht:    6.71
    Directional MAX:  BH:  21.34  PBW:  21.49  *Wake Effect Ht:   53.34
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  4  Bld Name:BOILER    TierNo:  1

Drtcn: 180.00

StkNo:  1  Stk Name:WTI1                                 Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  14.86  *Wake Effect Ht:   51.36
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  1  Bld Name:SCRUBBER  TierNo:  1
StkNo:  2  Stk Name:waste1                               Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.66  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  3  Stk Name:waste2                               Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.66  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  4  Stk Name:waste3                               Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.66  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  5  Stk Name:waste4                               Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.66  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  6  Stk Name:steam                                Stack Ht:    6.71
    Directional MAX:  BH:  21.34  PBW:  22.54  *Wake Effect Ht:   53.34
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  4  Bld Name:BOILER    TierNo:  1

Drtcn: 190.00

StkNo:  1  Stk Name:WTI1                                 Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  15.44  *Wake Effect Ht:   52.24
```

```
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  1  Bld Name:SCRUBBER  TierNo:  1
StkNo:  2  Stk Name:waste1                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.09  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.09  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.09  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.09  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  6  Stk Name:steam                                 Stack Ht:    6.71
    Directional MAX:  BH:  21.34  PBW:  22.91  *Wake Effect Ht:   53.34
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  4  Bld Name:BOILER    TierNo:  1

Drtcn: 200.00

StkNo:  1  Stk Name:WTI1                                  Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  16.22  *Wake Effect Ht:   53.40
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  1  Bld Name:SCRUBBER  TierNo:  1
StkNo:  2  Stk Name:waste1                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  47.00  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  47.00  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
```

```
    Directional MAX:  BH:  15.24  PBW:  47.00  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  5  Stk Name:waste4                              Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  47.00  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  6  Stk Name:steam                               Stack Ht:    6.71
    Directional MAX:  BH:  21.34  PBW:  22.58  *Wake Effect Ht:   53.34
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  4  Bld Name:BOILER    TierNo:  1

Drtcn: 210.00

StkNo:  1  Stk Name:WTI1                                Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  16.75  *Wake Effect Ht:   54.21
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  1  Bld Name:SCRUBBER  TierNo:  1
StkNo:  2  Stk Name:waste1                              Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  42.49  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  3  Stk Name:waste2                              Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  42.49  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  4  Stk Name:waste3                              Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  42.49  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  5  Stk Name:waste4                              Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  42.49  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  6  Stk Name:steam                               Stack Ht:    6.71
    Directional MAX:  BH:  32.31  PBW:  11.10  *Wake Effect Ht:   48.96
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  3  Bld Name:SPRAY D   TierNo:  1
```

```
 Drtcn: 220.00

 StkNo:  1  Stk Name:WTI1                                    Stack Ht:   45.72
    Directional MAX:  BH:  25.76  PBW:  27.61  *Wake Effect Ht:   64.39
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  5  Bld Name:INCIN FD  TierNo:  1
 StkNo:  2  Stk Name:waste1                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  36.68  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  8  Bld Name:wastefrm  TierNo:  1
 StkNo:  3  Stk Name:waste2                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  36.68  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  8  Bld Name:wastefrm  TierNo:  1
 StkNo:  4  Stk Name:waste3                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  36.68  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  8  Bld Name:wastefrm  TierNo:  1
 StkNo:  5  Stk Name:waste4                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  36.68  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  8  Bld Name:wastefrm  TierNo:  1
 StkNo:  6  Stk Name:steam                                   Stack Ht:    6.71
    Directional MAX:  BH:  32.31  PBW:  10.67  *Wake Effect Ht:   48.32
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  3  Bld Name:SPRAY D   TierNo:  1

 Drtcn: 230.00

 StkNo:  1  Stk Name:WTI1                                    Stack Ht:   45.72
    Directional MAX:  BH:  25.76  PBW:  26.08  *Wake Effect Ht:   64.39
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  5  Bld Name:INCIN FD  TierNo:  1
 StkNo:  2  Stk Name:waste1                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  29.75  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  8  Bld Name:wastefrm  TierNo:  1
 StkNo:  3  Stk Name:waste2                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  29.75  *Wake Effect Ht:   38.10
```

```
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  29.75  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  29.75  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  6  Stk Name:steam                                 Stack Ht:    6.71
    Directional MAX:  BH:  14.94  PBW:  80.48  *Wake Effect Ht:   37.34
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  7  Bld Name:contain   TierNo:  1

Drtcn: 240.00

StkNo:  1  Stk Name:WTI1                                  Stack Ht:   45.72
    Directional MAX:  BH:  25.76  PBW:  23.77  *Wake Effect Ht:   61.40
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  5  Bld Name:INCIN FD  TierNo:  1
StkNo:  2  Stk Name:waste1                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  21.92  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  21.92  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  21.92  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  21.92  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  6  Stk Name:steam                                 Stack Ht:    6.71
```

```
    Directional MAX:  BH:  14.94  PBW:  70.45  *Wake Effect Ht:   37.34
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  7  Bld Name:contain   TierNo:  1

Drtcn: 250.00

StkNo:  1  Stk Name:WTI1                                 Stack Ht:   45.72
    Directional MAX:  BH:  25.76  PBW:  22.43  *Wake Effect Ht:   59.40
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  5  Bld Name:INCIN FD  TierNo:  1
StkNo:  2  Stk Name:waste1                               Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  18.23  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  3  Stk Name:waste2                               Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  18.23  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  4  Stk Name:waste3                               Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  18.23  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  5  Stk Name:waste4                               Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  18.23  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  6  Stk Name:steam                                Stack Ht:    6.71
    Directional MAX:  BH:  14.94  PBW:  65.31  *Wake Effect Ht:   37.34
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  7  Bld Name:contain   TierNo:  1

Drtcn: 260.00

StkNo:  1  Stk Name:WTI1                                 Stack Ht:   45.72
    Directional MAX:  BH:  25.76  PBW:  24.81  *Wake Effect Ht:   62.98
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  5  Bld Name:INCIN FD  TierNo:  1
StkNo:  2  Stk Name:waste1                               Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  26.39  *Wake Effect Ht:   38.10
```

```
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:    38.10
         *adjusted for a Stack-Building elevation difference of     0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  26.39  *Wake Effect Ht:    38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:    38.10
         *adjusted for a Stack-Building elevation difference of     0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  26.39  *Wake Effect Ht:    38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:    38.10
         *adjusted for a Stack-Building elevation difference of     0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  26.39  *Wake Effect Ht:    38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:    38.10
         *adjusted for a Stack-Building elevation difference of     0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  6  Stk Name:steam                                 Stack Ht:    6.71
    Directional MAX:  BH:  25.76  PBW:  24.81  *Wake Effect Ht:    62.98
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:    68.00
         *adjusted for a Stack-Building elevation difference of     0.00
               BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn: 270.00

StkNo:  1  Stk Name:WTI1                                  Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  16.63  *Wake Effect Ht:    54.02
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:    72.69
         *adjusted for a Stack-Building elevation difference of     0.00
               BldNo:  1  Bld Name:SCRUBBER  TierNo:  1
StkNo:  2  Stk Name:waste1                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  33.74  *Wake Effect Ht:    38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:    38.10
         *adjusted for a Stack-Building elevation difference of     0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  33.74  *Wake Effect Ht:    38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:    38.10
         *adjusted for a Stack-Building elevation difference of     0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  33.74  *Wake Effect Ht:    38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:    38.10
         *adjusted for a Stack-Building elevation difference of     0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
```

```
    Directional MAX:  BH:  15.24  PBW:  33.74  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  6  Stk Name:steam                                Stack Ht:    6.71
    Directional MAX:  BH:  25.76  PBW:  26.44  *Wake Effect Ht:   64.39
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn: 280.00

StkNo:  1  Stk Name:WTI1                                 Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  16.83  *Wake Effect Ht:   54.32
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  1  Bld Name:SCRUBBER  TierNo:  1
StkNo:  2  Stk Name:waste1                               Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  40.06  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  3  Stk Name:waste2                               Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  40.06  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  4  Stk Name:waste3                               Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  40.06  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  5  Stk Name:waste4                               Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  40.06  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  6  Stk Name:steam                                Stack Ht:    6.71
    Directional MAX:  BH:  25.76  PBW:  27.27  *Wake Effect Ht:   64.39
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn: 290.00

StkNo:  1  Stk Name:WTI1                                 Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  16.57  *Wake Effect Ht:   53.94
```

```
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  1  Bld Name:SCRUBBER  TierNo:  1
 StkNo:  2  Stk Name:waste1                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  45.17  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
 StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  45.17  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
 StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  45.17  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
 StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  45.17  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
 StkNo:  6  Stk Name:steam                                 Stack Ht:    6.71
    Directional MAX:  BH:  25.76  PBW:  27.27  *Wake Effect Ht:   64.39
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  5  Bld Name:INCIN FD  TierNo:  1

 Drtcn: 300.00

 StkNo:  1  Stk Name:WTI1                                  Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  16.47  *Wake Effect Ht:   53.79
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  1  Bld Name:SCRUBBER  TierNo:  1
 StkNo:  2  Stk Name:waste1                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  48.91  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
 StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  48.91  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
 StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
```

```
    Directional MAX:  BH:  15.24  PBW:  48.91  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  48.91  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  6  Stk Name:steam                                 Stack Ht:    6.71
    Directional MAX:  BH:  25.76  PBW:  26.44  *Wake Effect Ht:   64.39
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn: 310.00

StkNo:  1  Stk Name:WTI1                                  Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  15.87  *Wake Effect Ht:   52.88
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  1  Bld Name:SCRUBBER  TierNo:  1
StkNo:  2  Stk Name:waste1                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.16  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.16  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.16  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.16  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  6  Stk Name:steam                                 Stack Ht:    6.71
    Directional MAX:  BH:  25.76  PBW:  24.80  *Wake Effect Ht:   62.96
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
         *adjusted for a Stack-Building elevation difference of    0.00
              BldNo:  5  Bld Name:INCIN FD  TierNo:  1
```

```
Drtcn: 320.00

StkNo:  1  Stk Name:WTI1                                    Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  14.78  *Wake Effect Ht:   51.25
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  1  Bld Name:SCRUBBER  TierNo:  1
StkNo:  2  Stk Name:waste1                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.86  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  3  Stk Name:waste2                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.86  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  4  Stk Name:waste3                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.86  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  5  Stk Name:waste4                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.86  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  6  Stk Name:steam                                   Stack Ht:    6.71
    Directional MAX:  BH:  25.76  PBW:  22.42  *Wake Effect Ht:   59.38
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn: 330.00

StkNo:  1  Stk Name:WTI1                                    Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  13.25  *Wake Effect Ht:   48.95
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  1  Bld Name:SCRUBBER  TierNo:  1
StkNo:  2  Stk Name:waste1                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.98  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  3  Stk Name:waste2                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.98  *Wake Effect Ht:   38.10
```

```
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.98  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.98  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  6  Stk Name:steam                                 Stack Ht:    6.71
    Directional MAX:  BH:  25.76  PBW:  20.13  *Wake Effect Ht:   55.96
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn: 340.00

StkNo:  1  Stk Name:WTI1                                  Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  12.36  *Wake Effect Ht:   47.62
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  1  Bld Name:SCRUBBER  TierNo:  1
StkNo:  2  Stk Name:waste1                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.09  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.09  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.09  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.09  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  6  Stk Name:steam                                 Stack Ht:    6.71
```

```
    Directional MAX:  BH:  21.34  PBW:  19.79  *Wake Effect Ht:   51.02
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  4  Bld Name:BOILER    TierNo:  1

Drtcn: 350.00

StkNo:  1  Stk Name:WTI1                                  Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  13.82  *Wake Effect Ht:   49.81
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  1  Bld Name:SCRUBBER  TierNo:  1
StkNo:  2  Stk Name:waste1                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.66  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.66  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.66  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.66  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  8  Bld Name:wastefrm  TierNo:  1
StkNo:  6  Stk Name:steam                                 Stack Ht:    6.71
    Directional MAX:  BH:  21.34  PBW:  21.49  *Wake Effect Ht:   53.34
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  4  Bld Name:BOILER    TierNo:  1

Drtcn: 360.00

StkNo:  1  Stk Name:WTI1                                  Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  14.86  *Wake Effect Ht:   51.36
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  1  Bld Name:SCRUBBER  TierNo:  1
StkNo:  2  Stk Name:waste1                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.66  *Wake Effect Ht:   38.10
```

```
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
 StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
     Directional MAX:  BH:  15.24  PBW:  51.66  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
 StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
     Directional MAX:  BH:  15.24  PBW:  51.66  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
 StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
     Directional MAX:  BH:  15.24  PBW:  51.66  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  8  Bld Name:wastefrm  TierNo:  1
 StkNo:  6  Stk Name:steam                                 Stack Ht:    6.71
     Directional MAX:  BH:  21.34  PBW:  22.54  *Wake Effect Ht:   53.34
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  4  Bld Name:BOILER    TierNo:  1


Dominate combined buildings:

 Drtcn:  10.00

 StkNo:  1  Stk Name:WTI1                                  Stack Ht:   45.72
     Directional MAX:  BH:  29.08  PBW:  26.88  *Wake Effect Ht:   69.39
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
  No. of Tiers affecting Stk:  2
   Bldg-Tier nos. contributing to MAX:   1   9
 StkNo:  2  Stk Name:waste1                                Stack Ht:   16.76
     Directional MAX:  BH:  15.24  PBW:  50.09  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
      No combined tiers affect this stack for  this direction
 StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
     Directional MAX:  BH:  15.24  PBW:  50.09  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
      No combined tiers affect this stack for  this direction
 StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
     Directional MAX:  BH:  15.24  PBW:  50.09  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
      No combined tiers affect this stack for  this direction
```

```
StkNo:  5  Stk Name:waste4                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.09  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  6  Stk Name:steam                                   Stack Ht:    6.71
    Directional MAX:  BH:  29.08  PBW:  25.95  *Wake Effect Ht:   68.00
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:   9   1

Drtcn:  20.00

StkNo:  1  Stk Name:WTI1                                    Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  24.72  *Wake Effect Ht:   66.16
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:   1   9
StkNo:  2  Stk Name:waste1                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  47.00  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  3  Stk Name:waste2                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  47.00  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  4  Stk Name:waste3                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  47.00  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  5  Stk Name:waste4                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  47.00  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  6  Stk Name:steam                                   Stack Ht:    6.71
    Directional MAX:  BH:  29.08  PBW:  24.72  *Wake Effect Ht:   66.16
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:   1   9

Drtcn:  30.00

StkNo:  1  Stk Name:WTI1                                    Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  21.81  *Wake Effect Ht:   61.80
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
```

```
          *adjusted for a Stack-Building elevation difference of    0.00
  No. of Tiers affecting Stk:  2
   Bldg-Tier nos. contributing to MAX:   1   9
 StkNo:  2  Stk Name:waste1                                Stack Ht:   16.76
     Directional MAX:  BH:  15.24  PBW:  42.49  *Wake Effect Ht:   38.10
                 GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
      No combined tiers affect this stack for  this direction
 StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
     Directional MAX:  BH:  15.24  PBW:  42.49  *Wake Effect Ht:   38.10
                 GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
      No combined tiers affect this stack for  this direction
 StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
     Directional MAX:  BH:  15.24  PBW:  42.49  *Wake Effect Ht:   38.10
                 GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
      No combined tiers affect this stack for  this direction
 StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
     Directional MAX:  BH:  15.24  PBW:  42.49  *Wake Effect Ht:   38.10
                 GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
      No combined tiers affect this stack for  this direction
 StkNo:  6  Stk Name:steam                                 Stack Ht:    6.71
     Directional MAX:  BH:  29.08  PBW:  21.81  *Wake Effect Ht:   61.80
                 GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
          *adjusted for a Stack-Building elevation difference of    0.00
  No. of Tiers affecting Stk:  2
   Bldg-Tier nos. contributing to MAX:   1   9

 Drtcn:  40.00

 StkNo:  1  Stk Name:WTI1                                  Stack Ht:   45.72
     Directional MAX:  BH:  25.76  PBW:  27.61  *Wake Effect Ht:   64.39
                 GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
  No. of Tiers affecting Stk:  3
   Bldg-Tier nos. contributing to MAX:   1   5   9
 StkNo:  2  Stk Name:waste1                                Stack Ht:   16.76
     Directional MAX:  BH:  15.24  PBW:  36.68  *Wake Effect Ht:   38.10
                 GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
      No combined tiers affect this stack for  this direction
 StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
     Directional MAX:  BH:  15.24  PBW:  36.68  *Wake Effect Ht:   38.10
                 GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
      No combined tiers affect this stack for  this direction
 StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
     Directional MAX:  BH:  15.24  PBW:  36.68  *Wake Effect Ht:   38.10
                 GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
      No combined tiers affect this stack for  this direction
 StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
```

```
    Directional MAX:  BH:  15.24  PBW:  36.68  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  6  Stk Name:steam                                Stack Ht:    6.71
    Directional MAX:  BH:  24.38  PBW:  28.86  *Wake Effect Ht:   60.96
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  3
  Bldg-Tier nos. contributing to MAX:   1   5   9

Drtcn:  50.00

StkNo:  1  Stk Name:WTI1                                 Stack Ht:   45.72
    Directional MAX:  BH:  24.38  PBW:  27.01  *Wake Effect Ht:   60.96
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  3
  Bldg-Tier nos. contributing to MAX:   1   5   9
StkNo:  2  Stk Name:waste1                               Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  29.75  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  3  Stk Name:waste2                               Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  29.75  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  4  Stk Name:waste3                               Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  29.75  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  5  Stk Name:waste4                               Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  29.75  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  6  Stk Name:steam                                Stack Ht:    6.71
    Directional MAX:  BH:  24.38  PBW:  27.01  *Wake Effect Ht:   60.96
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  3
  Bldg-Tier nos. contributing to MAX:   1   5   9

Drtcn:  60.00

StkNo:  1  Stk Name:WTI1                                 Stack Ht:   45.72
    Directional MAX:  BH:  24.38  PBW:  24.64  *Wake Effect Ht:   60.96
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
         *adjusted for a Stack-Building elevation difference of    0.00
```

```
 No. of Tiers affecting Stk:  3
  Bldg-Tier nos. contributing to MAX:   1   5   9
StkNo:  2  Stk Name:waste1                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  21.92  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  3  Stk Name:waste2                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  21.92  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  4  Stk Name:waste3                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  21.92  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  5  Stk Name:waste4                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  21.92  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  6  Stk Name:steam                                   Stack Ht:    6.71
    Directional MAX:  BH:  24.38  PBW:  24.64  *Wake Effect Ht:   60.96
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  3
  Bldg-Tier nos. contributing to MAX:   1   5   9

Drtcn:  70.00

StkNo:  1  Stk Name:WTI1                                    Stack Ht:   45.72
    Directional MAX:  BH:  24.38  PBW:  25.97  *Wake Effect Ht:   60.96
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  3
  Bldg-Tier nos. contributing to MAX:   1   5   9
StkNo:  2  Stk Name:waste1                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  18.23  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  3  Stk Name:waste2                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  18.23  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  4  Stk Name:waste3                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  18.23  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  5  Stk Name:waste4                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  18.23  *Wake Effect Ht:   38.10
```

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                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  6  Stk Name:steam                                Stack Ht:    6.71
    Directional MAX:  BH:   6.71  PBW:  16.41  *Wake Effect Ht:   16.76
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
     No combined tiers affect this stack for  this direction

Drtcn:  80.00

StkNo:  1  Stk Name:WTI1                                 Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  22.57  *Wake Effect Ht:   62.93
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:   1   9
StkNo:  2  Stk Name:waste1                               Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  26.39  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  3  Stk Name:waste2                               Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  26.39  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  4  Stk Name:waste3                               Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  26.39  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  5  Stk Name:waste4                               Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  26.39  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  6  Stk Name:steam                                Stack Ht:    6.71
    Directional MAX:  BH:  25.76  PBW:  24.81  *Wake Effect Ht:   62.98
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
     No combined tiers affect this stack for  this direction

Drtcn:  90.00

StkNo:  1  Stk Name:WTI1                                 Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  25.75  *Wake Effect Ht:   67.71
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:   1   9
StkNo:  2  Stk Name:waste1                               Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  33.74  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
```

```
     No combined tiers affect this stack for  this direction
StkNo:  3  Stk Name:waste2                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  33.74  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  4  Stk Name:waste3                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  33.74  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  5  Stk Name:waste4                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  33.74  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  6  Stk Name:steam                                   Stack Ht:    6.71
    Directional MAX:  BH:  25.76  PBW:  26.44  *Wake Effect Ht:   64.39
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
     No combined tiers affect this stack for  this direction

Drtcn: 100.00

StkNo:  1  Stk Name:WTI1                                    Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  28.77  *Wake Effect Ht:   72.23
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:   1   9
StkNo:  2  Stk Name:waste1                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  40.06  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  3  Stk Name:waste2                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  40.06  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  4  Stk Name:waste3                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  40.06  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  5  Stk Name:waste4                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  40.06  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  6  Stk Name:steam                                   Stack Ht:    6.71
    Directional MAX:  BH:  25.76  PBW:  27.27  *Wake Effect Ht:   64.39
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
     No combined tiers affect this stack for  this direction
```

```
Drtcn: 110.00

StkNo:  1  Stk Name:WTI1                                  Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  30.90  *Wake Effect Ht:   72.69
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:   1   9
StkNo:  2  Stk Name:waste1                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  45.17  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  45.17  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  45.17  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  45.17  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  6  Stk Name:steam                                 Stack Ht:    6.71
    Directional MAX:  BH:  25.76  PBW:  27.27  *Wake Effect Ht:   64.39
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
     No combined tiers affect this stack for  this direction

Drtcn: 120.00

StkNo:  1  Stk Name:WTI1                                  Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  32.10  *Wake Effect Ht:   72.69
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:   1   9
StkNo:  2  Stk Name:waste1                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  48.91  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  48.91  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  48.91  *Wake Effect Ht:   38.10
```

```
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  48.91  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  6  Stk Name:steam                                 Stack Ht:    6.71
    Directional MAX:  BH:  25.76  PBW:  26.44  *Wake Effect Ht:   64.39
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
     No combined tiers affect this stack for  this direction

Drtcn: 130.00

StkNo:  1  Stk Name:WTI1                                  Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  32.33  *Wake Effect Ht:   72.69
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:   1   9
StkNo:  2  Stk Name:waste1                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.16  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.16  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.16  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.16  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  6  Stk Name:steam                                 Stack Ht:    6.71
    Directional MAX:  BH:  25.76  PBW:  24.80  *Wake Effect Ht:   62.96
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
     No combined tiers affect this stack for  this direction

Drtcn: 140.00

StkNo:  1  Stk Name:WTI1                                  Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  31.85  *Wake Effect Ht:   72.69
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
```

```
  Bldg-Tier nos. contributing to MAX:   1   9
StkNo:  2  Stk Name:waste1                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.86  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  3  Stk Name:waste2                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.86  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  4  Stk Name:waste3                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.86  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  5  Stk Name:waste4                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.86  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  6  Stk Name:steam                                   Stack Ht:    6.71
    Directional MAX:  BH:  25.76  PBW:  22.42  *Wake Effect Ht:   59.38
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
     No combined tiers affect this stack for  this direction

Drtcn: 150.00

StkNo:  1  Stk Name:WTI1                                    Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  30.86  *Wake Effect Ht:   72.69
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:   1   9
StkNo:  2  Stk Name:waste1                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.98  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  3  Stk Name:waste2                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.98  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  4  Stk Name:waste3                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.98  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  5  Stk Name:waste4                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.98  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  6  Stk Name:steam                                   Stack Ht:    6.71
```

```
    Directional MAX:  BH:  25.76  PBW:  20.13  *Wake Effect Ht:   55.96
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
     No combined tiers affect this stack for  this direction

Drtcn: 160.00

StkNo:  1  Stk Name:WTI1                                  Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  29.63  *Wake Effect Ht:   72.69
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:   1   9
StkNo:  2  Stk Name:waste1                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.09  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.09  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.09  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.09  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  6  Stk Name:steam                                 Stack Ht:    6.71
    Directional MAX:  BH:  29.08  PBW:  25.95  *Wake Effect Ht:   68.00
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:   9   1

Drtcn: 170.00

StkNo:  1  Stk Name:WTI1                                  Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  29.30  *Wake Effect Ht:   72.69
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:   1   9
StkNo:  2  Stk Name:waste1                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.66  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
```

```
StkNo:  3  Stk Name:waste2                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.66  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  4  Stk Name:waste3                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.66  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  5  Stk Name:waste4                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.66  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  6  Stk Name:steam                                   Stack Ht:    6.71
    Directional MAX:  BH:  29.08  PBW:  25.95  *Wake Effect Ht:   68.00
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:   9   1

Drtcn: 180.00

StkNo:  1  Stk Name:WTI1                                    Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  28.21  *Wake Effect Ht:   71.40
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:   1   9
StkNo:  2  Stk Name:waste1                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.66  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  3  Stk Name:waste2                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.66  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  4  Stk Name:waste3                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.66  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  5  Stk Name:waste4                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.66  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  6  Stk Name:steam                                   Stack Ht:    6.71
    Directional MAX:  BH:  29.08  PBW:  25.95  *Wake Effect Ht:   68.00
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
         *adjusted for a Stack-Building elevation difference of    0.00
```

```
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:   9   1

Drtcn: 190.00

StkNo:  1  Stk Name:WTI1                                    Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  26.88  *Wake Effect Ht:   69.39
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:   1   9
StkNo:  2  Stk Name:waste1                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.09  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  3  Stk Name:waste2                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.09  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  4  Stk Name:waste3                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.09  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  5  Stk Name:waste4                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.09  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  6  Stk Name:steam                                   Stack Ht:    6.71
    Directional MAX:  BH:  29.08  PBW:  25.95  *Wake Effect Ht:   68.00
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:   9   1

Drtcn: 200.00

StkNo:  1  Stk Name:WTI1                                    Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  24.72  *Wake Effect Ht:   66.16
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:   1   9
StkNo:  2  Stk Name:waste1                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  47.00  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  3  Stk Name:waste2                                  Stack Ht:   16.76
```

```
    Directional MAX:  BH:  15.24  PBW:  47.00  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  47.00  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  47.00  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  6  Stk Name:steam                                 Stack Ht:    6.71
    Directional MAX:  BH:  29.08  PBW:  24.72  *Wake Effect Ht:   66.16
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:   1   9

Drtcn: 210.00

StkNo:  1  Stk Name:WTI1                                  Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  21.81  *Wake Effect Ht:   61.80
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:   1   9
StkNo:  2  Stk Name:waste1                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  42.49  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  42.49  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  42.49  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  42.49  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  6  Stk Name:steam                                 Stack Ht:    6.71
    Directional MAX:  BH:  29.08  PBW:  21.81  *Wake Effect Ht:   61.80
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
```

```
  Bldg-Tier nos. contributing to MAX:   1   9

 Drtcn: 220.00

 StkNo:  1  Stk Name:WTI1                                    Stack Ht:   45.72
    Directional MAX:  BH:  25.76  PBW:  27.61  *Wake Effect Ht:   64.39
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
         *adjusted for a Stack-Building elevation difference of    0.00
  No. of Tiers affecting Stk:  3
   Bldg-Tier nos. contributing to MAX:   1   5   9
 StkNo:  2  Stk Name:waste1                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  36.68  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
 StkNo:  3  Stk Name:waste2                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  36.68  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
 StkNo:  4  Stk Name:waste3                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  36.68  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
 StkNo:  5  Stk Name:waste4                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  36.68  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
 StkNo:  6  Stk Name:steam                                   Stack Ht:    6.71
    Directional MAX:  BH:  24.38  PBW:  28.86  *Wake Effect Ht:   60.96
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
         *adjusted for a Stack-Building elevation difference of    0.00
  No. of Tiers affecting Stk:  3
   Bldg-Tier nos. contributing to MAX:   1   5   9

 Drtcn: 230.00

 StkNo:  1  Stk Name:WTI1                                    Stack Ht:   45.72
    Directional MAX:  BH:  25.76  PBW:  26.08  *Wake Effect Ht:   64.39
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
         *adjusted for a Stack-Building elevation difference of    0.00
  No. of Tiers affecting Stk:  3
   Bldg-Tier nos. contributing to MAX:   1   5   9
 StkNo:  2  Stk Name:waste1                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  29.75  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
 StkNo:  3  Stk Name:waste2                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  29.75  *Wake Effect Ht:   38.10
```

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                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  29.75  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  29.75  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  6  Stk Name:steam                                 Stack Ht:    6.71
    Directional MAX:  BH:  24.38  PBW:  27.01  *Wake Effect Ht:   60.96
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  3
  Bldg-Tier nos. contributing to MAX:   1   5   9

Drtcn: 240.00

StkNo:  1  Stk Name:WTI1                                  Stack Ht:   45.72
    Directional MAX:  BH:  25.76  PBW:  23.77  *Wake Effect Ht:   61.40
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  3
  Bldg-Tier nos. contributing to MAX:   1   5   9
StkNo:  2  Stk Name:waste1                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  21.92  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  21.92  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  21.92  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  21.92  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  6  Stk Name:steam                                 Stack Ht:    6.71
    Directional MAX:  BH:  24.38  PBW:  24.64  *Wake Effect Ht:   60.96
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  3
  Bldg-Tier nos. contributing to MAX:   1   5   9
```

```
Drtcn: 250.00

StkNo:  1  Stk Name:WTI1                                    Stack Ht:   45.72
    Directional MAX:  BH:  24.38  PBW:  25.97  *Wake Effect Ht:   60.96
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  3
  Bldg-Tier nos. contributing to MAX:   1   5   9
StkNo:  2  Stk Name:waste1                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  18.23  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  3  Stk Name:waste2                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  18.23  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  4  Stk Name:waste3                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  18.23  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  5  Stk Name:waste4                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  18.23  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  6  Stk Name:steam                                   Stack Ht:    6.71
    Directional MAX:  BH:  14.94  PBW:  65.31  *Wake Effect Ht:   37.34
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
     No combined tiers affect this stack for  this direction

Drtcn: 260.00

StkNo:  1  Stk Name:WTI1                                    Stack Ht:   45.72
    Directional MAX:  BH:  25.76  PBW:  24.81  *Wake Effect Ht:   62.98
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:   1   9
StkNo:  2  Stk Name:waste1                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  26.39  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  3  Stk Name:waste2                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  26.39  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  4  Stk Name:waste3                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  26.39  *Wake Effect Ht:   38.10
```

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                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  26.39  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  6  Stk Name:steam                                 Stack Ht:    6.71
    Directional MAX:  BH:  25.76  PBW:  24.81  *Wake Effect Ht:   62.98
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
     No combined tiers affect this stack for  this direction

Drtcn: 270.00

StkNo:  1  Stk Name:WTI1                                  Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  25.75  *Wake Effect Ht:   67.71
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:   1   9
StkNo:  2  Stk Name:waste1                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  33.74  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  33.74  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  33.74  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  33.74  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  6  Stk Name:steam                                 Stack Ht:    6.71
    Directional MAX:  BH:  25.76  PBW:  26.44  *Wake Effect Ht:   64.39
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
     No combined tiers affect this stack for  this direction

Drtcn: 280.00

StkNo:  1  Stk Name:WTI1                                  Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  28.77  *Wake Effect Ht:   72.23
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
```

```
  Bldg-Tier nos. contributing to MAX:    1    9
StkNo:  2  Stk Name:waste1                                  Stack Ht:    16.76
    Directional MAX:  BH:  15.24  PBW:  40.06  *Wake Effect Ht:    38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:    38.10
     No combined tiers affect this stack for  this direction
StkNo:  3  Stk Name:waste2                                  Stack Ht:    16.76
    Directional MAX:  BH:  15.24  PBW:  40.06  *Wake Effect Ht:    38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:    38.10
     No combined tiers affect this stack for  this direction
StkNo:  4  Stk Name:waste3                                  Stack Ht:    16.76
    Directional MAX:  BH:  15.24  PBW:  40.06  *Wake Effect Ht:    38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:    38.10
     No combined tiers affect this stack for  this direction
StkNo:  5  Stk Name:waste4                                  Stack Ht:    16.76
    Directional MAX:  BH:  15.24  PBW:  40.06  *Wake Effect Ht:    38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:    38.10
     No combined tiers affect this stack for  this direction
StkNo:  6  Stk Name:steam                                   Stack Ht:     6.71
    Directional MAX:  BH:  25.76  PBW:  27.27  *Wake Effect Ht:    64.39
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:    68.00
     No combined tiers affect this stack for  this direction

Drtcn: 290.00

StkNo:  1  Stk Name:WTI1                                    Stack Ht:    45.72
    Directional MAX:  BH:  29.08  PBW:  30.90  *Wake Effect Ht:    72.69
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:    72.69
          *adjusted for a Stack-Building elevation difference of     0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:    1    9
StkNo:  2  Stk Name:waste1                                  Stack Ht:    16.76
    Directional MAX:  BH:  15.24  PBW:  45.17  *Wake Effect Ht:    38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:    38.10
     No combined tiers affect this stack for  this direction
StkNo:  3  Stk Name:waste2                                  Stack Ht:    16.76
    Directional MAX:  BH:  15.24  PBW:  45.17  *Wake Effect Ht:    38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:    38.10
     No combined tiers affect this stack for  this direction
StkNo:  4  Stk Name:waste3                                  Stack Ht:    16.76
    Directional MAX:  BH:  15.24  PBW:  45.17  *Wake Effect Ht:    38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:    38.10
     No combined tiers affect this stack for  this direction
StkNo:  5  Stk Name:waste4                                  Stack Ht:    16.76
    Directional MAX:  BH:  15.24  PBW:  45.17  *Wake Effect Ht:    38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:    38.10
     No combined tiers affect this stack for  this direction
StkNo:  6  Stk Name:steam                                   Stack Ht:     6.71
```

```
    Directional MAX:  BH:  25.76  PBW:  27.27  *Wake Effect Ht:   64.39
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
     No combined tiers affect this stack for  this direction

 Drtcn: 300.00

 StkNo:  1  Stk Name:WTI1                                  Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  32.10  *Wake Effect Ht:   72.69
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
  No. of Tiers affecting Stk:  2
   Bldg-Tier nos. contributing to MAX:   1   9
 StkNo:  2  Stk Name:waste1                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  48.91  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
 StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  48.91  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
 StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  48.91  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
 StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  48.91  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
 StkNo:  6  Stk Name:steam                                 Stack Ht:    6.71
    Directional MAX:  BH:  25.76  PBW:  26.44  *Wake Effect Ht:   64.39
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
     No combined tiers affect this stack for  this direction

 Drtcn: 310.00

 StkNo:  1  Stk Name:WTI1                                  Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  32.33  *Wake Effect Ht:   72.69
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
  No. of Tiers affecting Stk:  2
   Bldg-Tier nos. contributing to MAX:   1   9
 StkNo:  2  Stk Name:waste1                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.16  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
 StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.16  *Wake Effect Ht:   38.10
```

```
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:    38.10
     No combined tiers affect this stack for  this direction
StkNo:  4  Stk Name:waste3                                Stack Ht:    16.76
    Directional MAX:  BH:  15.24  PBW:  51.16  *Wake Effect Ht:    38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:    38.10
     No combined tiers affect this stack for  this direction
StkNo:  5  Stk Name:waste4                                Stack Ht:    16.76
    Directional MAX:  BH:  15.24  PBW:  51.16  *Wake Effect Ht:    38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:    38.10
     No combined tiers affect this stack for  this direction
StkNo:  6  Stk Name:steam                                 Stack Ht:     6.71
    Directional MAX:  BH:  25.76  PBW:  24.80  *Wake Effect Ht:    62.96
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:    68.00
     No combined tiers affect this stack for  this direction

Drtcn: 320.00

StkNo:  1  Stk Name:WTI1                                  Stack Ht:    45.72
    Directional MAX:  BH:  29.08  PBW:  31.85  *Wake Effect Ht:    72.69
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:    72.69
         *adjusted for a Stack-Building elevation difference of     0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:   1   9
StkNo:  2  Stk Name:waste1                                Stack Ht:    16.76
    Directional MAX:  BH:  15.24  PBW:  51.86  *Wake Effect Ht:    38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:    38.10
     No combined tiers affect this stack for  this direction
StkNo:  3  Stk Name:waste2                                Stack Ht:    16.76
    Directional MAX:  BH:  15.24  PBW:  51.86  *Wake Effect Ht:    38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:    38.10
     No combined tiers affect this stack for  this direction
StkNo:  4  Stk Name:waste3                                Stack Ht:    16.76
    Directional MAX:  BH:  15.24  PBW:  51.86  *Wake Effect Ht:    38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:    38.10
     No combined tiers affect this stack for  this direction
StkNo:  5  Stk Name:waste4                                Stack Ht:    16.76
    Directional MAX:  BH:  15.24  PBW:  51.86  *Wake Effect Ht:    38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:    38.10
     No combined tiers affect this stack for  this direction
StkNo:  6  Stk Name:steam                                 Stack Ht:     6.71
    Directional MAX:  BH:  25.76  PBW:  22.42  *Wake Effect Ht:    59.38
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:    68.00
     No combined tiers affect this stack for  this direction

Drtcn: 330.00

StkNo:  1  Stk Name:WTI1                                  Stack Ht:    45.72
```

```
    Directional MAX:  BH:  29.08  PBW:  30.86  *Wake Effect Ht:   72.69
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:   1   9
StkNo:  2  Stk Name:waste1                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.98  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.98  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.98  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.98  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  6  Stk Name:steam                                 Stack Ht:    6.71
    Directional MAX:  BH:  25.76  PBW:  20.13  *Wake Effect Ht:   55.96
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
     No combined tiers affect this stack for  this direction

Drtcn: 340.00

StkNo:  1  Stk Name:WTI1                                  Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  29.63  *Wake Effect Ht:   72.69
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:   1   9
StkNo:  2  Stk Name:waste1                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.09  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  3  Stk Name:waste2                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.09  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  4  Stk Name:waste3                                Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  50.09  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  5  Stk Name:waste4                                Stack Ht:   16.76
```

```
    Directional MAX:  BH:  15.24  PBW:  50.09  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
 StkNo:  6  Stk Name:steam                                Stack Ht:    6.71
    Directional MAX:  BH:  29.08  PBW:  25.95  *Wake Effect Ht:   68.00
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
          *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:   9   1

Drtcn: 350.00

StkNo:  1  Stk Name:WTI1                                 Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  29.30  *Wake Effect Ht:   72.69
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:   1   9
StkNo:  2  Stk Name:waste1                               Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.66  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  3  Stk Name:waste2                               Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.66  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  4  Stk Name:waste3                               Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.66  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  5  Stk Name:waste4                               Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.66  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  6  Stk Name:steam                                Stack Ht:    6.71
    Directional MAX:  BH:  29.08  PBW:  25.95  *Wake Effect Ht:   68.00
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
          *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:   9   1

Drtcn: 360.00

StkNo:  1  Stk Name:WTI1                                 Stack Ht:   45.72
    Directional MAX:  BH:  29.08  PBW:  28.21  *Wake Effect Ht:   71.40
                GEP:  BH:  29.08  PBW:  29.08   *Equation 1 Ht:   72.69
          *adjusted for a Stack-Building elevation difference of    0.00
```

```
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:   1   9
StkNo:  2  Stk Name:waste1                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.66  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  3  Stk Name:waste2                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.66  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  4  Stk Name:waste3                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.66  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  5  Stk Name:waste4                                  Stack Ht:   16.76
    Directional MAX:  BH:  15.24  PBW:  51.66  *Wake Effect Ht:   38.10
                GEP:  BH:  15.24  PBW:  15.88   *Equation 1 Ht:   38.10
     No combined tiers affect this stack for  this direction
StkNo:  6  Stk Name:steam                                   Stack Ht:    6.71
    Directional MAX:  BH:  29.08  PBW:  25.95  *Wake Effect Ht:   68.00
                GEP:  BH:  29.08  PBW:  25.95   *Equation 1 Ht:   68.00
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:   9   1
```

CADBPIP.OUT

DATE : 02/14/95
TIME : 17:54:22.75
A363 - WTI Downwash Analysis

==========
BPIP PROCESSING INFORMATION:
==========

The ST flag has been set for processing for an ISCST2 run.

Inputs entered in FEET will be converted to meters using a conversion factor of 0.3048. Output will be in meters.

UTMP is set to UTMN. The input is assumed to be in a local X-Y coordinate system as opposed to a UTM coordinate system. True North is in the positive Y direction.

Plant north is set to 337.21 degrees with respect to True North.

A363 - WTI Downwash Analysis

PRELIMINARY* GEP STACK HEIGHT RESULTS TABLE
(Output Units: meters)

Stack Name	Stack Height	Stack-Building Base Elevation Differences	GEP** EQN1	Preliminary* GEP Stack Height Value
cadbed	28.80	0.00	64.39	65.00

* Results are based on Determinants 1 & 2 on pages 1 & 2 of the GEP Technical Support Document. Determinant 3 may be investigated for additional stack height credit. Final values result after Determinant 3 has been taken into consideration.

** Results were derived from Equation 1 on page 6 of GEP Technical Support Document. Values have been adjusted for any stack-building base elevation differences.

Note: Criteria for determining stack heights for modeling emission

limitations for a source can be found in Table 3.1 of the GEP Technical Support Document.

DATE : 02/14/95
TIME : 17:54:22.75

A363 - WTI Downwash Analysis

BPIP output is in meters

SO BUILDHGT cadbed	25.76	25.76	25.76	25.76	25.76	25.76
SO BUILDHGT cadbed	24.38	25.76	25.76	25.76	25.76	25.76
SO BUILDHGT cadbed	25.76	25.76	25.76	25.76	25.76	25.76
SO BUILDHGT cadbed	25.76	25.76	25.76	25.76	25.76	25.76
SO BUILDHGT cadbed	24.38	25.76	25.76	25.76	25.76	25.76
SO BUILDHGT cadbed	25.76	25.76	25.76	25.76	25.76	25.76
SO BUILDWID cadbed	27.09	28.12	28.29	27.61	26.08	23.77
SO BUILDWID cadbed	25.97	24.81	26.44	27.27	27.27	26.44
SO BUILDWID cadbed	24.80	22.42	20.13	19.32	22.62	25.24
SO BUILDWID cadbed	27.09	28.12	28.29	27.61	26.08	23.77
SO BUILDWID cadbed	25.97	24.81	26.44	27.27	27.27	26.44
SO BUILDWID cadbed	24.80	22.42	20.13	19.32	22.62	25.24

CADBPIP.SUM

```
 DATE : 02/14/95
 TIME : 17:54:22.75
 A363 - WTI Downwash Analysis


============================
BPIP PROCESSING INFORMATION:
============================

   The ST flag has been set for processing for an ISCST2 run.

   Inputs entered in FEET       will be converted to meters using
    a conversion factor of    0.3048.  Output will be in meters.

   UTMP is set to UTMN.  The input is assumed to be in a local
    X-Y coordinate system as opposed to a UTM coordinate system.
    True North is in the positive Y direction.

   Plant north is set to 337.21 degrees with respect to True North.


    The plant coordinates will appear as entered in the Summary output
    file and they will be adjusted to True North prior to processing.
    The True North oriented coordinates appear below between
    the square brackets.



==============
INPUT SUMMARY:
==============

 Number of buildings to be processed :   8


 SCRUBBER has 1 tier(s) with a base elevation of    0.00 FEET
                                                 (    0.00) meters

 BUILDING  TIER  BLDG-TIER  TIER   NO. OF      CORNER   COORDINATES
   NAME   NUMBER   NUMBER  HEIGHT  CORNERS        X           Y

 SCRUBBER    1        1     95.40     8
                           29.08 meters
                                              -15.00       19.00 FEET
                                               -4.57        5.79 meters
```

```
                                        [       -6.46        3.57] meters
                                       -15.00       66.00 FEET
                                        -4.57       20.12 meters
                                        [      -12.01       16.78] meters
                                        14.00       66.00 FEET
                                         4.27       20.12 meters
                                        [       -3.86       20.20] meters
                                        14.00       57.00 FEET
                                         4.27       17.37 meters
                                        [       -2.79       17.67] meters
                                        24.00       57.00 FEET
                                         7.32       17.37 meters
                                        [        0.02       18.85] meters
                                        24.00       33.00 FEET
                                         7.32       10.06 meters
                                        [        2.85       12.11] meters
                                        14.00       33.00 FEET
                                         4.27       10.06 meters
                                        [        0.04       10.93] meters
                                        14.00       19.00 FEET
                                         4.27        5.79 meters
                                        [        1.69        6.99] meters

PRECIP   has 1 tier(s) with a base elevation of    0.00 FEET
                                                (    0.00) meters

BUILDING  TIER  BLDG-TIER  TIER   NO. OF      CORNER   COORDINATES
  NAME   NUMBER   NUMBER  HEIGHT  CORNERS        X           Y

PRECIP      1        5     80.00     4
                          24.38 meters
                                        17.00       29.00 FEET
                                         5.18        8.84 meters
                                        [        1.35       10.16] meters
                                        52.00       29.00 FEET
                                        15.85        8.84 meters
                                        [       11.19       14.29] meters
                                        52.00       -6.00 FEET
                                        15.85       -1.83 meters
                                        [       15.32        4.45] meters
                                        17.00       -6.00 FEET
                                         5.18       -1.83 meters
                                        [        5.49        0.32] meters


SPRAY D  has 1 tier(s) with a base elevation of    0.00 FEET
```

(0.00) meters

BUILDING NAME	TIER NUMBER	BLDG-TIER NUMBER	TIER HEIGHT	NO. OF CORNERS	CORNER	COORDINATES X	Y
SPRAY D	1	9	106.00	8			
			32.31 meters				
						64.00	77.00 FEET
						19.51	23.47 meters
					[	8.89	29.19] meters
						77.00	72.00 FEET
						23.47	21.95 meters
					[	13.14	29.32] meters
						82.00	59.00 FEET
						24.99	17.98 meters
					[	16.08	26.26] meters
						77.00	46.00 FEET
						23.47	14.02 meters
					[	16.21	22.02] meters
						64.00	41.00 FEET
						19.51	12.50 meters
					[	13.14	19.08] meters
						51.00	46.00 FEET
						15.54	14.02 meters
					[	8.90	18.95] meters
						46.00	59.00 FEET
						14.02	17.98 meters
					[	5.96	22.01] meters
						51.00	72.00 FEET
						15.54	21.95 meters
					[	5.83	26.25] meters

BOILER has 1 tier(s) with a base elevation of 0.00 FEET

(0.00) meters

BUILDING NAME	TIER NUMBER	BLDG-TIER NUMBER	TIER HEIGHT	NO. OF CORNERS	CORNER	COORDINATES X	Y
BOILER	1	13	70.00	6			
			21.34 meters				
						80.00	30.00 FEET
						24.38	9.14 meters
					[	18.94	17.87] meters
						143.00	30.00 FEET
						43.59	9.14 meters
					[	36.64	25.31] meters

	143.00	-11.00 FEET
	43.59	-3.35 meters
[	41.48	13.79] meters
	121.00	-11.00 FEET
	36.88	-3.35 meters
[	35.30	11.19] meters
	121.00	7.00 FEET
	36.88	2.13 meters
[	33.18	16.25] meters
	80.00	7.00 FEET
	24.38	2.13 meters
[	21.65	11.41] meters

INCIN FD has 1 tier(s) with a base elevation of 0.00 FEET
(0.00) meters

BUILDING NAME	TIER NUMBER	BLDG-TIER NUMBER	TIER HEIGHT	NO. OF CORNERS	CORNER	COORDINATES
					X	Y
INCIN FD	1	17	84.50	6		
			25.76 meters			
					179.00	52.00 FEET
					54.56	15.85 meters
				[	44.16	35.74] meters
					239.00	52.00 FEET
					72.85	15.85 meters
				[	61.02	42.83] meters
					239.00	-19.00 FEET
					72.85	-5.79 meters
				[	69.40	22.87] meters
					184.00	-19.00 FEET
					56.08	-5.79 meters
				[	53.95	16.38] meters
					184.00	0.00 FEET
					56.08	0.00 meters
				[	51.71	21.72] meters
					179.00	0.00 FEET
					54.56	0.00 meters
				[	50.30	21.13] meters

steamplt has 1 tier(s) with a base elevation of 0.00 FEET
(0.00) meters

BUILDING NAME	TIER NUMBER	BLDG-TIER NUMBER	TIER HEIGHT	NO. OF CORNERS	CORNER	COORDINATES
					X	Y

steamplt	1	21	22.00	4		
			6.71 meters			
					52.00	168.00 FEET
					15.85	51.21 meters
				[	-5.22	53.35] meters
					132.00	168.00 FEET
					40.23	51.21 meters
				[	17.26	62.79] meters
					132.00	118.00 FEET
					40.23	35.97 meters
				[	23.16	48.74] meters
					52.00	118.00 FEET
					15.85	35.97 meters
				[	0.68	39.30] meters

contain has 1 tier(s) with a base elevation of 0.00 FEET
(0.00) meters

BUILDING NAME	TIER NUMBER	BLDG-TIER NUMBER	TIER HEIGHT	NO. OF CORNERS	CORNER	COORDINATES X	Y
contain	1	25	49.00	4			
			14.94 meters				
						338.00	237.00 FEET
						103.02	72.24 meters
					[	67.00	106.50] meters
						575.00	237.00 FEET
						175.26	72.24 meters
					[	133.60	134.48] meters
						575.00	34.00 FEET
						175.26	10.36 meters
					[	157.57	77.43] meters
						338.00	34.00 FEET
						103.02	10.36 meters
					[	90.97	49.46] meters

wastefrm has 1 tier(s) with a base elevation of 0.00 FEET
(0.00) meters

BUILDING NAME	TIER NUMBER	BLDG-TIER NUMBER	TIER HEIGHT	NO. OF CORNERS	CORNER	COORDINATES X	Y
wastefrm	1	29	50.00	4			
			15.24 meters				
						617.00	106.00 FEET

```
                                    188.06        32.31 meters
                                [   160.87       102.62] meters
                                    779.00       106.00 FEET
                                    237.44        32.31 meters
                                [   206.39       121.75] meters
                                    779.00        54.00 FEET
                                    237.44        16.46 meters
                                [   212.53       107.14] meters
                                    617.00        54.00 FEET
                                    188.06        16.46 meters
                                [   167.01        88.01] meters
```

Number of stacks to be processed : 1

STACK NAME	STACK BASE	STACK HEIGHT	STACK X	COORDINATES Y
cadbed	0.00	94.50 FEET		
	(0.00	28.80) meters		
			239.00	52.00 FEET
			(72.85	15.85) meters
			[61.02	42.83] meters

The number of stack-tier combinations entered, where each stack is at least 5L
in from at least one of the edges of their respective tier roofs, is: 0

Overall GEP Summary Table
(Units: meters)

StkNo: 1 Stk Name:cadbed Stk Ht: 28.80 Prelim. GEP Stk.Ht: 65.00
GEP: BH: 25.76 PBW: 25.76 *Eqn1 Ht: 64.39
*adjusted for a Stack-Building elevation difference of 0.00
No. of Tiers affecting Stk: 1 Direction occurred: 124.75
Bldg-Tier nos. contributing to GEP: 17

Summary By Direction Table
(Units: meters)

Dominate stand alone tiers:

```
Drtcn:  10.00

StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  27.09  *Wake Effect Ht:   64.39
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  7  Bld Name:contain   TierNo:  1

Drtcn:  20.00

StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  28.12  *Wake Effect Ht:   64.39
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn:  30.00

StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  28.29  *Wake Effect Ht:   64.39
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn:  40.00

StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  27.61  *Wake Effect Ht:   64.39
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn:  50.00

StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  26.08  *Wake Effect Ht:   64.39
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn:  60.00

StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  23.77  *Wake Effect Ht:   61.40
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
```

CADBPIP.SUM

BldNo: 5 Bld Name:INCIN FD TierNo: 1

Drtcn: 70.00

StkNo: 1 Stk Name:cadbed Stack Ht: 28.80
Directional MAX: BH: 25.76 PBW: 22.43 *Wake Effect Ht: 59.40
GEP: BH: 25.76 PBW: 25.76 *Equation 1 Ht: 64.39
*adjusted for a Stack-Building elevation difference of 0.00
BldNo: 5 Bld Name:INCIN FD TierNo: 1

Drtcn: 80.00

StkNo: 1 Stk Name:cadbed Stack Ht: 28.80
Directional MAX: BH: 25.76 PBW: 24.81 *Wake Effect Ht: 62.98
GEP: BH: 25.76 PBW: 25.76 *Equation 1 Ht: 64.39
*adjusted for a Stack-Building elevation difference of 0.00
BldNo: 5 Bld Name:INCIN FD TierNo: 1

Drtcn: 90.00

StkNo: 1 Stk Name:cadbed Stack Ht: 28.80
Directional MAX: BH: 25.76 PBW: 26.44 *Wake Effect Ht: 64.39
GEP: BH: 25.76 PBW: 25.76 *Equation 1 Ht: 64.39
*adjusted for a Stack-Building elevation difference of 0.00
BldNo: 7 Bld Name:contain TierNo: 1

Drtcn: 100.00

StkNo: 1 Stk Name:cadbed Stack Ht: 28.80
Directional MAX: BH: 25.76 PBW: 27.27 *Wake Effect Ht: 64.39
GEP: BH: 25.76 PBW: 25.76 *Equation 1 Ht: 64.39
*adjusted for a Stack-Building elevation difference of 0.00
BldNo: 5 Bld Name:INCIN FD TierNo: 1

Drtcn: 110.00

StkNo: 1 Stk Name:cadbed Stack Ht: 28.80
Directional MAX: BH: 25.76 PBW: 27.27 *Wake Effect Ht: 64.39
GEP: BH: 25.76 PBW: 25.76 *Equation 1 Ht: 64.39
*adjusted for a Stack-Building elevation difference of 0.00
BldNo: 5 Bld Name:INCIN FD TierNo: 1

Drtcn: 120.00

StkNo: 1 Stk Name:cadbed Stack Ht: 28.80
Directional MAX: BH: 25.76 PBW: 26.44 *Wake Effect Ht: 64.39
GEP: BH: 25.76 PBW: 25.76 *Equation 1 Ht: 64.39

```
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn: 130.00

StkNo:  1  Stk Name:cadbed                                Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  24.80  *Wake Effect Ht:   62.96
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn: 140.00

StkNo:  1  Stk Name:cadbed                                Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  22.42  *Wake Effect Ht:   59.38
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn: 150.00

StkNo:  1  Stk Name:cadbed                                Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  20.13  *Wake Effect Ht:   55.96
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn: 160.00

StkNo:  1  Stk Name:cadbed                                Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  19.32  *Wake Effect Ht:   54.73
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn: 170.00

StkNo:  1  Stk Name:cadbed                                Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  22.62  *Wake Effect Ht:   59.69
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn: 180.00

StkNo:  1  Stk Name:cadbed                                Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  25.24  *Wake Effect Ht:   63.62
```

```
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  7  Bld Name:contain   TierNo:  1

Drtcn: 190.00

StkNo:  1  Stk Name:cadbed                                Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  27.09  *Wake Effect Ht:   64.39
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  7  Bld Name:contain   TierNo:  1

Drtcn: 200.00

StkNo:  1  Stk Name:cadbed                                Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  28.12  *Wake Effect Ht:   64.39
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn: 210.00

StkNo:  1  Stk Name:cadbed                                Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  28.29  *Wake Effect Ht:   64.39
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn: 220.00

StkNo:  1  Stk Name:cadbed                                Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  27.61  *Wake Effect Ht:   64.39
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn: 230.00

StkNo:  1  Stk Name:cadbed                                Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  26.08  *Wake Effect Ht:   64.39
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
                BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn: 240.00

StkNo:  1  Stk Name:cadbed                                Stack Ht:   28.80
```

```
    Directional MAX:  BH:  25.76  PBW:  23.77  *Wake Effect Ht:   61.40
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  7  Bld Name:contain   TierNo:  1

Drtcn: 250.00

StkNo:  1  Stk Name:cadbed                                Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  22.43  *Wake Effect Ht:   59.40
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  7  Bld Name:contain   TierNo:  1

Drtcn: 260.00

StkNo:  1  Stk Name:cadbed                                Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  24.81  *Wake Effect Ht:   62.98
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  7  Bld Name:contain   TierNo:  1

Drtcn: 270.00

StkNo:  1  Stk Name:cadbed                                Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  26.44  *Wake Effect Ht:   64.39
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  7  Bld Name:contain   TierNo:  1

Drtcn: 280.00

StkNo:  1  Stk Name:cadbed                                Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  27.27  *Wake Effect Ht:   64.39
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn: 290.00

StkNo:  1  Stk Name:cadbed                                Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  27.27  *Wake Effect Ht:   64.39
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn: 300.00
```

```
StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  26.44  *Wake Effect Ht:   64.39
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn: 310.00

StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  24.80  *Wake Effect Ht:   62.96
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn: 320.00

StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  22.42  *Wake Effect Ht:   59.38
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn: 330.00

StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  20.13  *Wake Effect Ht:   55.96
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn: 340.00

StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  19.32  *Wake Effect Ht:   54.73
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn: 350.00

StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  22.62  *Wake Effect Ht:   59.69
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  5  Bld Name:INCIN FD  TierNo:  1

Drtcn: 360.00
```

```
 StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  25.24  *Wake Effect Ht:   63.62
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
               BldNo:  7  Bld Name:contain   TierNo:  1


Dominate combined buildings:

 Drtcn:  10.00

 StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  27.09  *Wake Effect Ht:   64.39
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
  No. of Tiers affecting Stk:  2
   Bldg-Tier nos. contributing to MAX:  17  13

 Drtcn:  20.00

 StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  28.12  *Wake Effect Ht:   64.39
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
  No. of Tiers affecting Stk:  2
   Bldg-Tier nos. contributing to MAX:  17  13

 Drtcn:  30.00

 StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  28.29  *Wake Effect Ht:   64.39
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
  No. of Tiers affecting Stk:  2
   Bldg-Tier nos. contributing to MAX:  17  13

 Drtcn:  40.00

 StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  27.61  *Wake Effect Ht:   64.39
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
  No. of Tiers affecting Stk:  3
   Bldg-Tier nos. contributing to MAX:   1   5   9

 Drtcn:  50.00
```

```
StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  26.08  *Wake Effect Ht:   64.39
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  3
  Bldg-Tier nos. contributing to MAX:   1   5   9

Drtcn:  60.00

StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  23.77  *Wake Effect Ht:   61.40
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  3
  Bldg-Tier nos. contributing to MAX:   1   5   9

Drtcn:  70.00

StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  24.38  PBW:  25.97  *Wake Effect Ht:   60.96
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  3
  Bldg-Tier nos. contributing to MAX:   1   5   9

Drtcn:  80.00

StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  24.81  *Wake Effect Ht:   62.98
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:   1   9

Drtcn:  90.00

StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  26.44  *Wake Effect Ht:   64.39
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:  17  13

Drtcn: 100.00

StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  27.27  *Wake Effect Ht:   64.39
```

```
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:  17  13

Drtcn: 110.00

StkNo:  1  Stk Name:cadbed                                Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  27.27  *Wake Effect Ht:   64.39
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:  17  13

Drtcn: 120.00

StkNo:  1  Stk Name:cadbed                                Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  26.44  *Wake Effect Ht:   64.39
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:  17  13

Drtcn: 130.00

StkNo:  1  Stk Name:cadbed                                Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  24.80  *Wake Effect Ht:   62.96
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:  17  13

Drtcn: 140.00

StkNo:  1  Stk Name:cadbed                                Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  22.42  *Wake Effect Ht:   59.38
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:  17  13

Drtcn: 150.00

StkNo:  1  Stk Name:cadbed                                Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  20.13  *Wake Effect Ht:   55.96
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
```

```
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:  17  13

Drtcn: 160.00

StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  19.32  *Wake Effect Ht:   54.73
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:  17  13

Drtcn: 170.00

StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  22.62  *Wake Effect Ht:   59.69
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:  17  13

Drtcn: 180.00

StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  25.24  *Wake Effect Ht:   63.62
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:  17  13

Drtcn: 190.00

StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  27.09  *Wake Effect Ht:   64.39
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:  17  13

Drtcn: 200.00

StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  28.12  *Wake Effect Ht:   64.39
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:  17  13,
```

```
Drtcn: 210.00

StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  28.29  *Wake Effect Ht:   64.39
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:  17  13

Drtcn: 220.00

StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  27.61  *Wake Effect Ht:   64.39
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  3
  Bldg-Tier nos. contributing to MAX:   1   5   9

Drtcn: 230.00

StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  26.08  *Wake Effect Ht:   64.39
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  3
  Bldg-Tier nos. contributing to MAX:   1   5   9

Drtcn: 240.00

StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  23.77  *Wake Effect Ht:   61.40
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  3
  Bldg-Tier nos. contributing to MAX:   1   5   9

Drtcn: 250.00

StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  24.38  PBW:  25.97  *Wake Effect Ht:   60.96
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  3
  Bldg-Tier nos. contributing to MAX:   1   5   9

Drtcn: 260.00
```

```
StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  24.81  *Wake Effect Ht:   62.98
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  3
  Bldg-Tier nos. contributing to MAX:   1   5   9

Drtcn: 270.00

StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  26.44  *Wake Effect Ht:   64.39
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:  17  13

Drtcn: 280.00

StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  27.27  *Wake Effect Ht:   64.39
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:  17  13

Drtcn: 290.00

StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  27.27  *Wake Effect Ht:   64.39
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:  17  13

Drtcn: 300.00

StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  26.44  *Wake Effect Ht:   64.39
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
          *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:  17  13

Drtcn: 310.00

StkNo:  1  Stk Name:cadbed                                  Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  24.80  *Wake Effect Ht:   62.96
```

```
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:  17  13

Drtcn: 320.00

StkNo:  1  Stk Name:cadbed                                 Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  22.42  *Wake Effect Ht:   59.38
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:  17  13

Drtcn: 330.00

StkNo:  1  Stk Name:cadbed                                 Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  20.13  *Wake Effect Ht:   55.96
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:  17  13

Drtcn: 340.00

StkNo:  1  Stk Name:cadbed                                 Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  19.32  *Wake Effect Ht:   54.73
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:  17  13

Drtcn: 350.00

StkNo:  1  Stk Name:cadbed                                 Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  22.62  *Wake Effect Ht:   59.69
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
         *adjusted for a Stack-Building elevation difference of    0.00
 No. of Tiers affecting Stk:  2
  Bldg-Tier nos. contributing to MAX:  17  13

Drtcn: 360.00

StkNo:  1  Stk Name:cadbed                                 Stack Ht:   28.80
    Directional MAX:  BH:  25.76  PBW:  25.24  *Wake Effect Ht:   63.62
                GEP:  BH:  25.76  PBW:  25.76   *Equation 1 Ht:   64.39
         *adjusted for a Stack-Building elevation difference of    0.00
```

```
No. of Tiers affecting Stk:  2
 Bldg-Tier nos. contributing to MAX:  17  13
```

APPENDIX IV-2

Additional Wind Data Plots

Figures IV-2-1 thru IV-2-21. Beaver Valley Power Station Meteorological Tower (BVPSMT) wind data for each level for 1986-1990, 1992, Jan. - Apr. 1993.

Figures IV-2-22 thru IV-2-29. Greater Pittsburgh International Airport sounding data for 1988 and 1989 at 0 GMT at various heights.

Figures IV-2-30 thru IV-2-37. Greater Pittsburgh International Airport sounding data for 1988 and 1989 at 12 GMT at various heights.

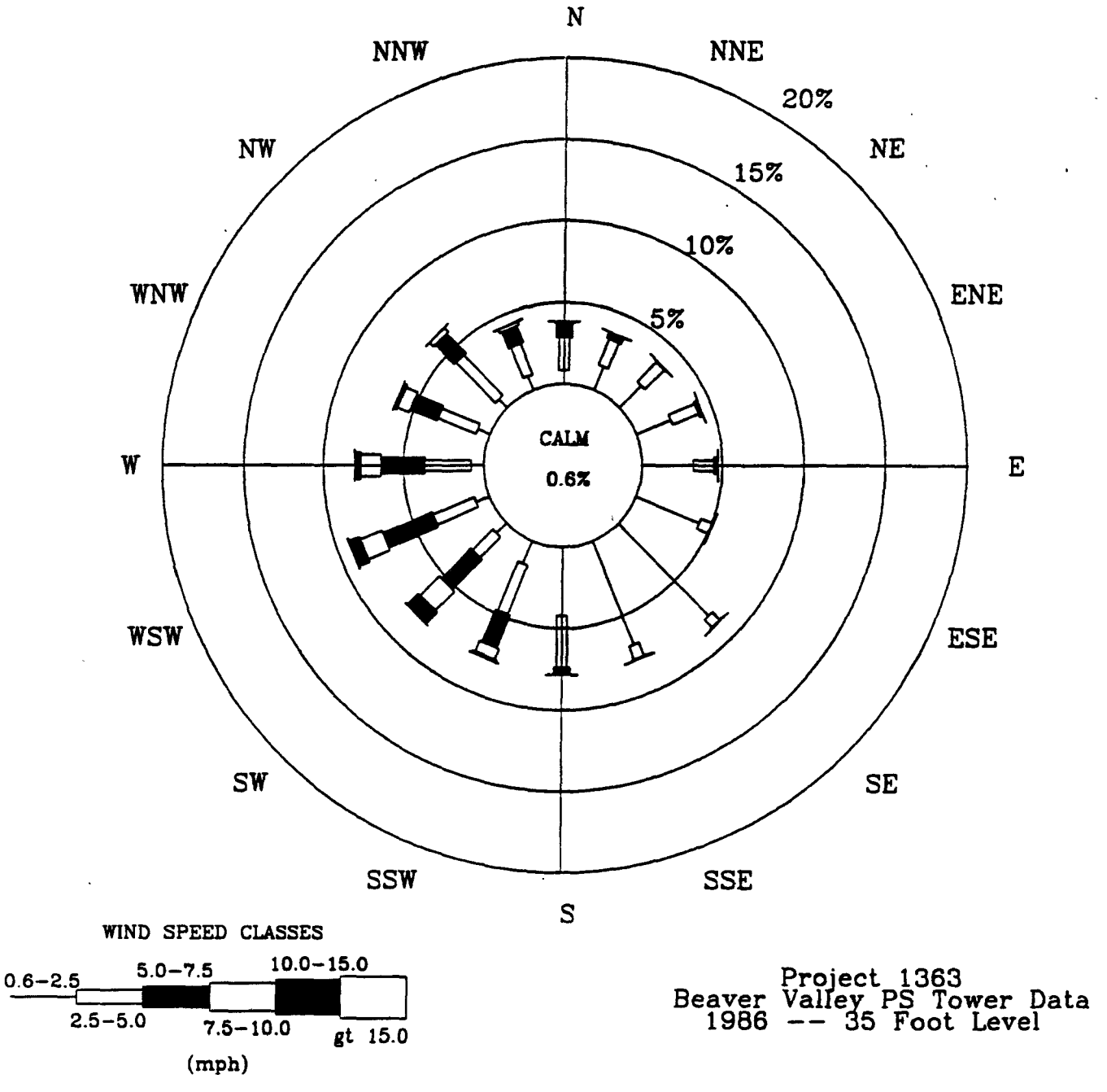

Figure IV-2-1. Annual wind rose for the BVPSMT for 1986, 35-foot level.

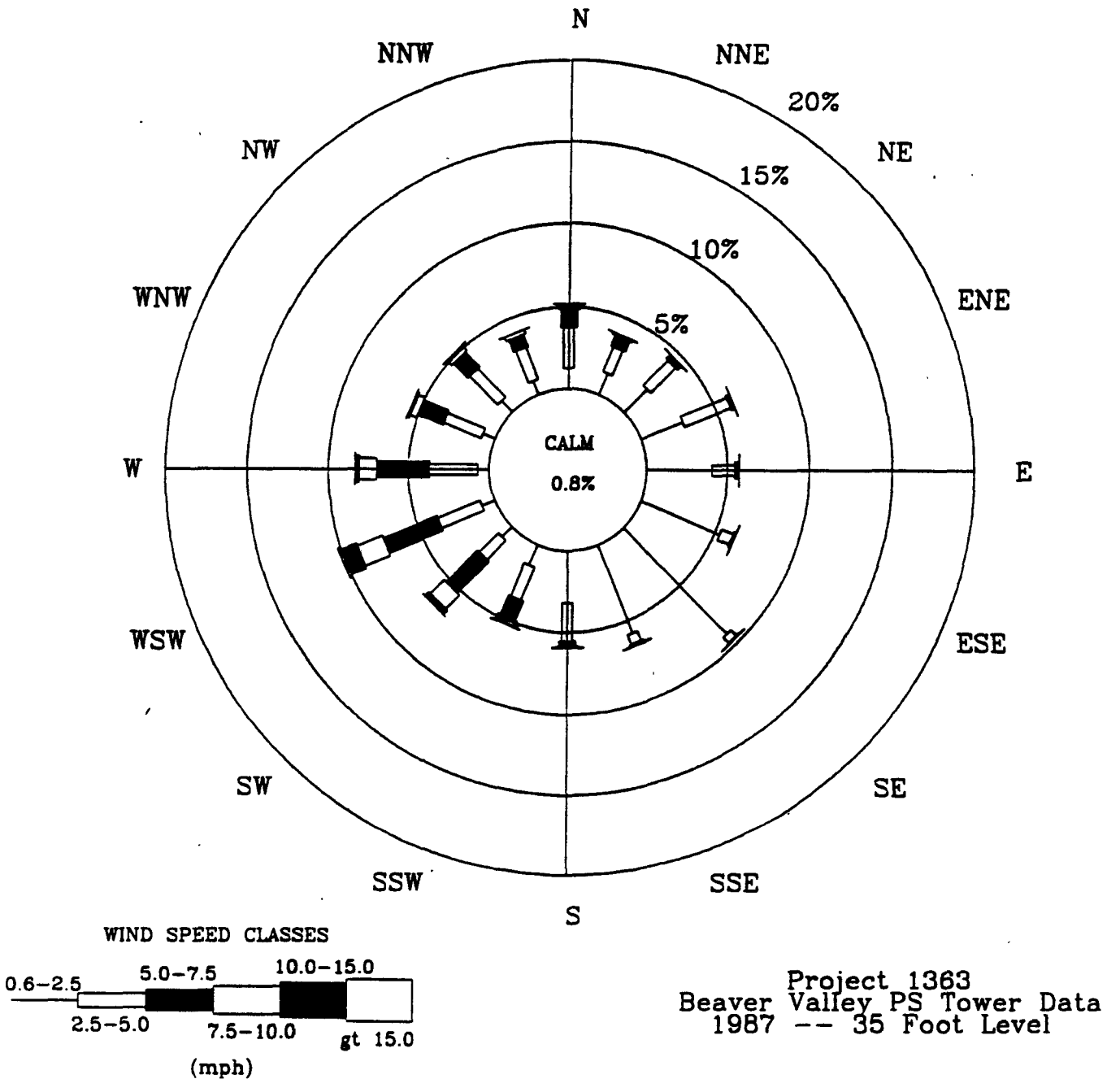

Figure IV-2-2. Annual wind rose for the BVPSMT for 1987, 35-foot level.

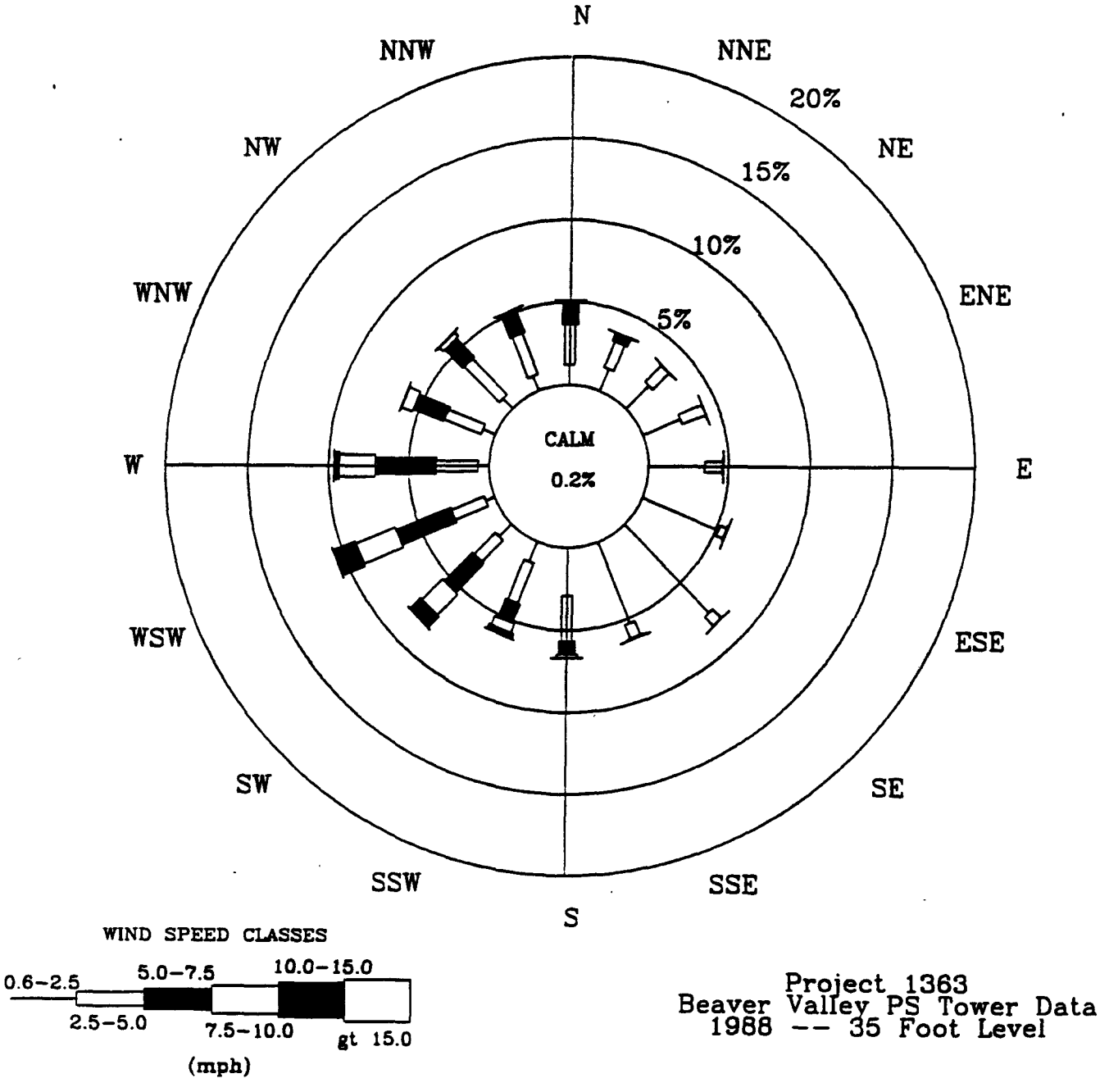

Figure IV-2-3. Annual wind rose for the BVPSMT for 1988, 35-foot level.

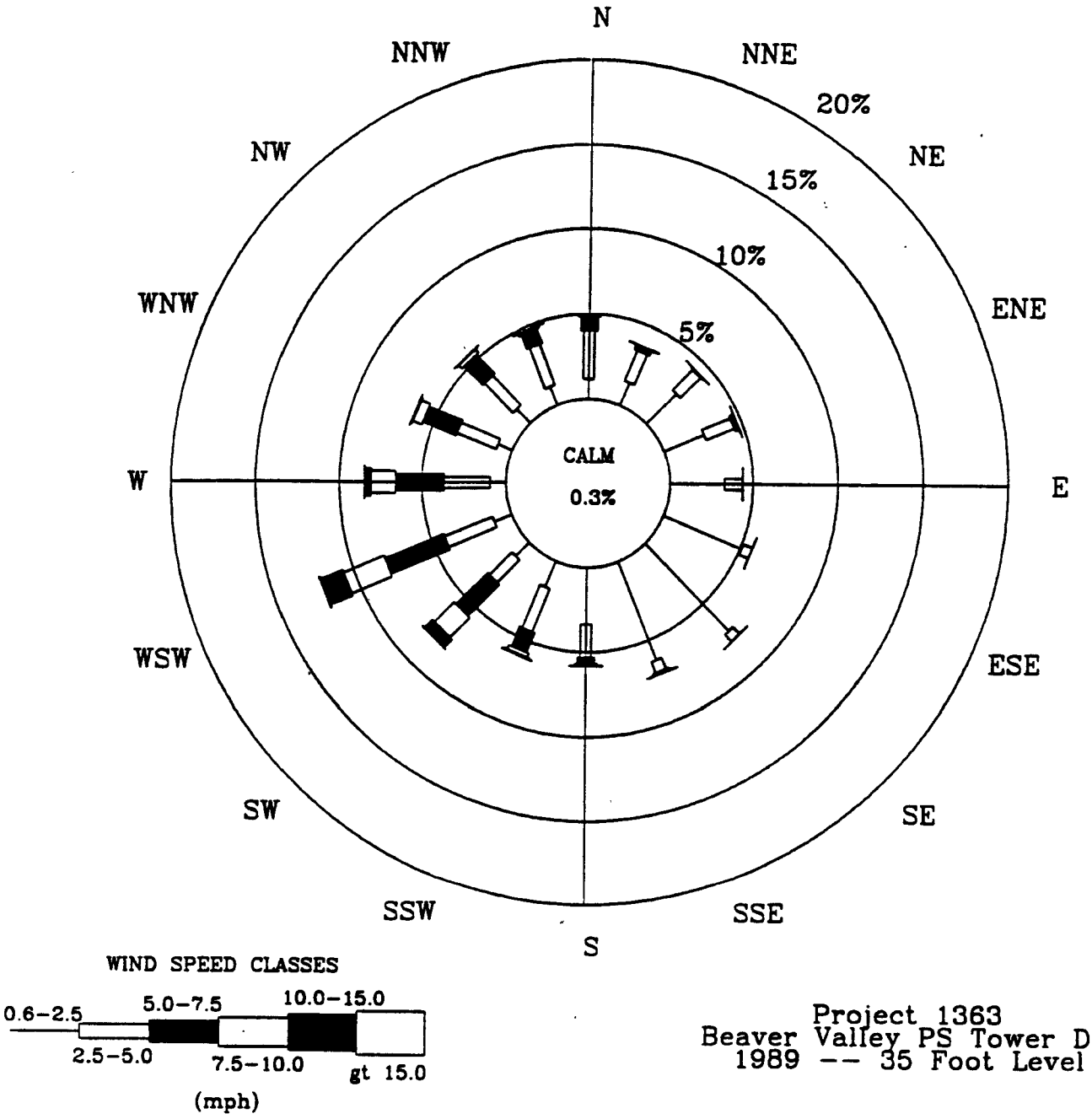

Figure IV-2-4. Annual wind rose for the BVPSMT for 1989, 35-foot level.

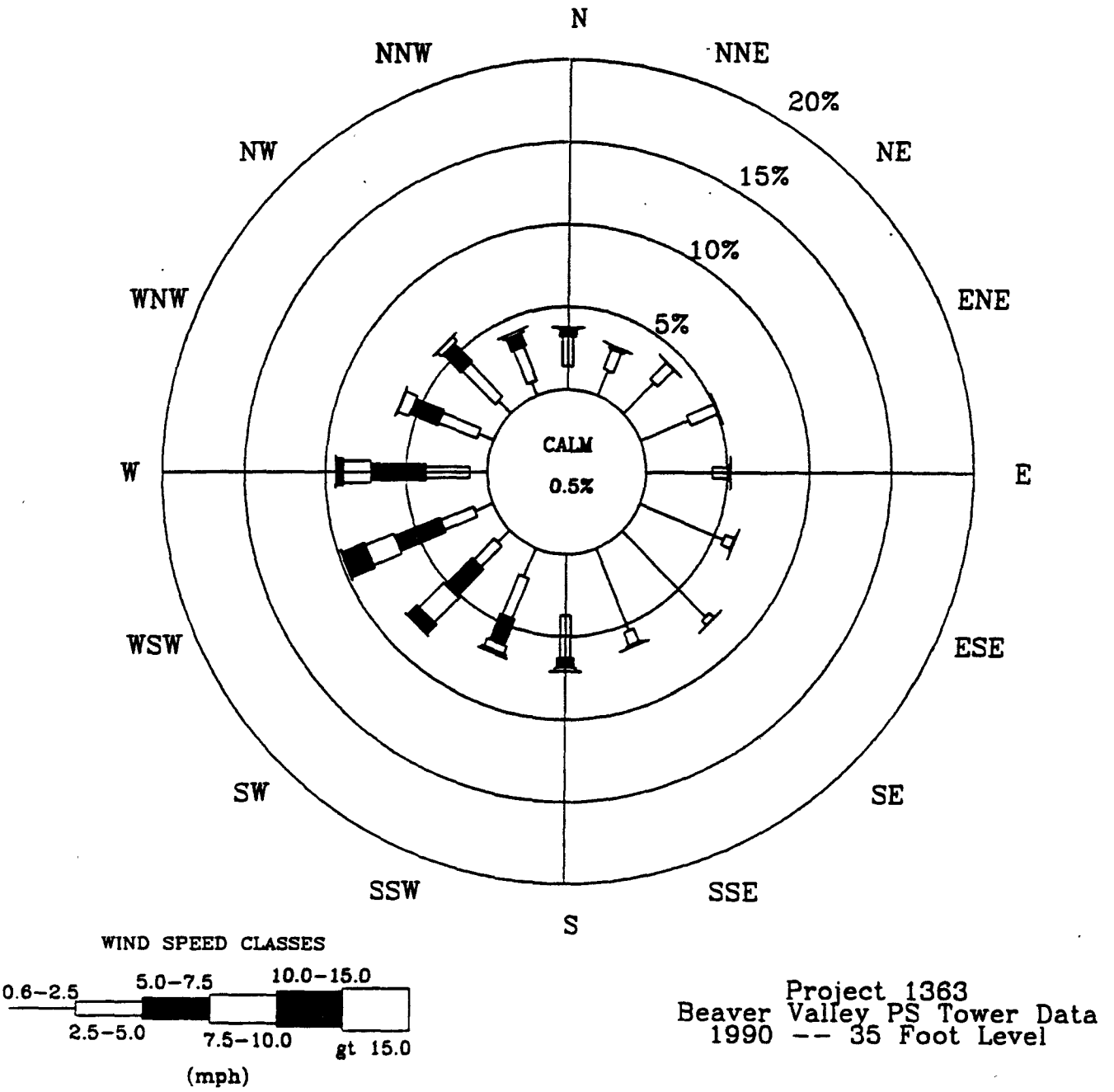

Figure IV-2-5. Annual wind rose for the BVPSMT for 1990, 35-foot level.

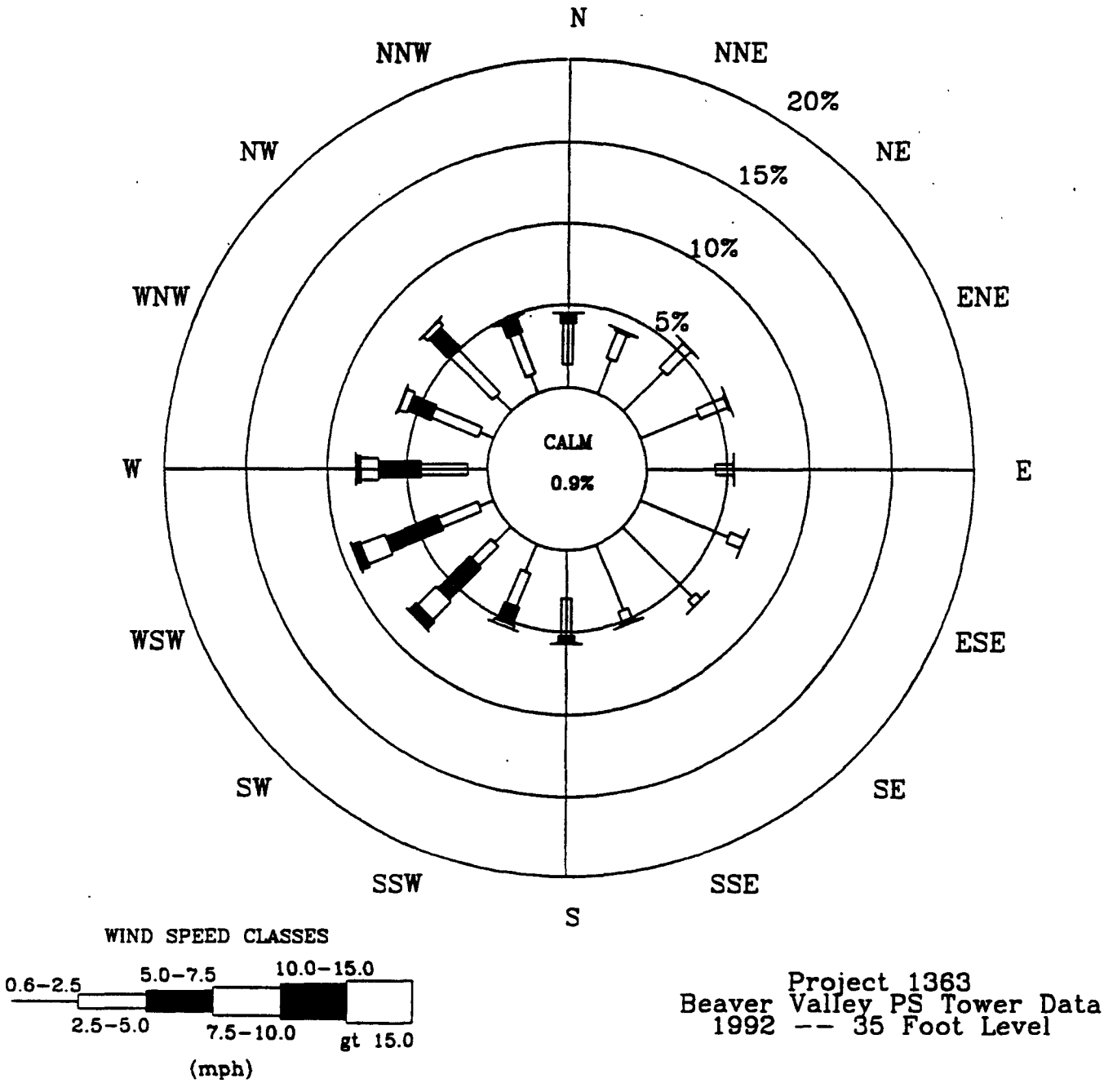

Figure IV-2-6. Annual wind rose for the BVPSMT for 1992, 35-foot level.

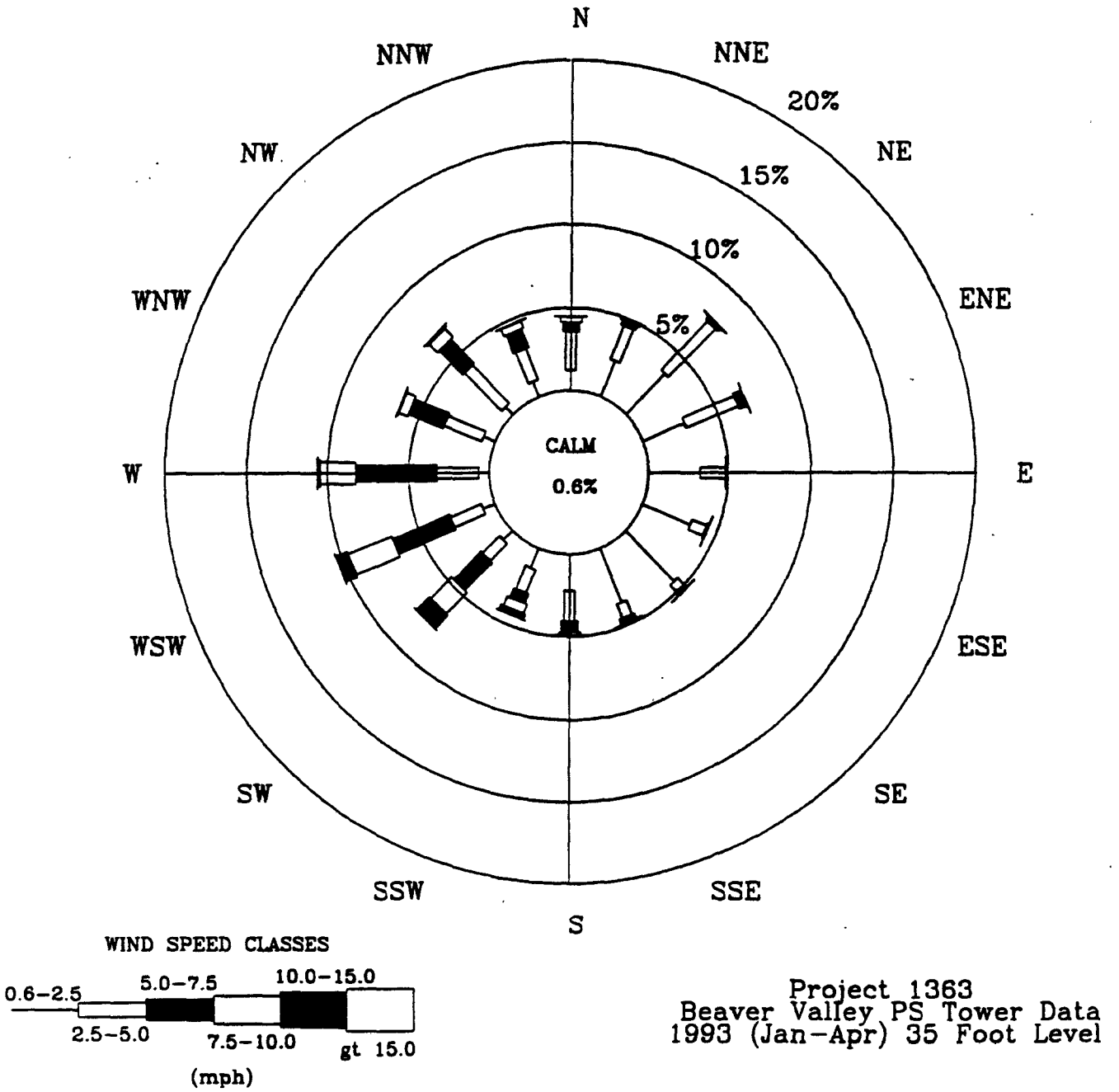

Figure IV-2-7. Four-month (Jan.-Apr.) wind rose for the BVPSMT for 1993, 35-foot level.

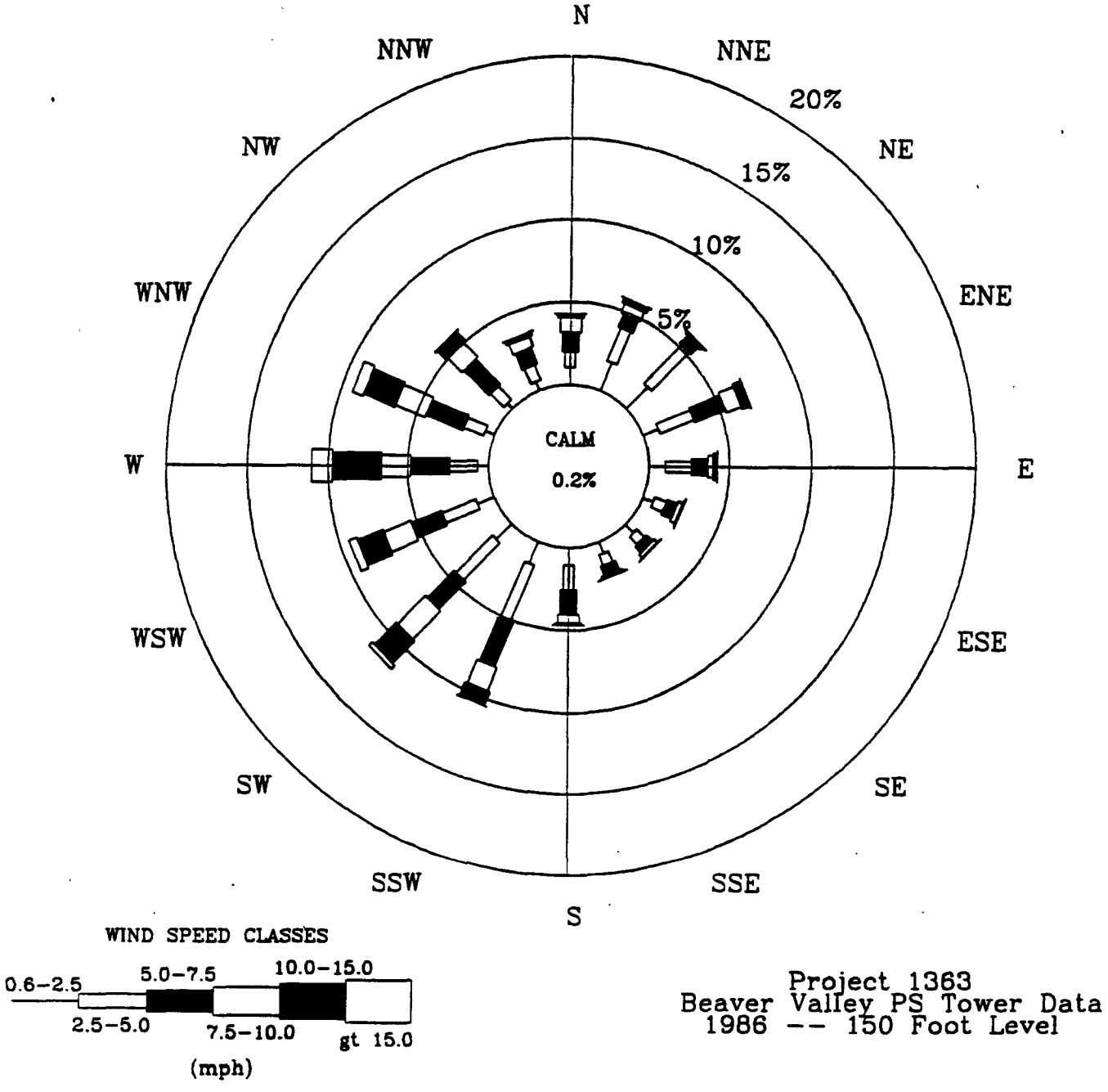

Figure IV-2-8. Annual wind rose for the BVPSMT for 1986, 150-foot level.

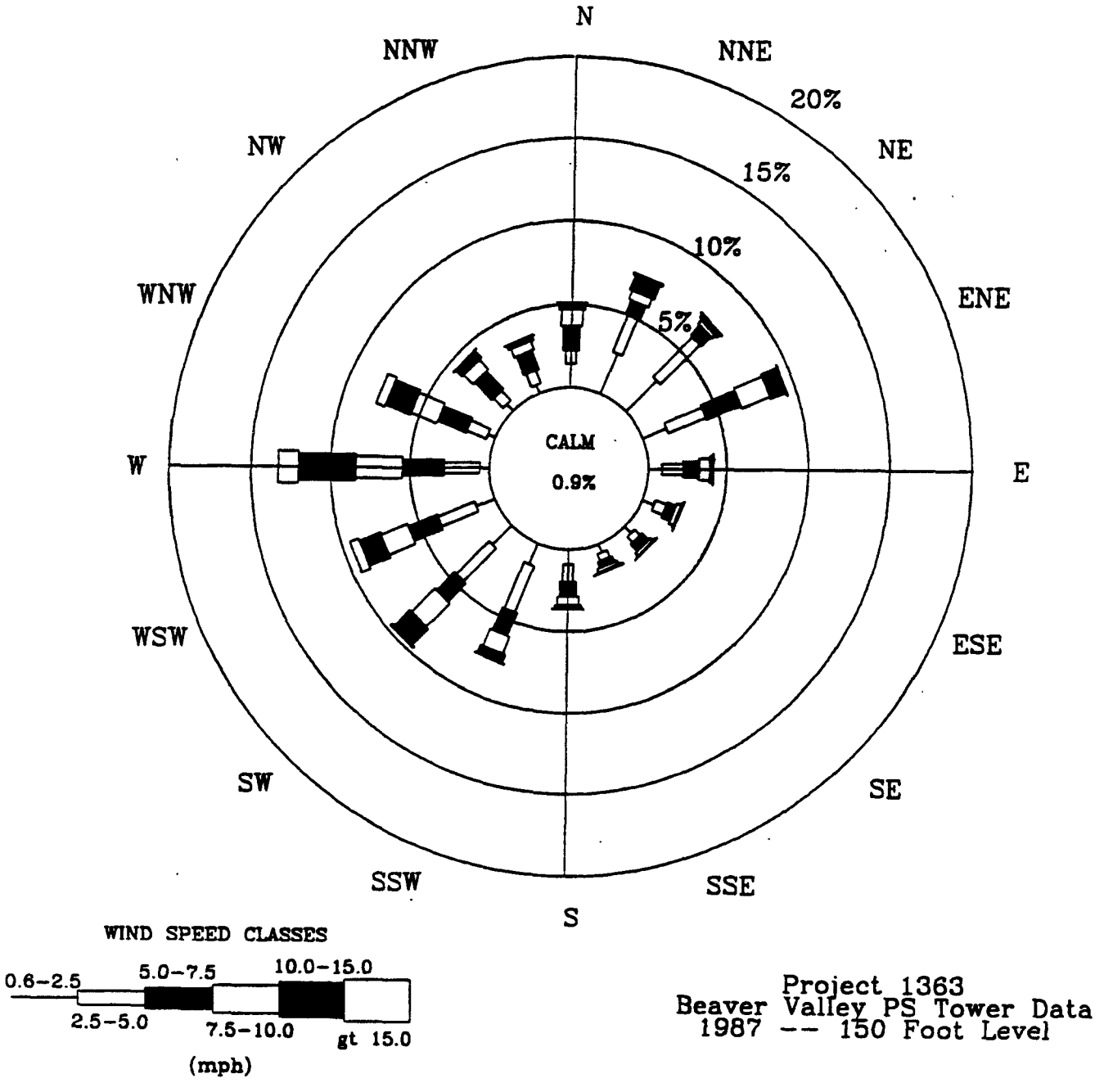

Figure IV-2-9. Annual wind rose for the BVPSMT for 1987, 150-foot level.

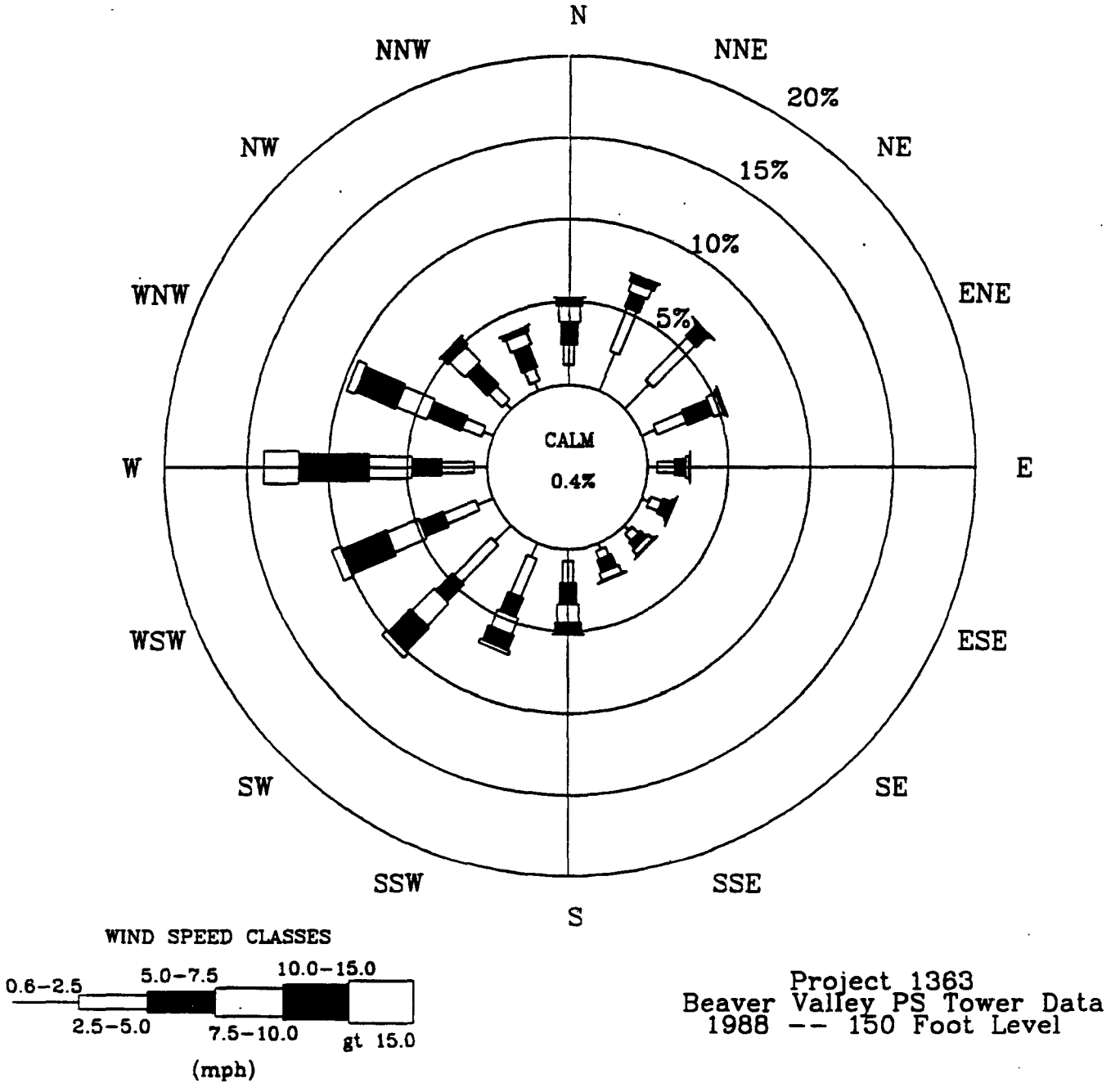

Figure IV-2-10. Annual wind rose for the BVPSMT for 1988, 150-foot level.

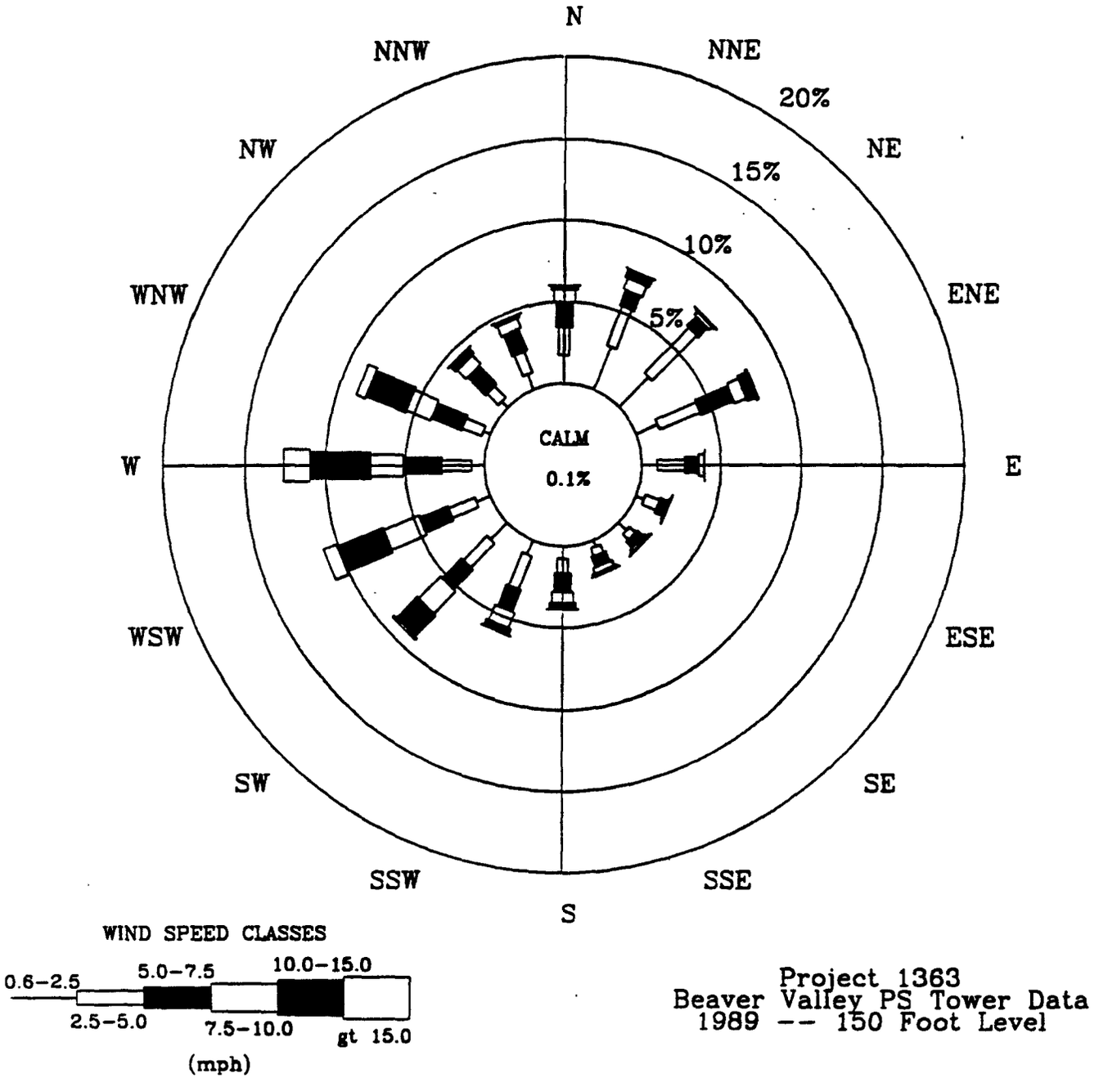

Figure IV-2-11. Annual wind rose for the BVPSMT for 1989, 150-foot level.

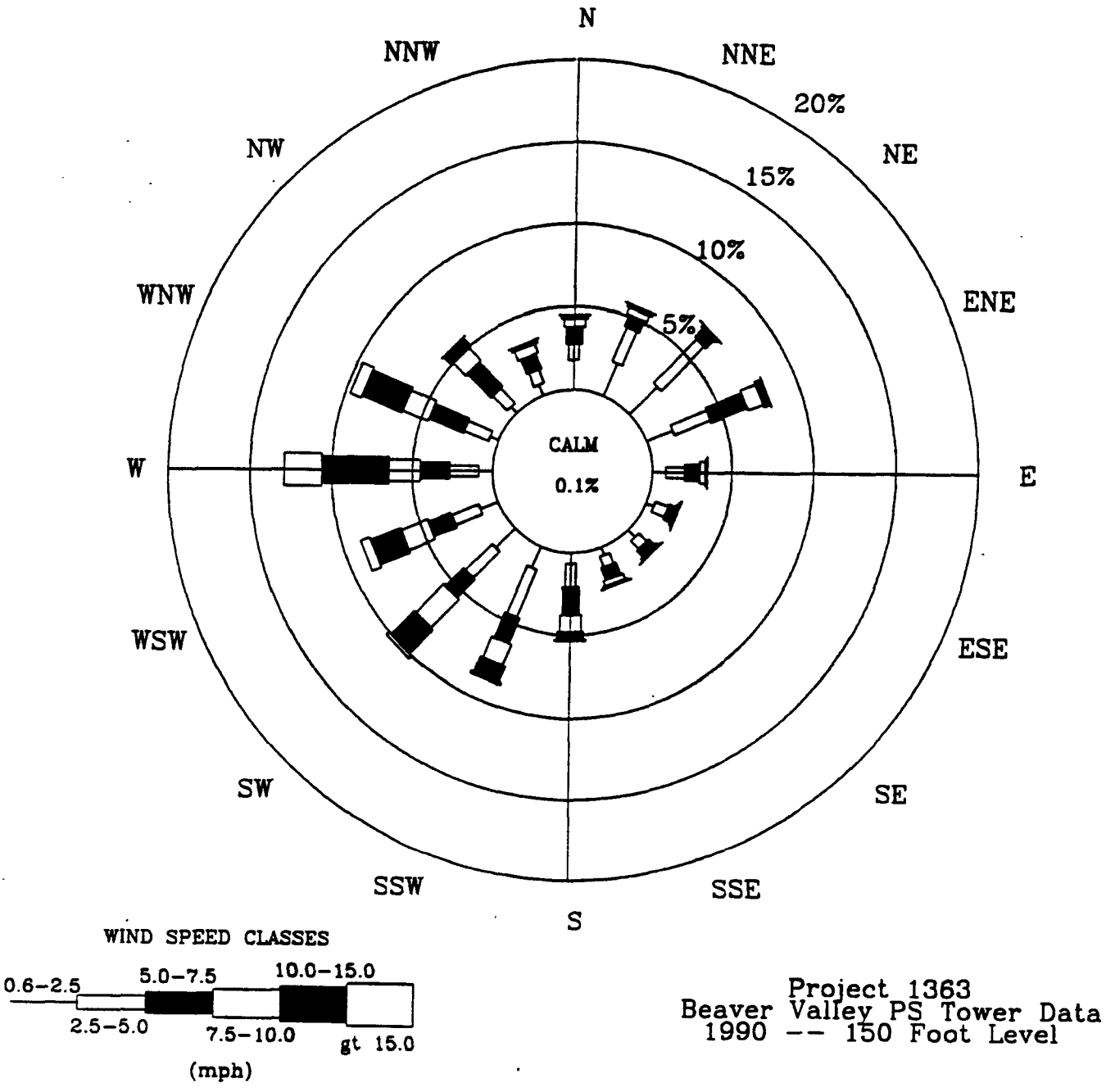

Figure IV-2-12. Annual wind rose for the BVPSMT for 1990, 150-foot level.

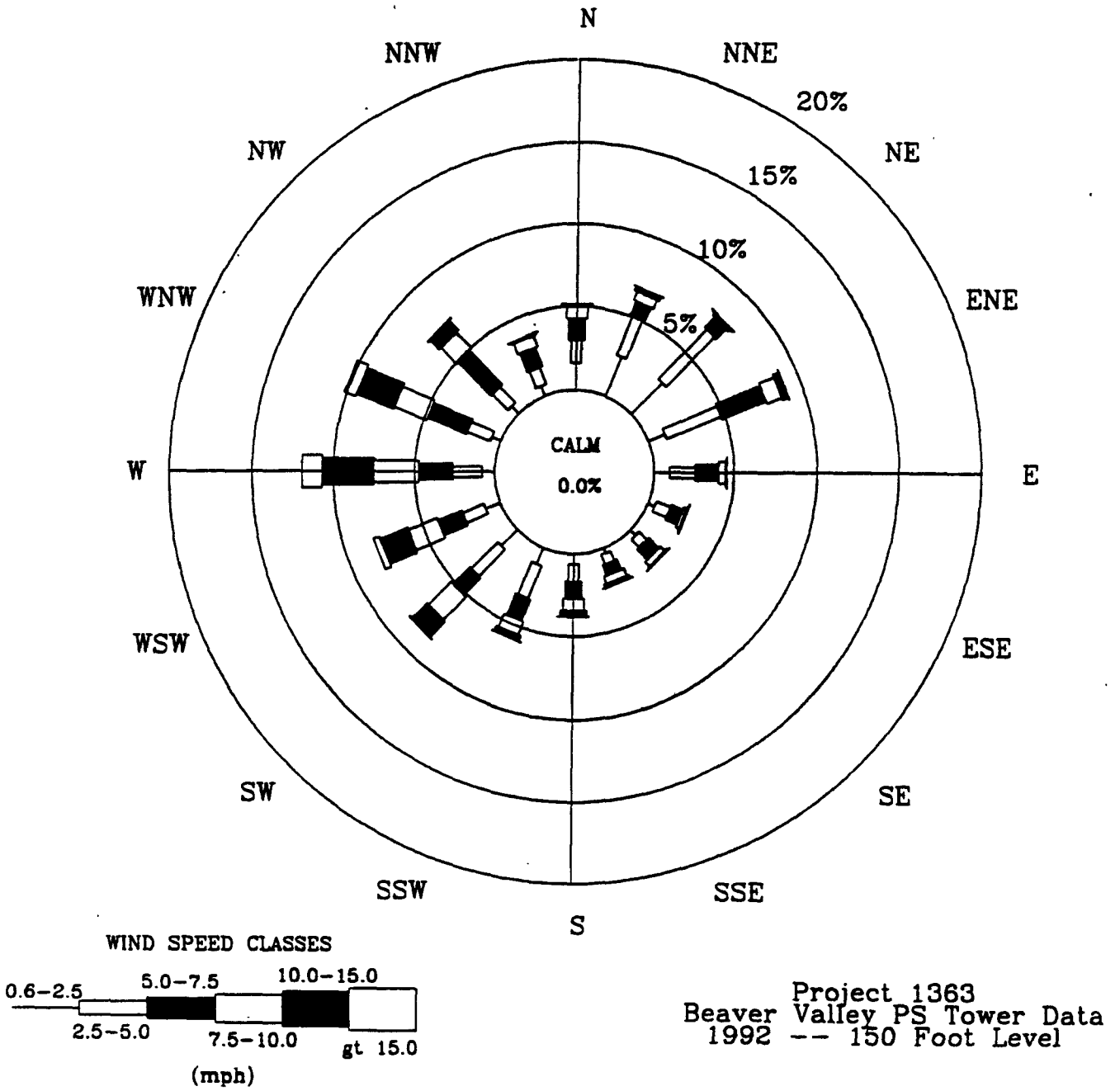

Figure IV-2-13. Annual wind rose for the BVPSMT for 1992, 150-foot level.

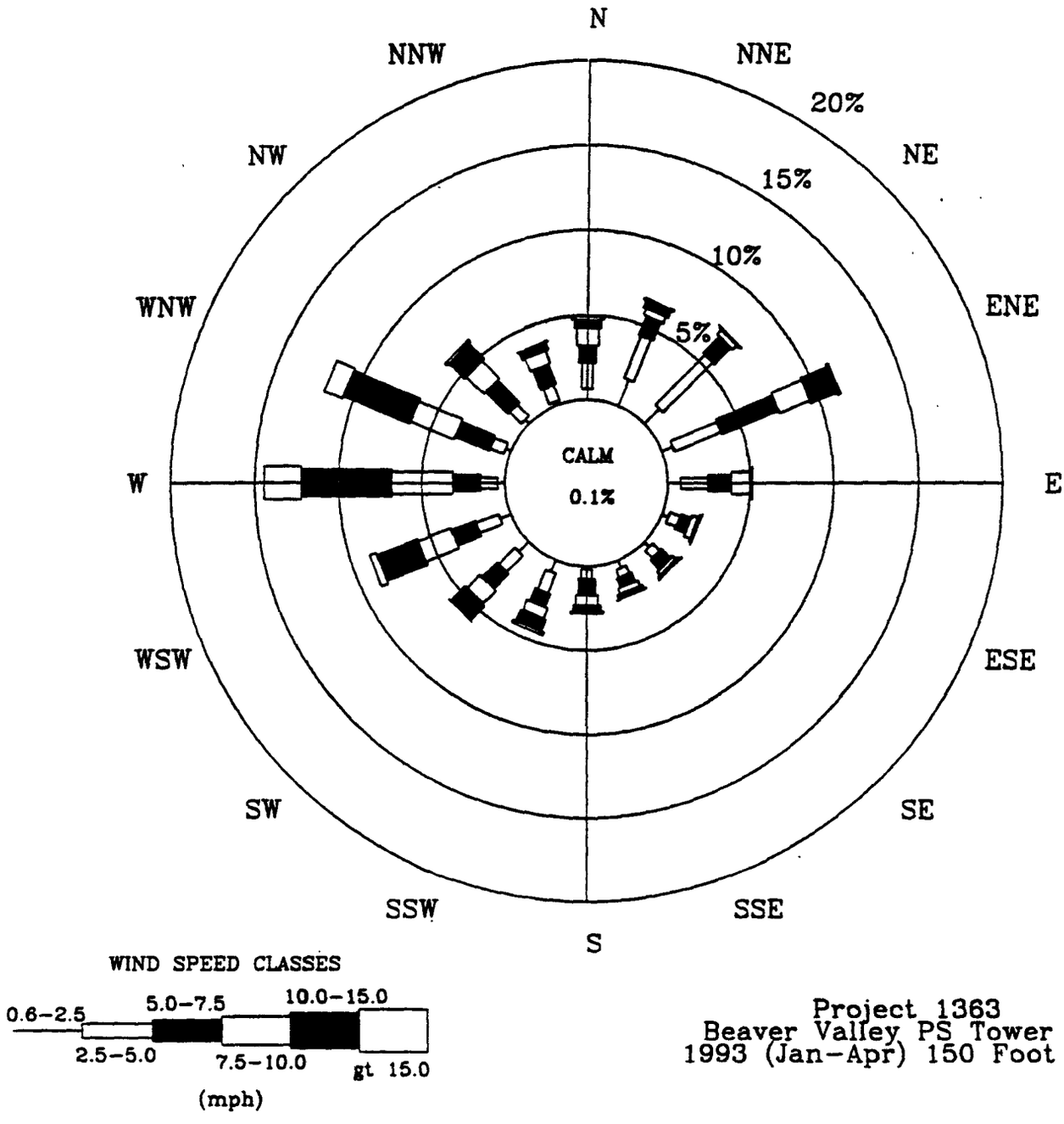

Figure IV-2-14. Four-month (Jan.-Apr.) wind rose for the BVPSMT for 1993, 150-foot level.

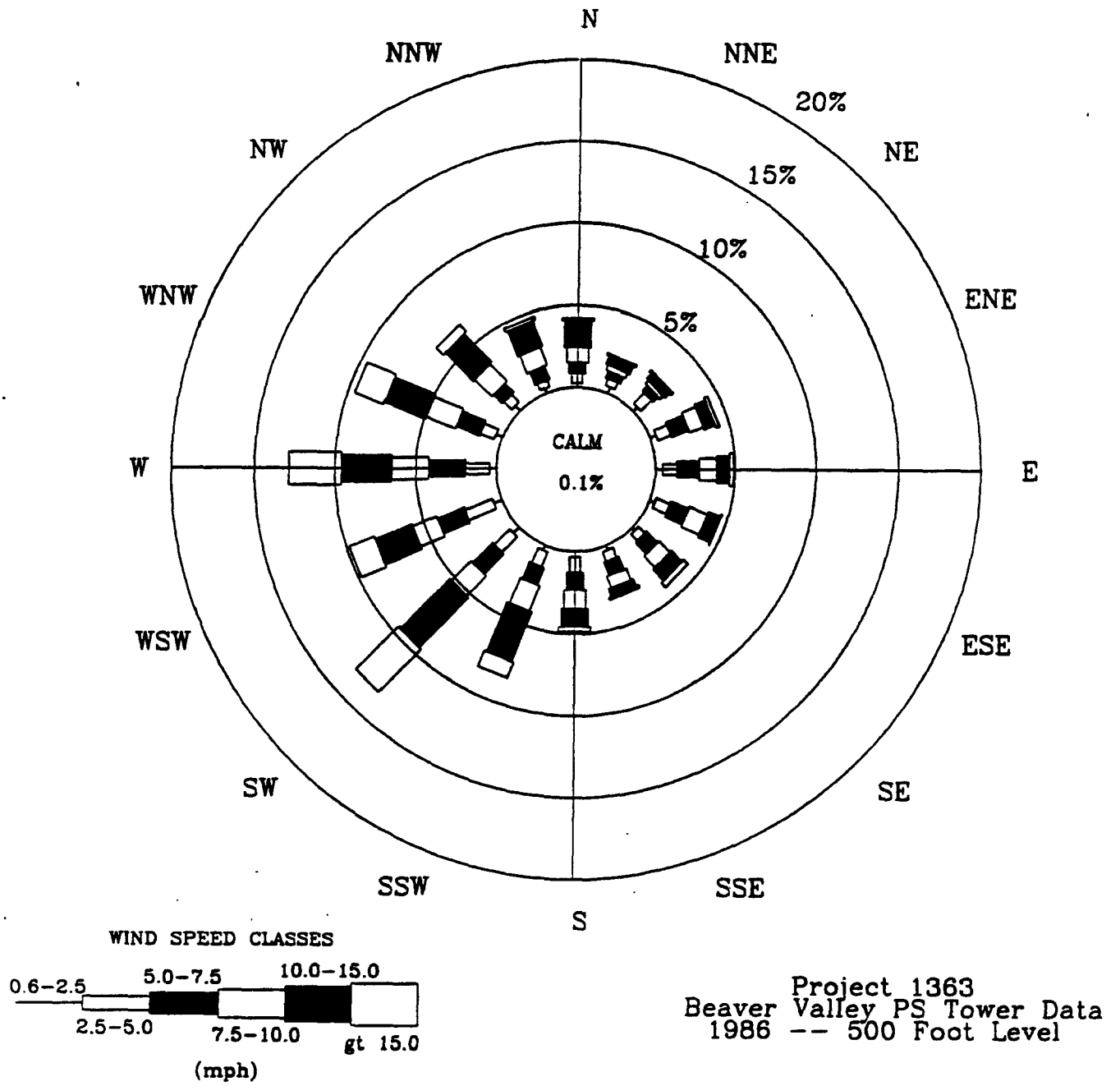

Figure IV-2-15. Annual wind rose for the BVPSMT for 1986, 500-foot level.

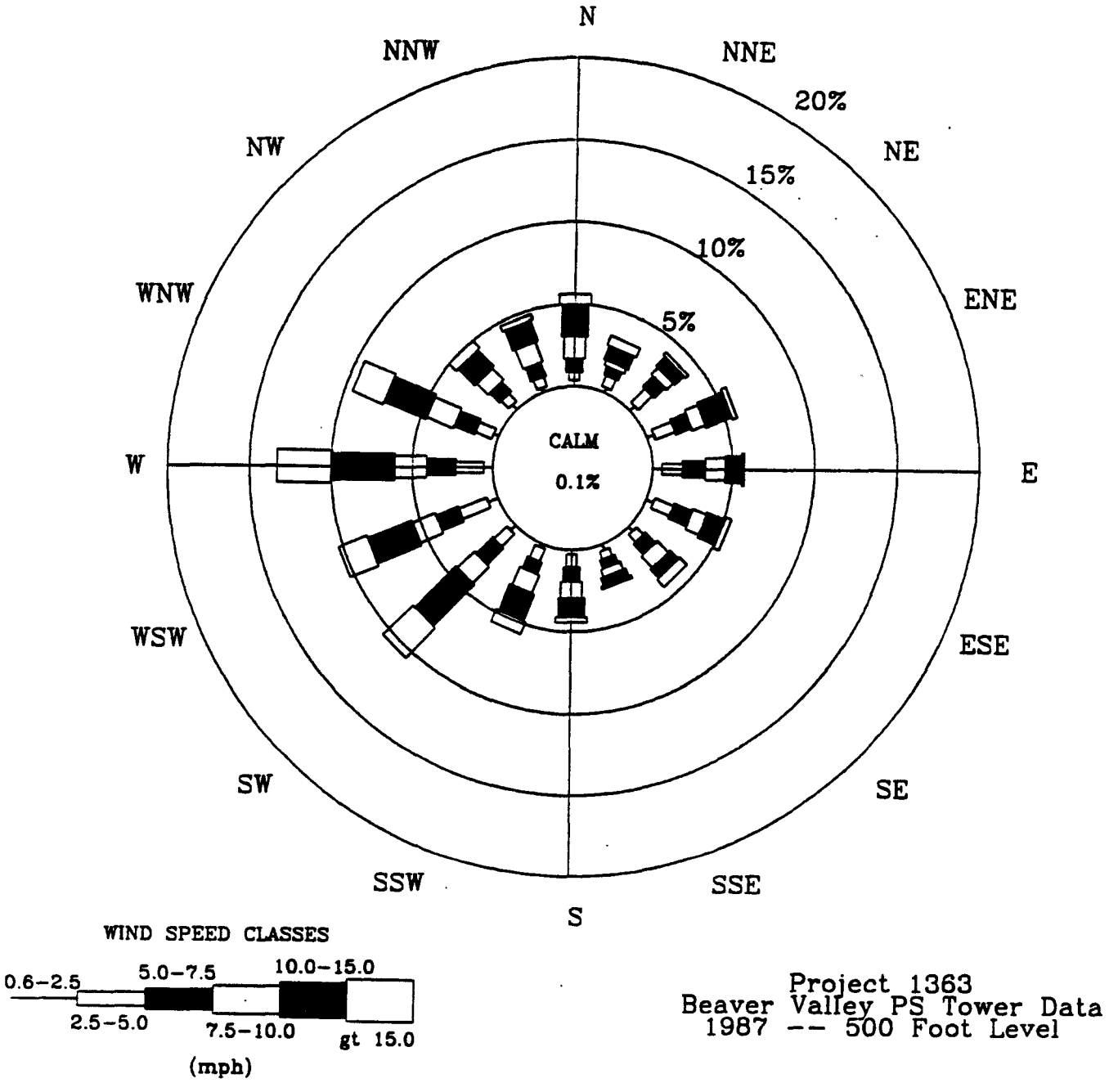

Figure IV-2-16. Annual wind rose for the BVPSMT for 1987, 500-foot level.

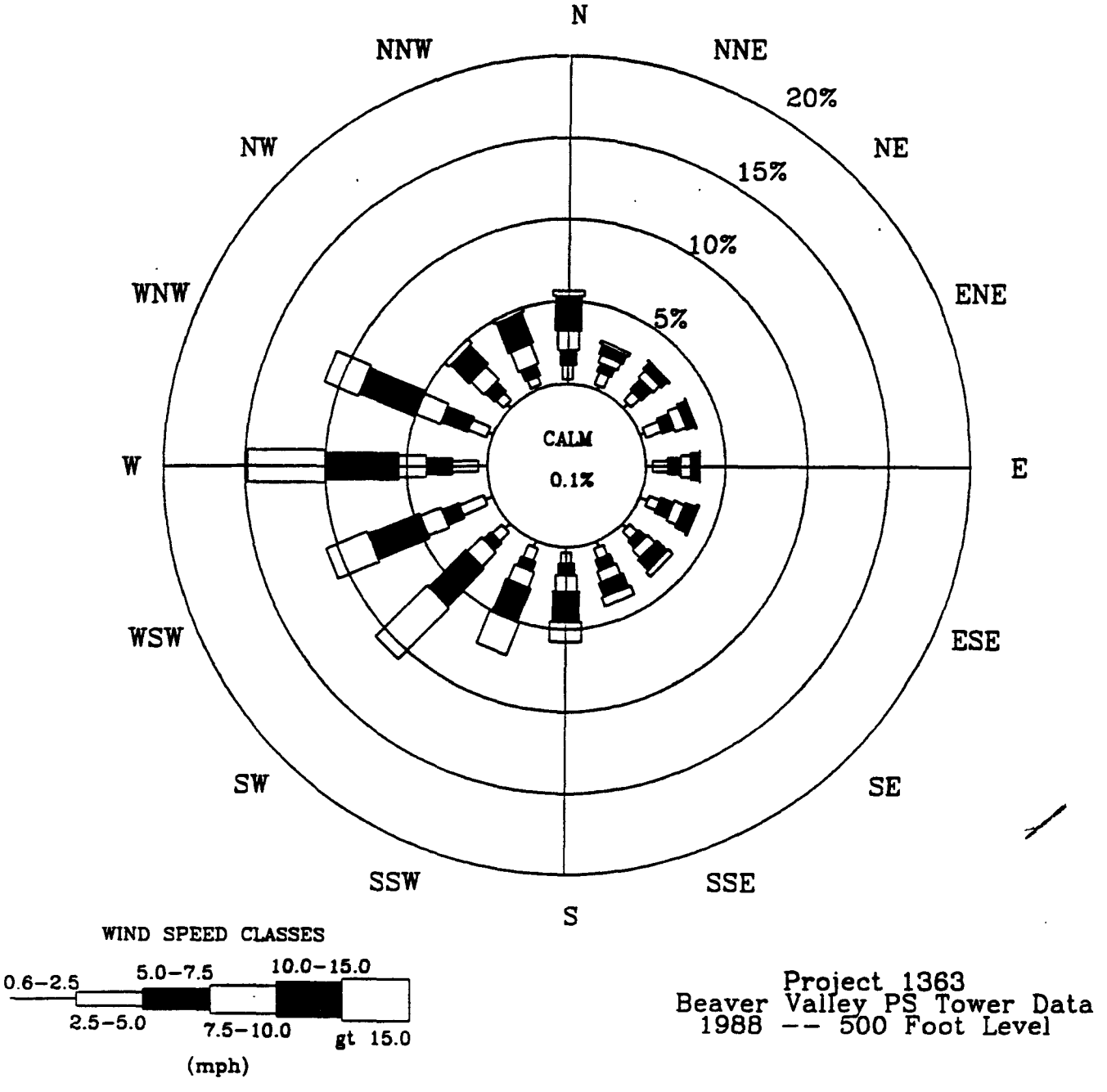

Figure IV-2-17. Annual wind rose for the BVPSMT for 1988, 500-foot level.

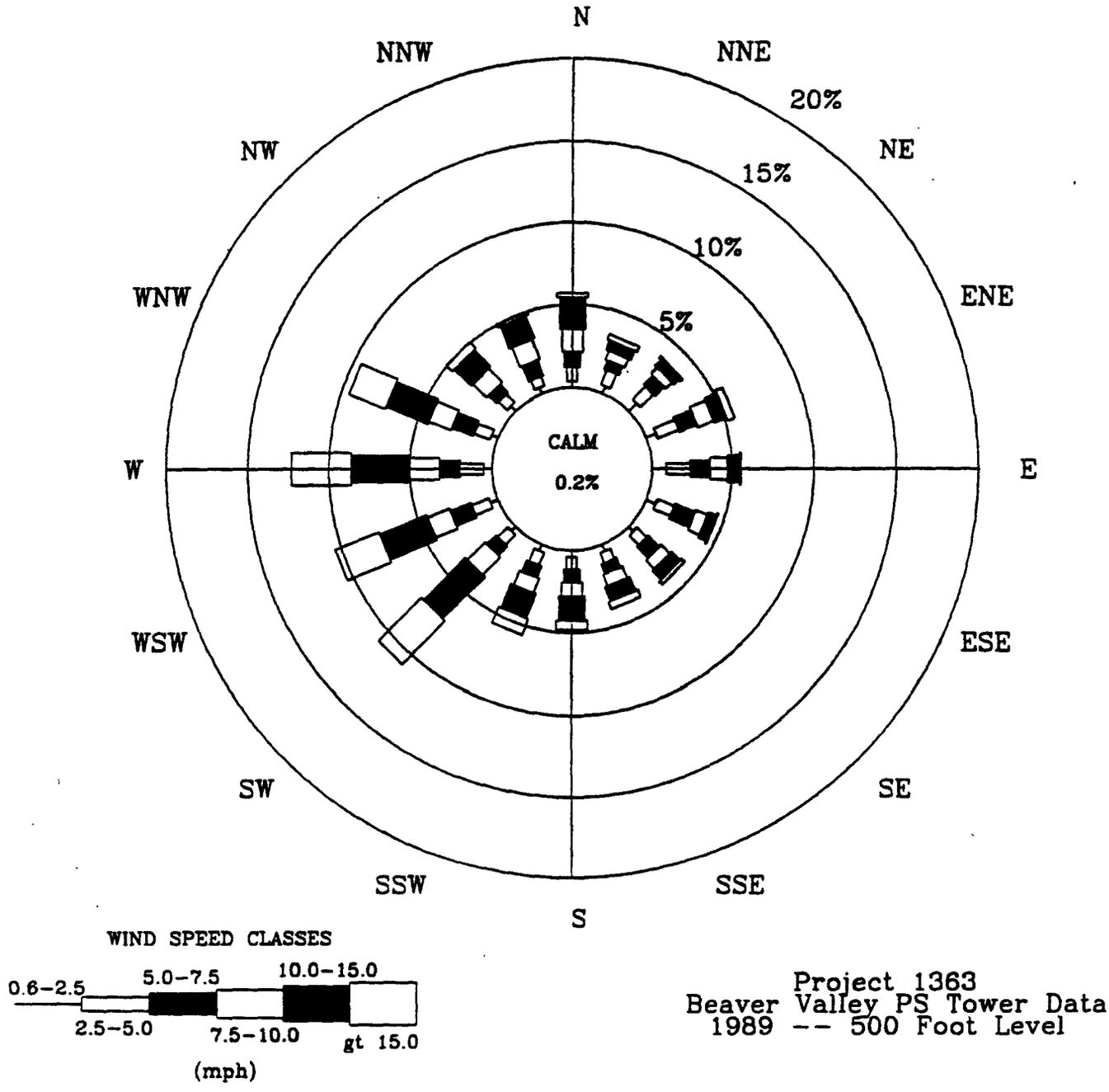

Figure IV-2-18. Annual wind rose for the BVPSMT for 1989, 500-foot level.

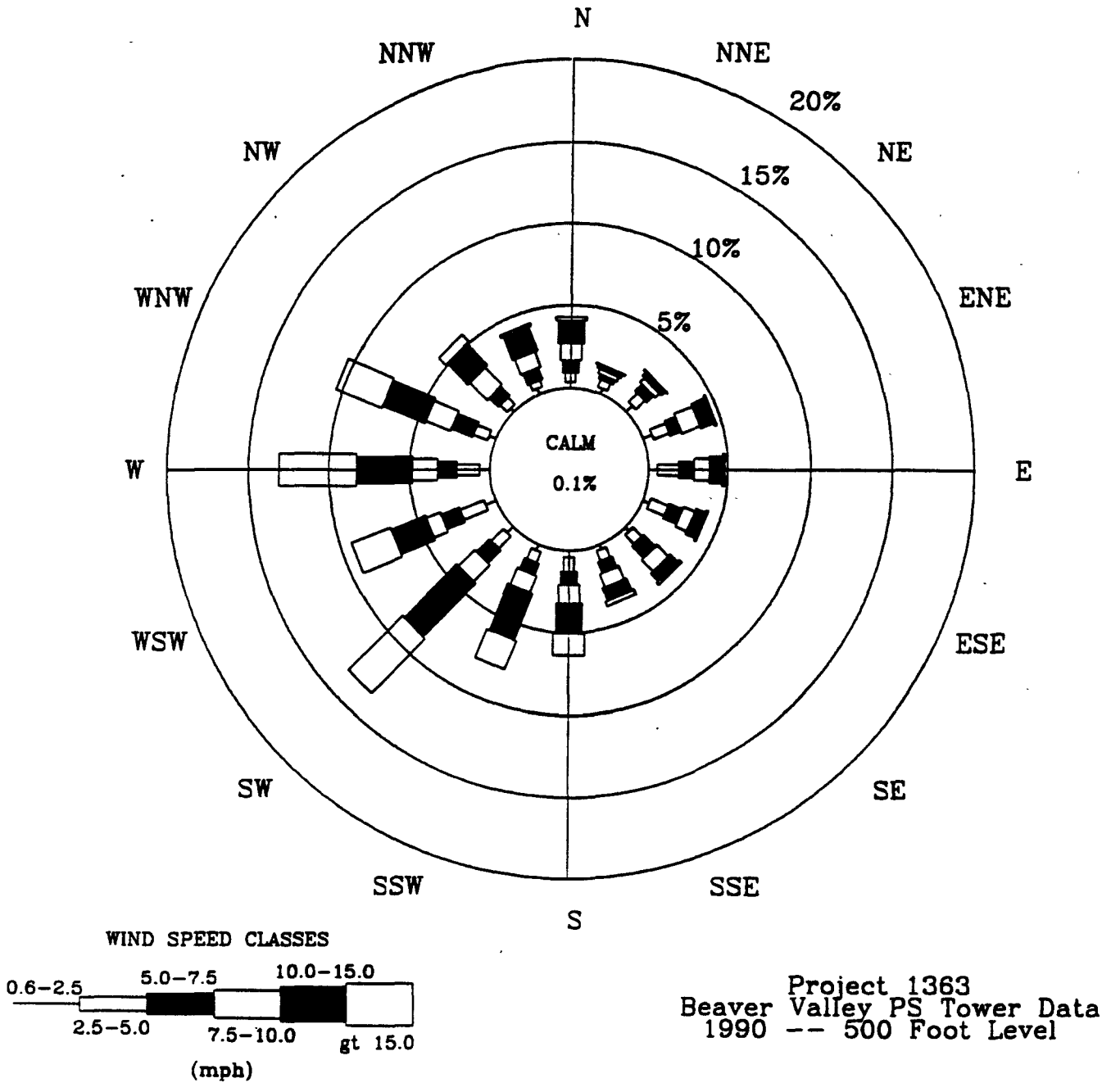

Figure IV-2-19. Annual wind rose for the BVPSMT for 1990, 500-foot level.

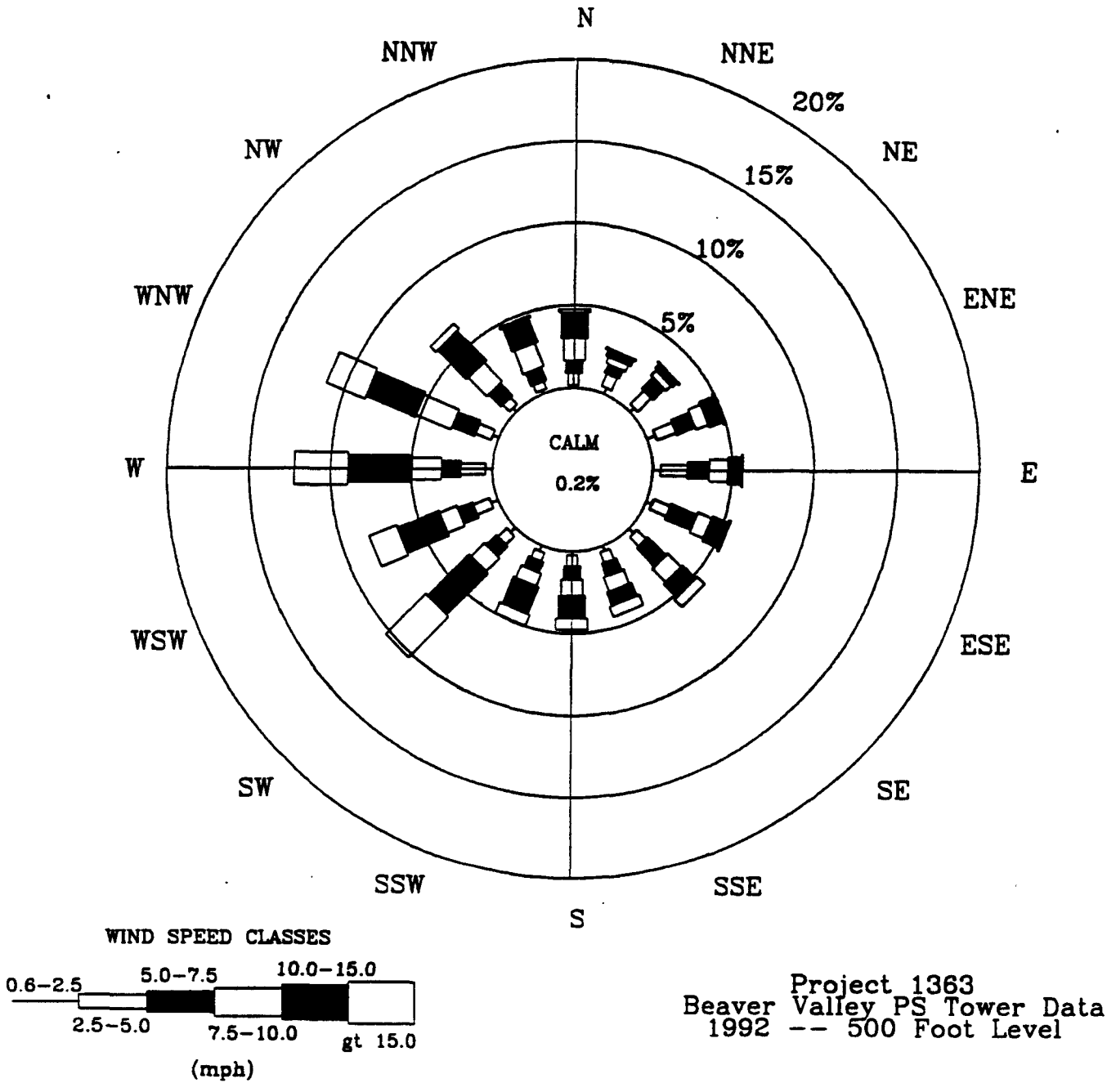

Figure IV-2-20. Annual wind rose for the BVPSMT for 1992, 500-foot level.

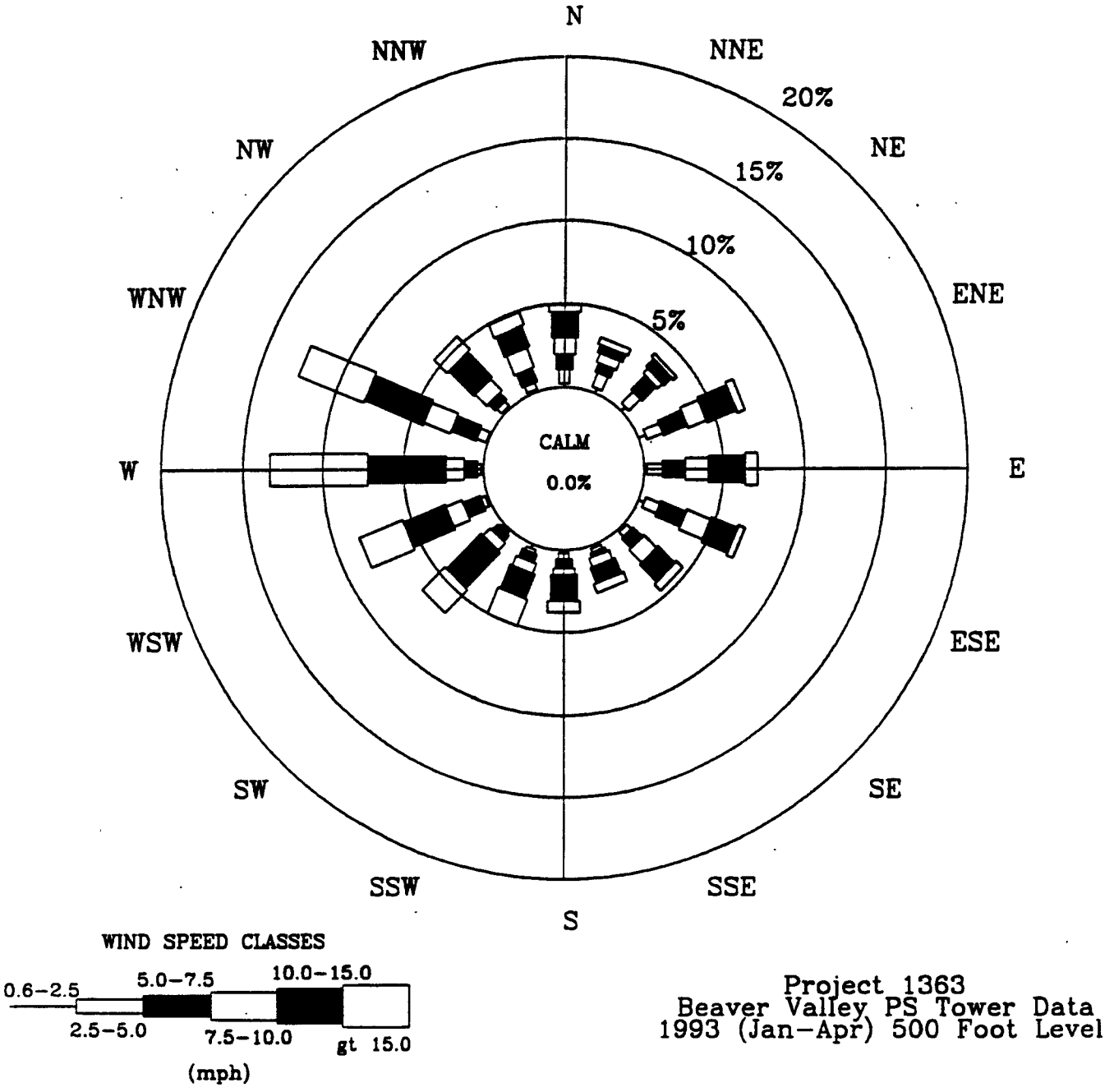

Figure IV-2-21. Four-month (Jan.-Apr.) wind rose for the BVPSMT for 1993, 500-foot level.

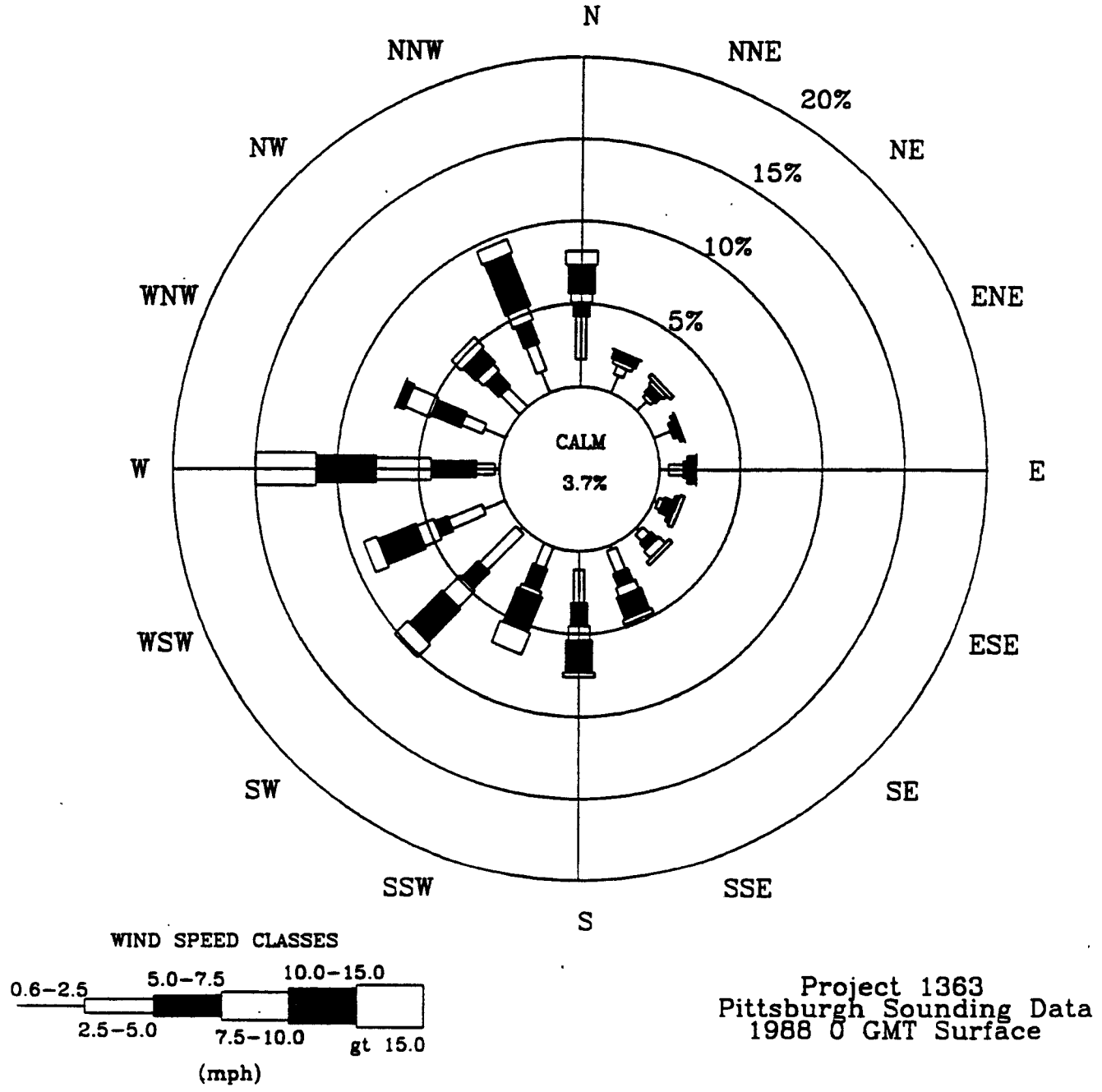

Figure IV-2-22. Annual wind rose for Pittsburgh 0 GMT sounding data, surface level, 1988.

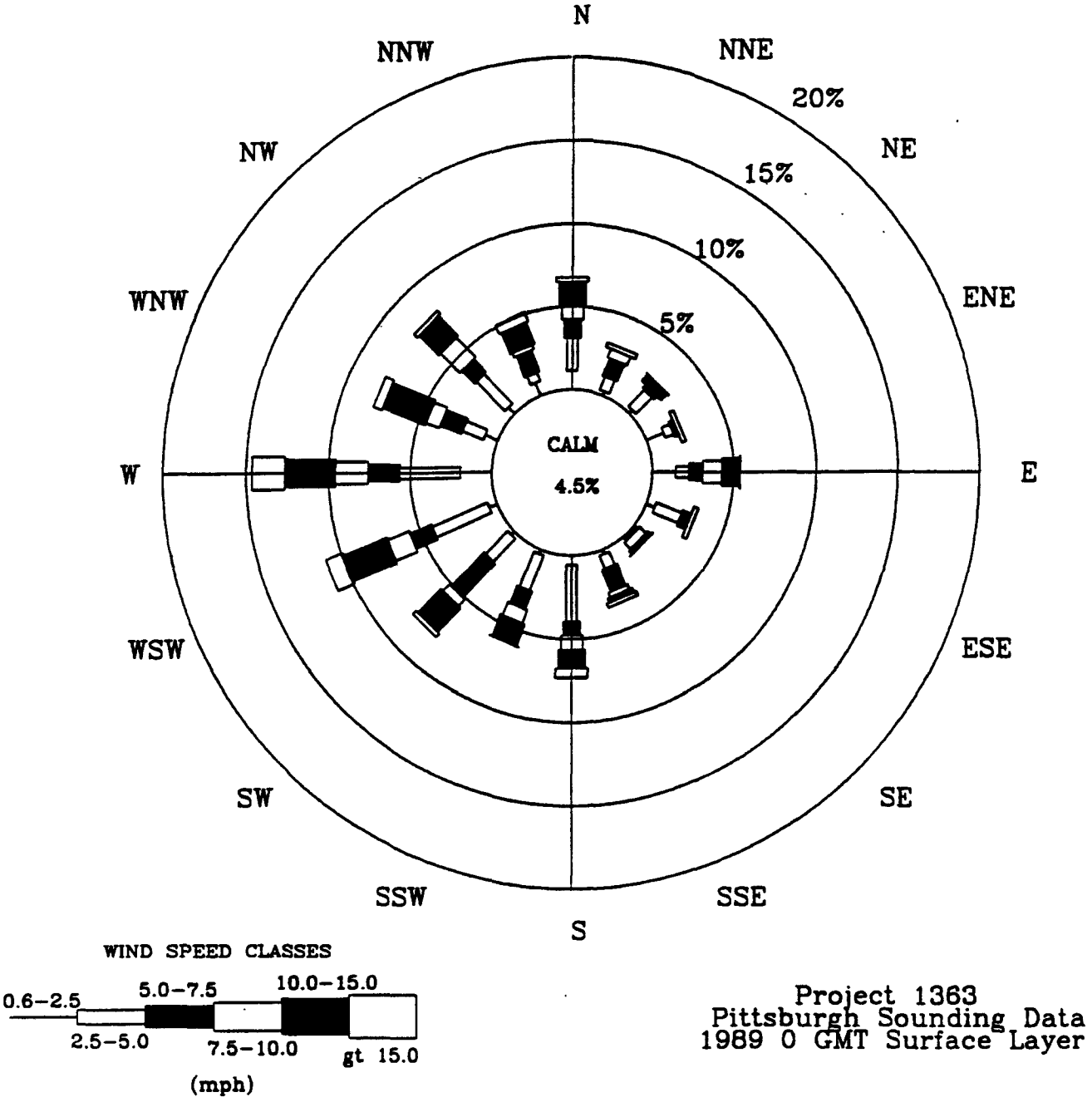

Figure IV-2-23. Annual wind rose for Pittsburgh 0 GMT sounding data, surface level, 1989.

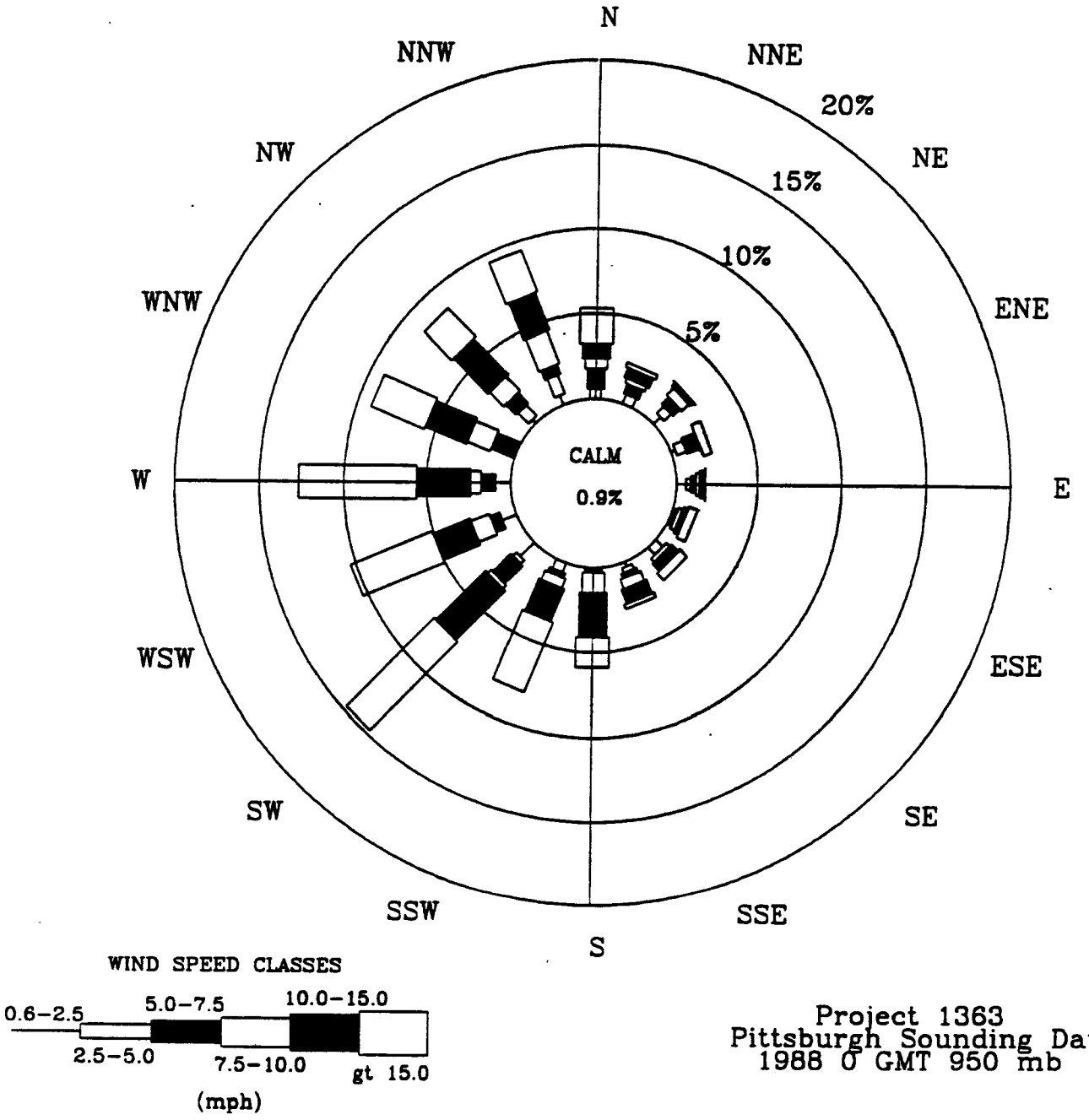

Figure IV-2-24. Annual wind rose for Pittsburgh 0 GMT sounding data, 950 mb level, 1988.

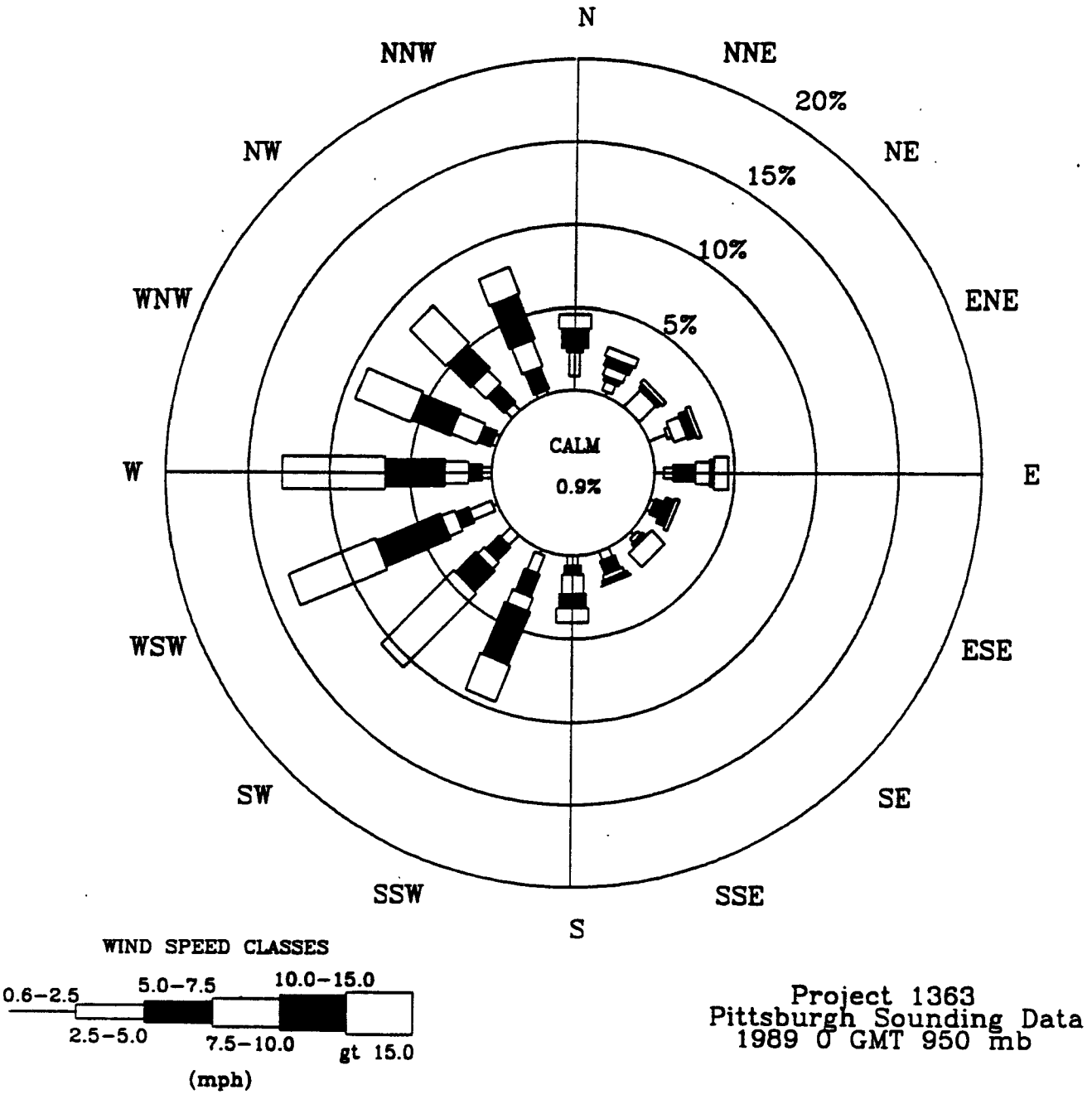

Figure IV-2-25. Annual wind rose for Pittsburgh 0 GMT sounding data, 950 mb level, 1989.

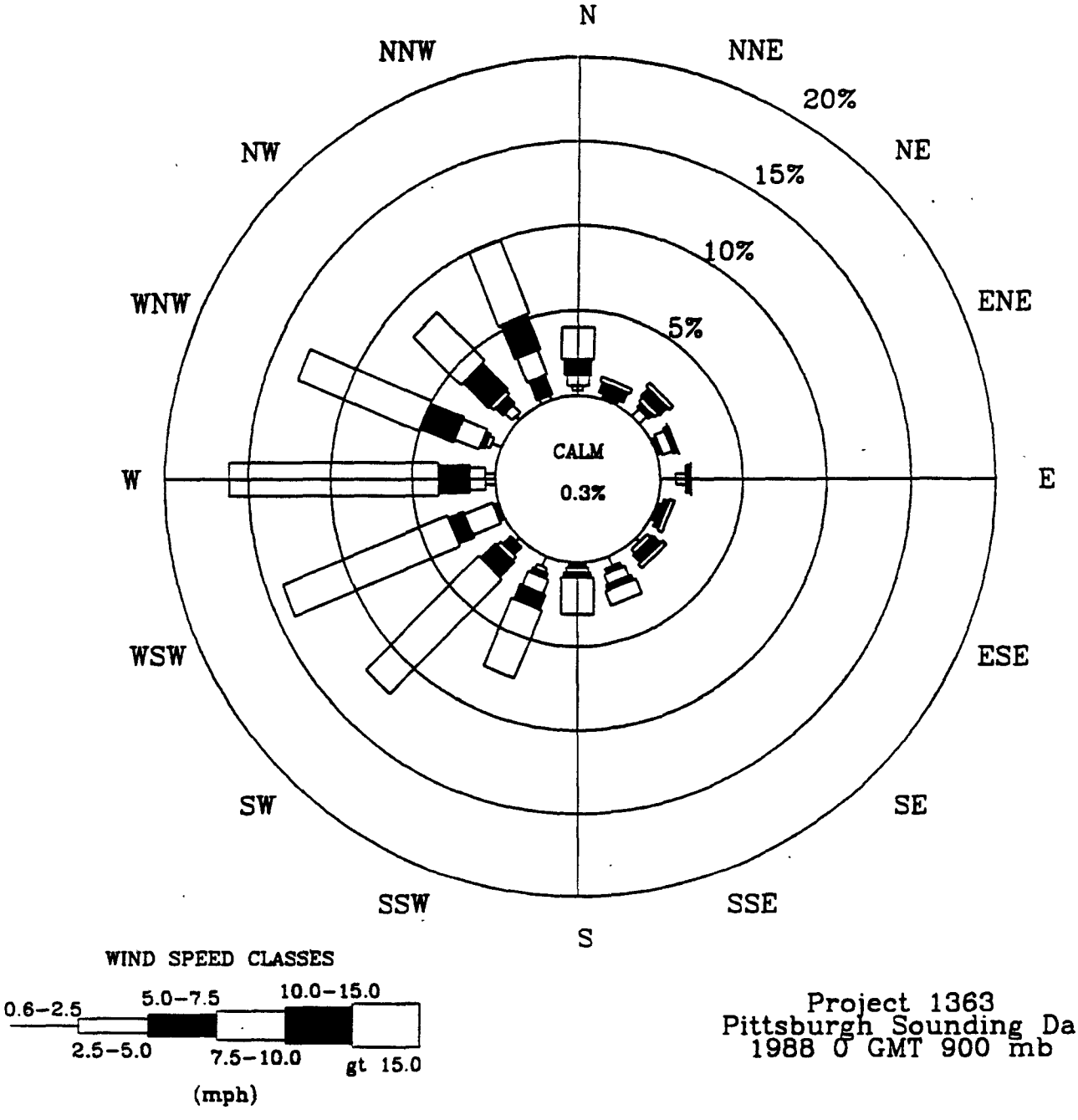

Figure IV-2-26. Annual wind rose for Pittsburgh 0 GMT sounding data, 900 mb level, 1988.

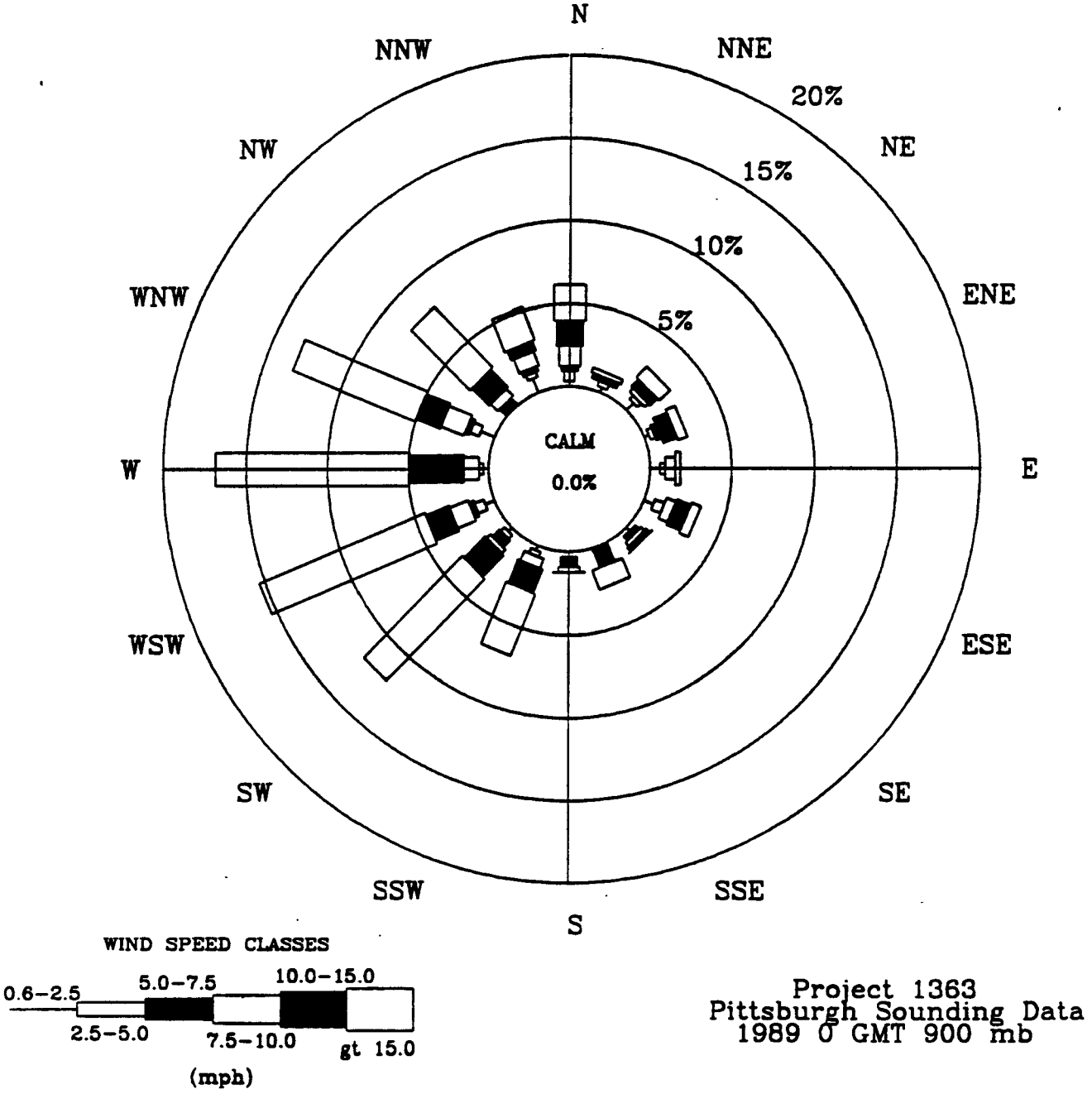

Figure IV-2-27. Annual wind rose for Pittsburgh 0 GMT sounding data, 900 mb level, 1989.

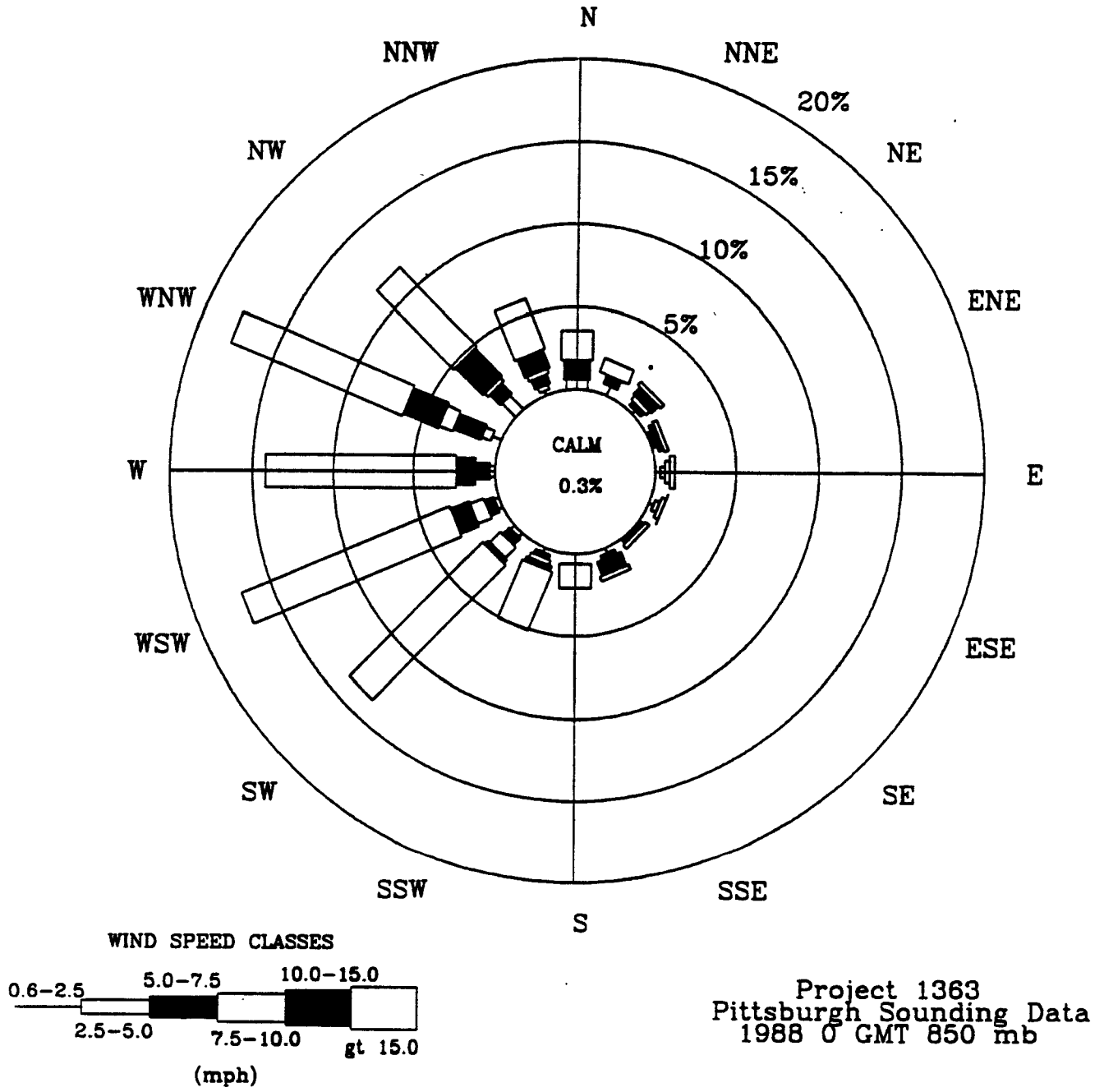

Figure IV-2-28. Annual wind rose for Pittsburgh 0 GMT sounding data, 850 mb level, 1988.

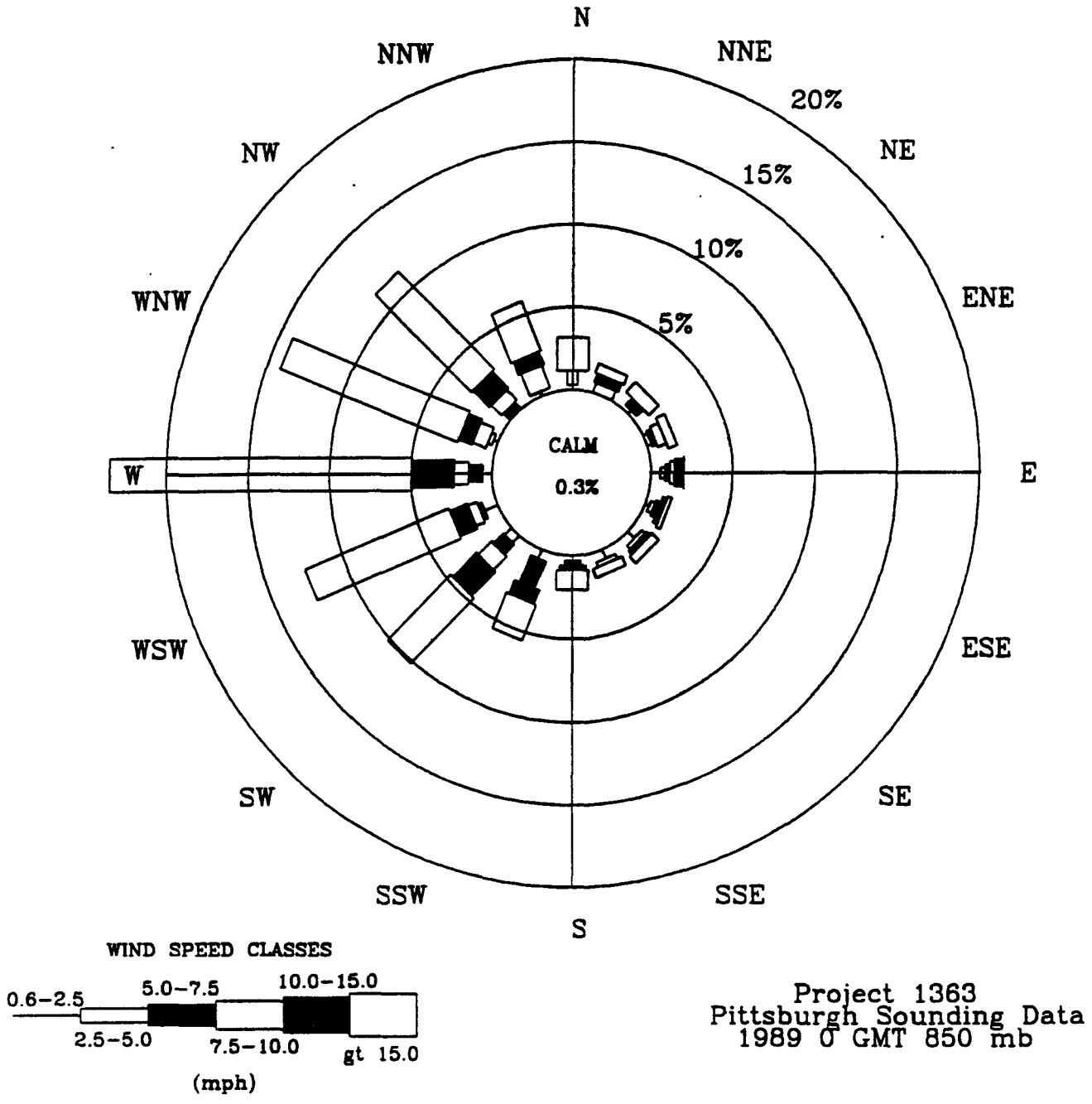

Figure IV-2-29. Annual wind rose for Pittsburgh 0 GMT sounding data, 850 mb level, 1989.

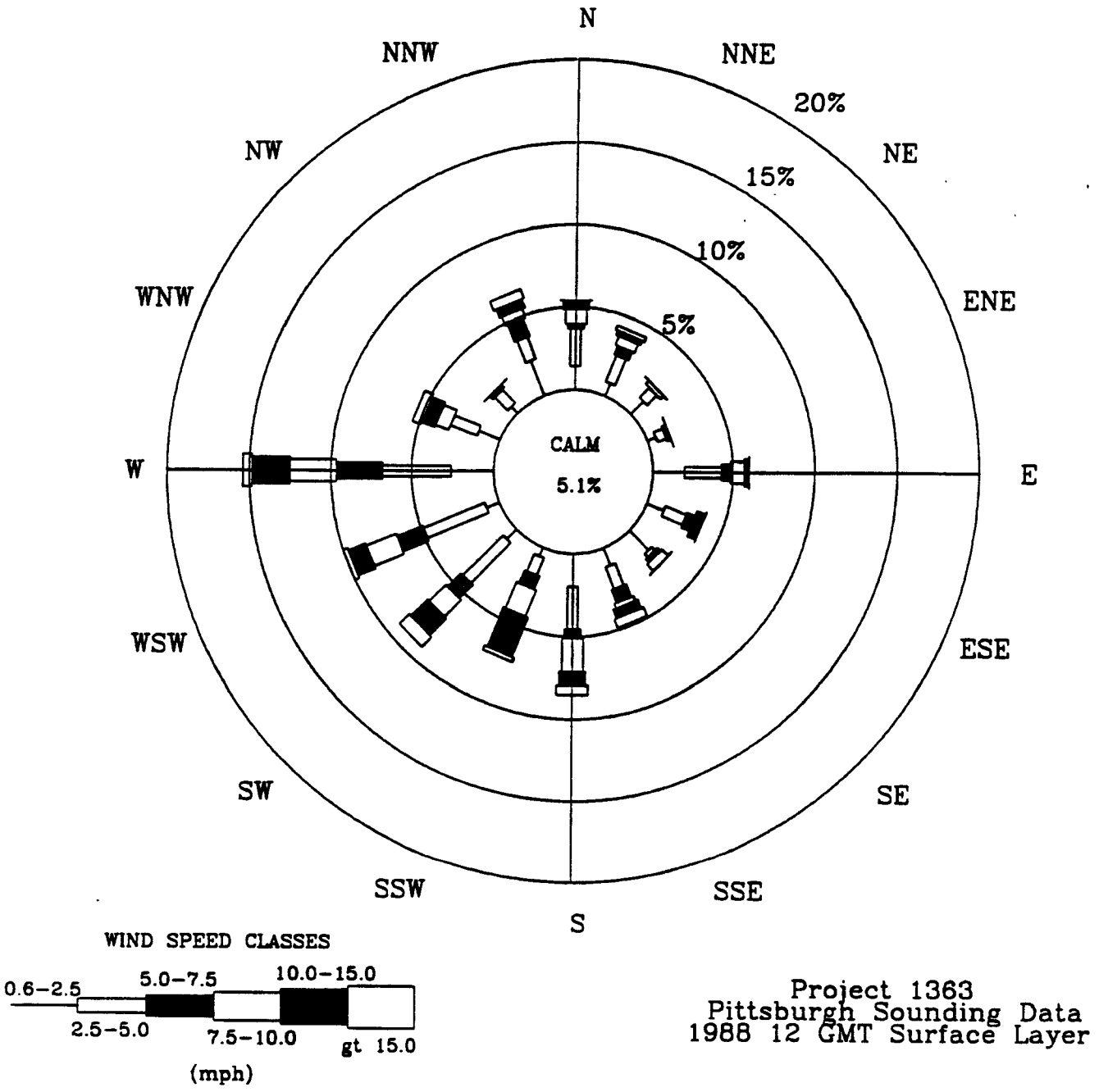

Figure IV-2-30. Annual wind rose for Pittsburgh 12 GMT sounding data, surface level, 1988.

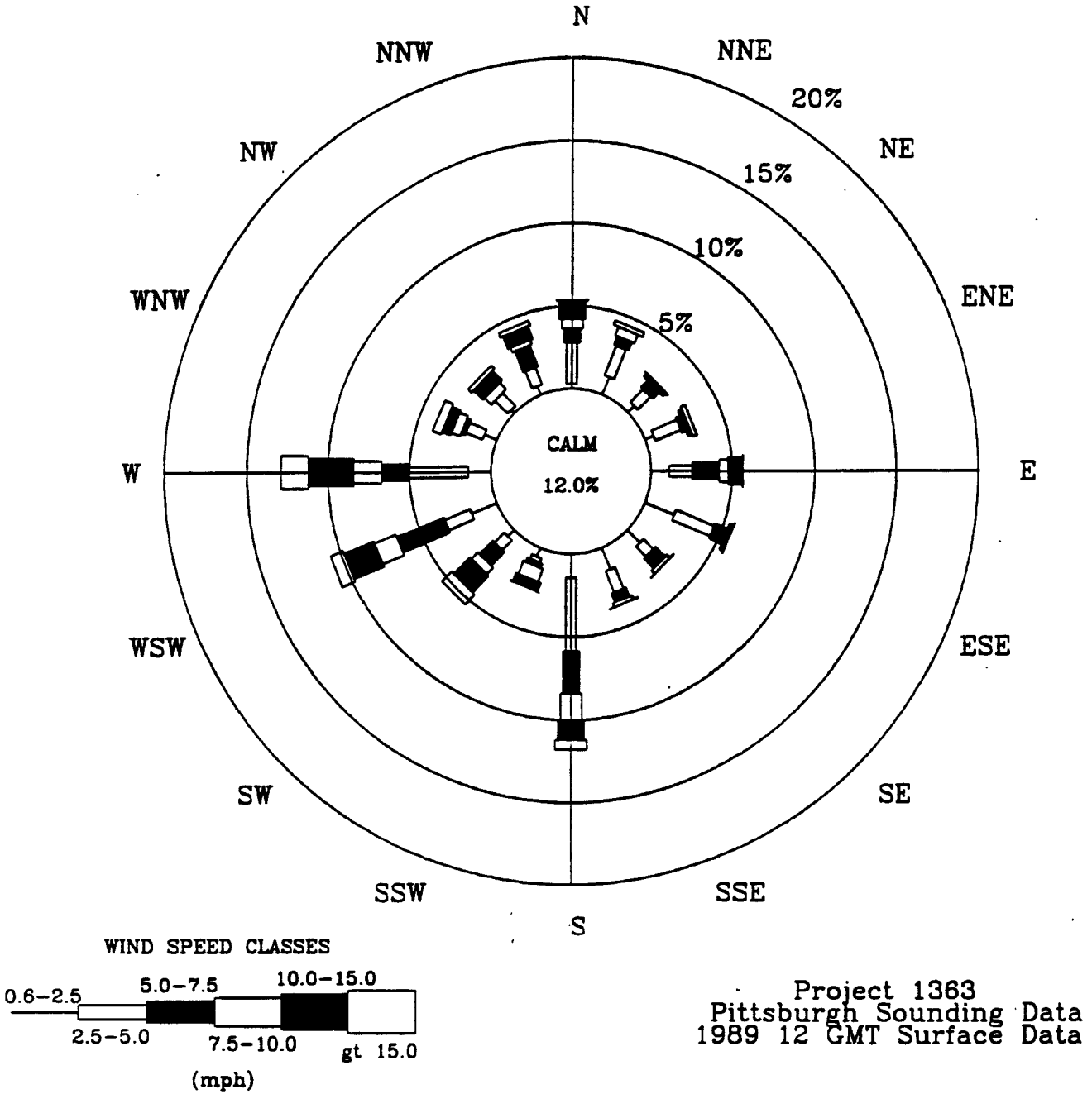

Figure IV-2-31. Annual wind rose for Pittsburgh 12 GMT sounding data, surface level, 1989.

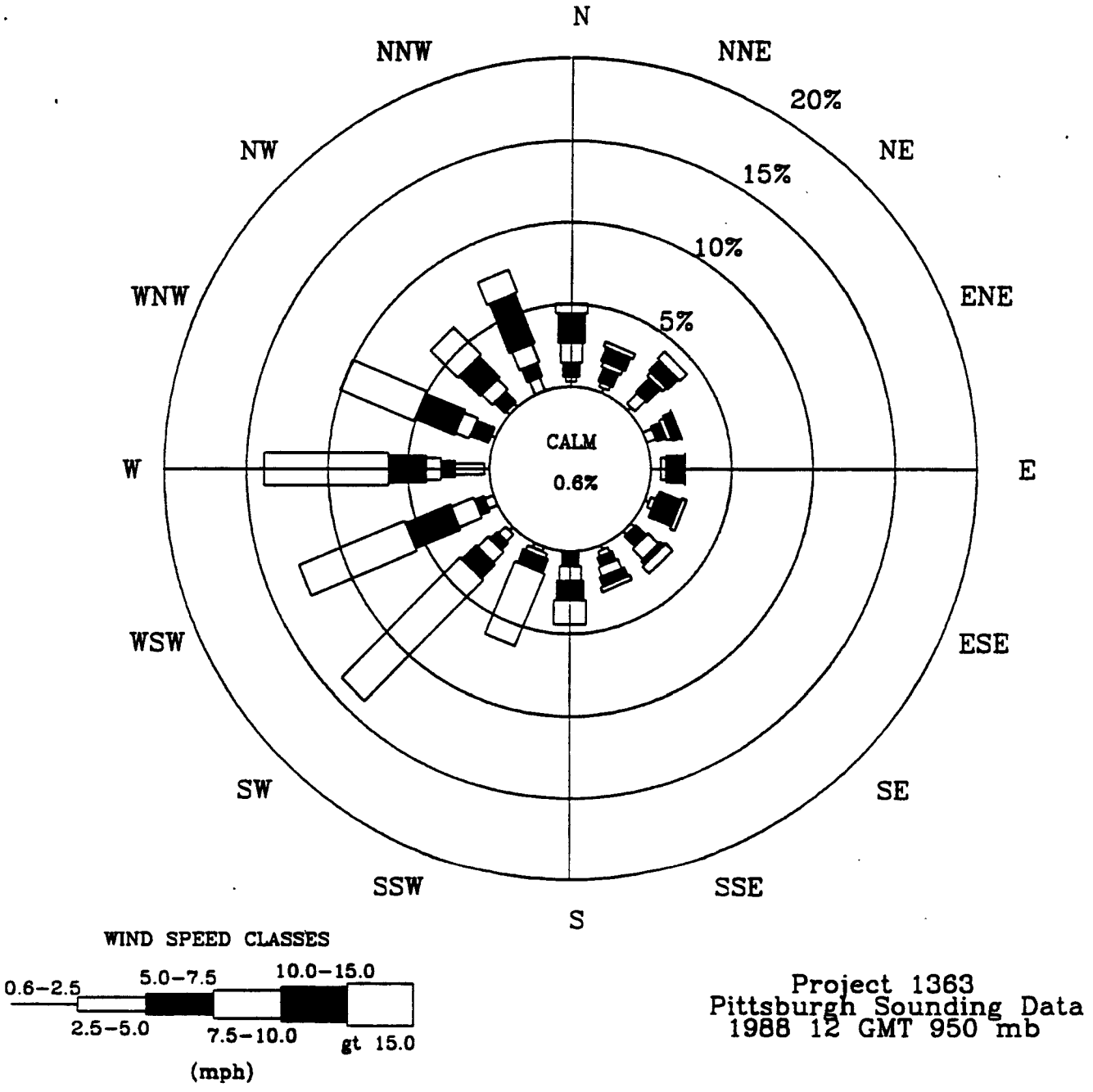

Figure IV-2-32. Annual wind rose for Pittsburgh 12 GMT sounding data, 950 mb level, 1988.

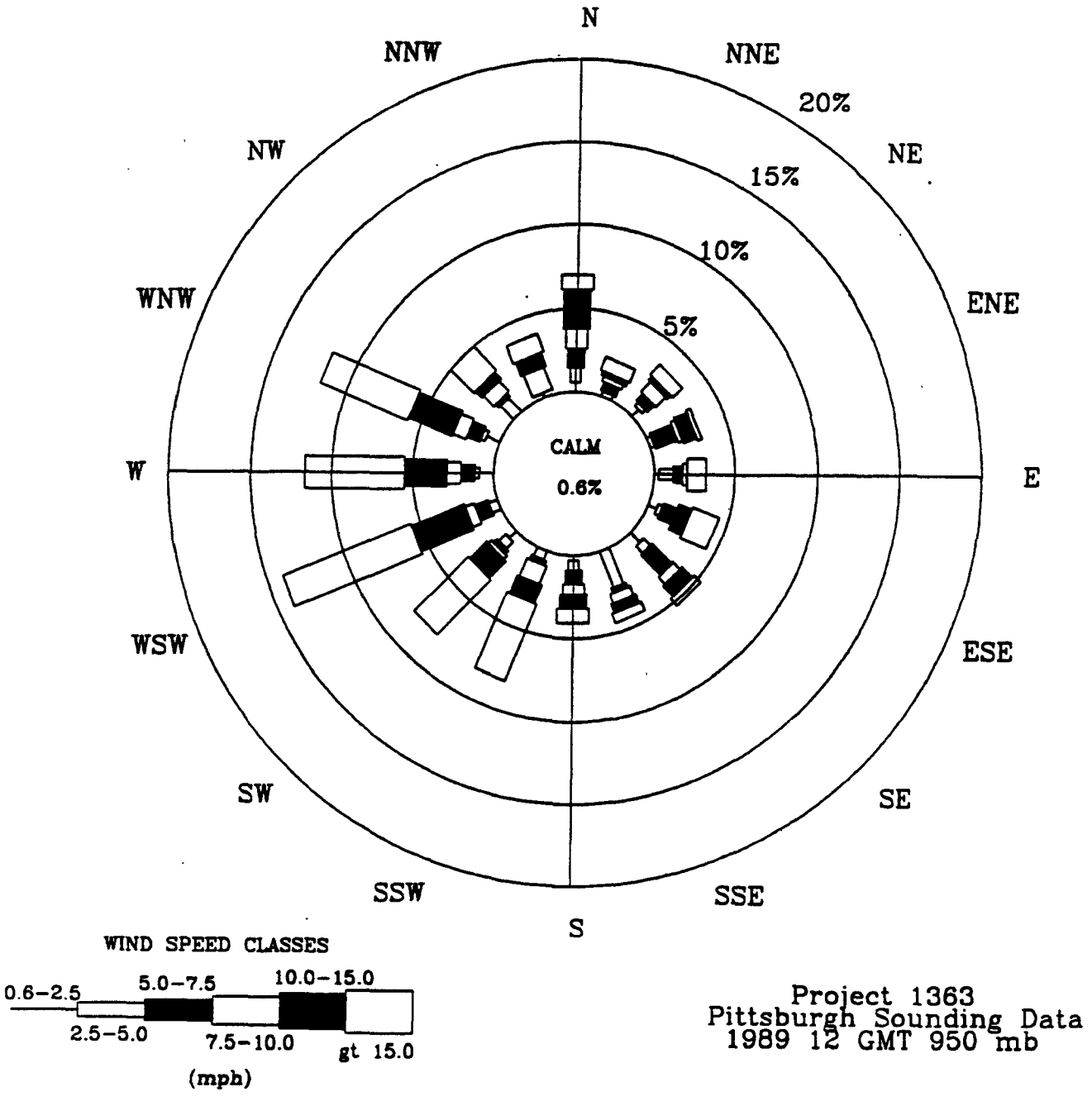

Figure IV-2-33. Annual wind rose for Pittsburgh 12 GMT sounding data, 950 mb level, 1989.

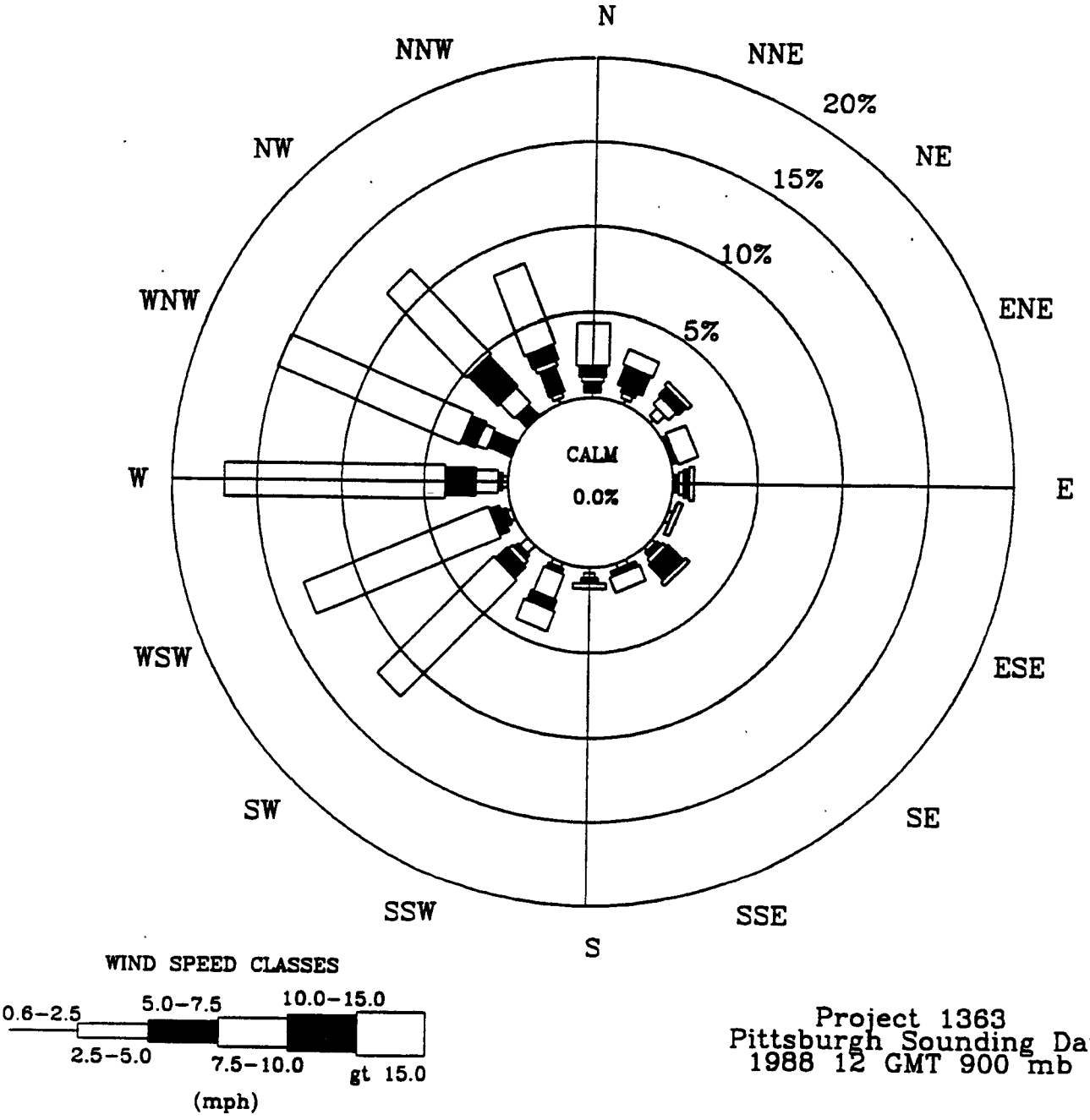

Figure IV-2-34. Annual wind rose for Pittsburgh 12 GMT sounding data, 900 mb level, 1988.

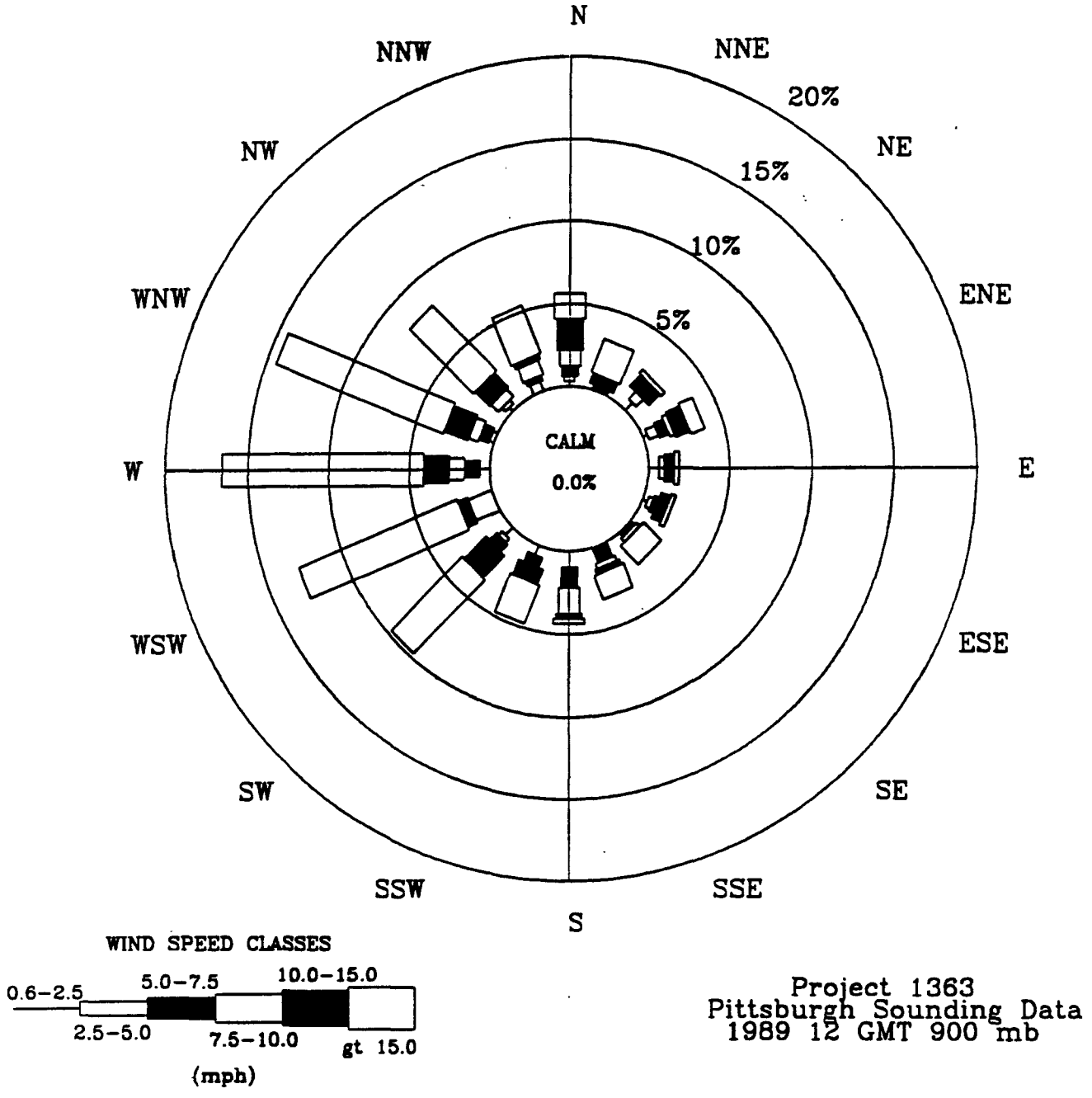

Figure IV-2-35. Annual wind rose for Pittsburgh 12 GMT sounding data, 900 mb level, 1989.

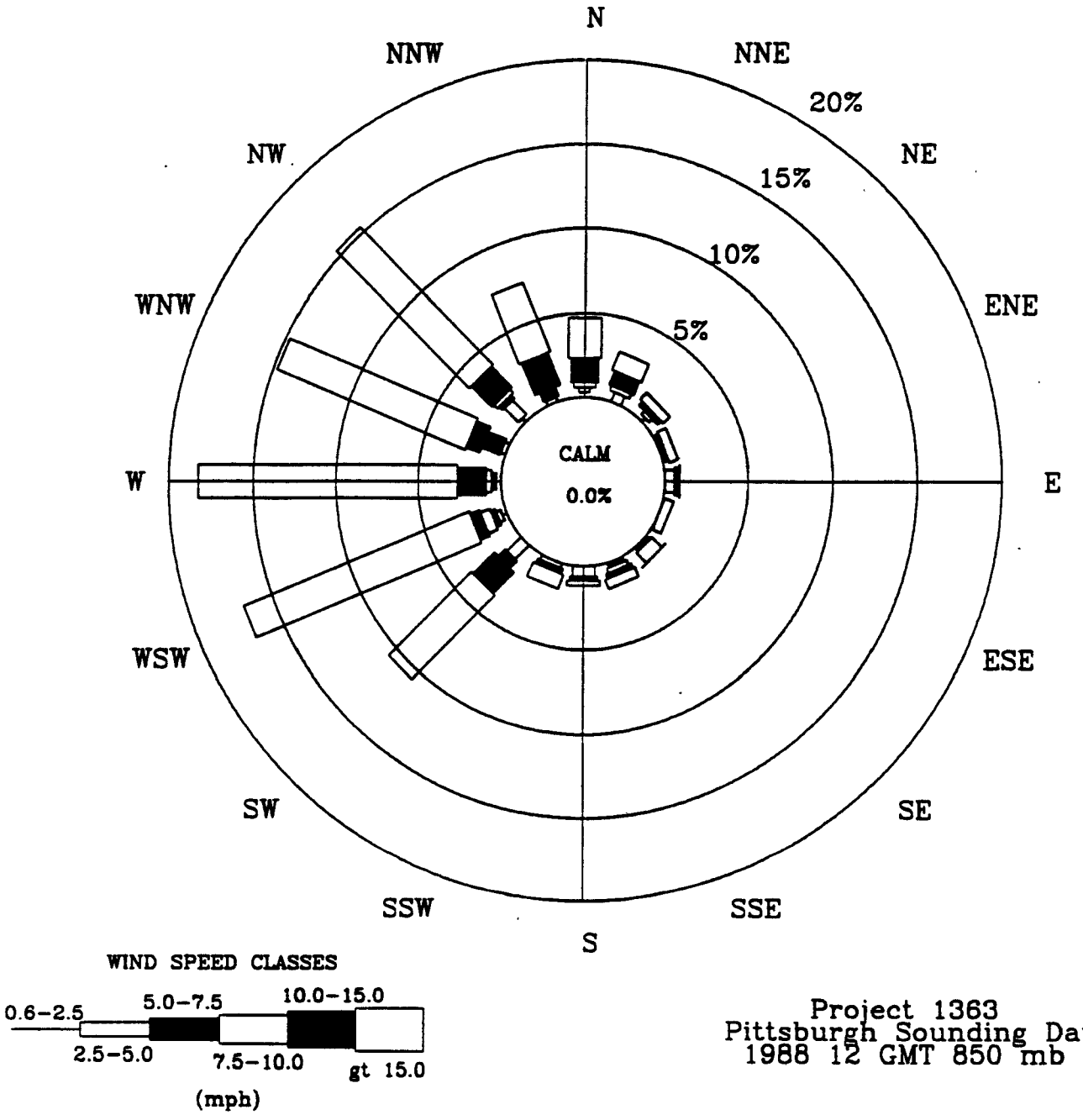

Figure IV-2-36. Annual wind rose for Pittsburgh 12 GMT sounding data, 850 mb level, 1988.

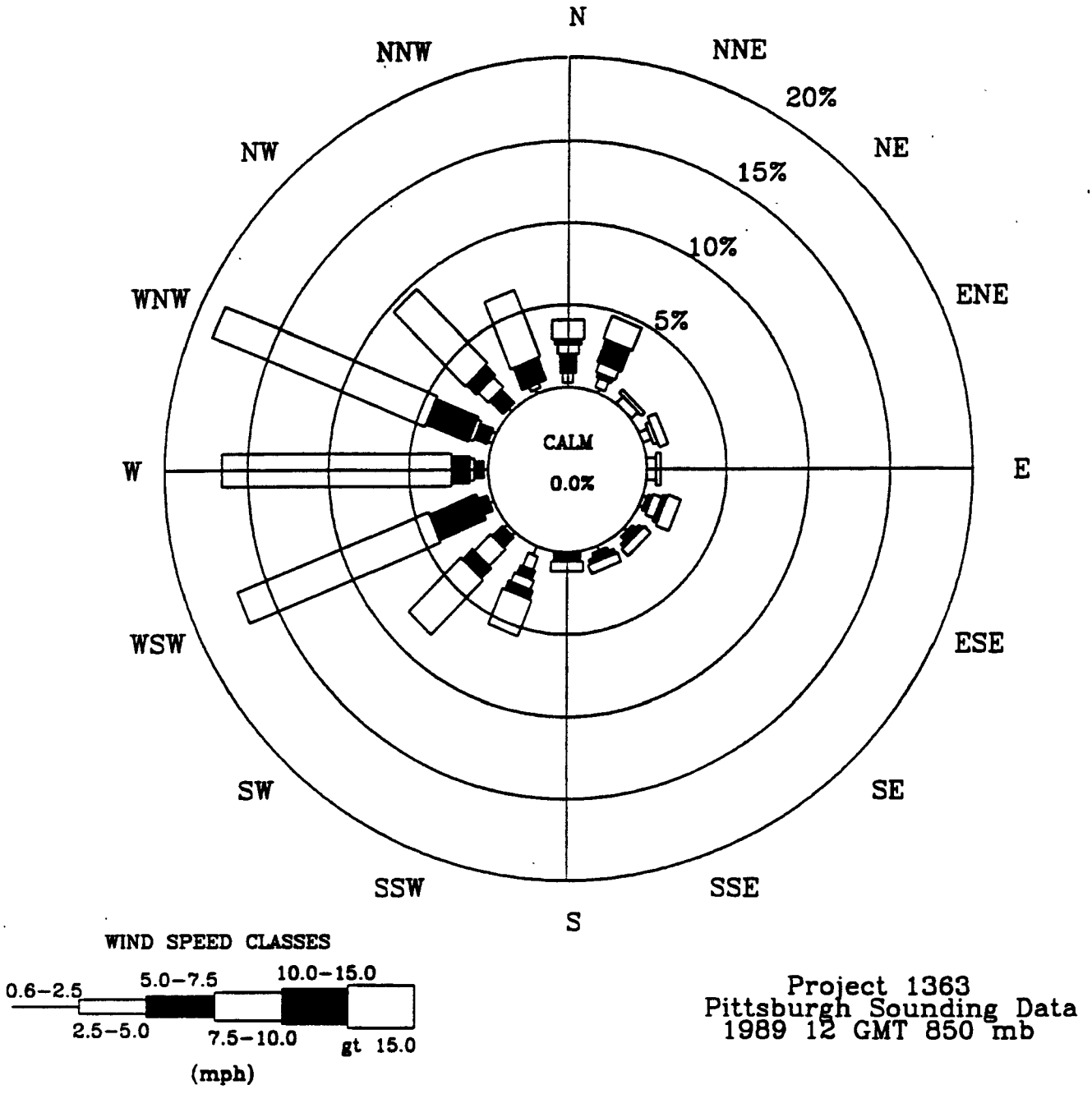

Figure IV-2-37. Annual wind rose for Pittsburgh 12 GMT sounding data, 850 mb level, 1989.

APPENDIX IV-3

ISC-COMPDEP Model Output Files
(Partial Listings Showing Model Inputs)

Main Incinerator Stack - Base Case Simulations

BASEA.PRT - Mass-weighted pollutant distribution.

BASEB.PRT - Surface area-weighted pollutant distribution.

BASEC.PRT - Vapor pollutant.

Fugitive Emission Sources

TRUCKWSH.OUT - Truck wash

WASTE.OUT - Organic waste tank farm stacks

TANK.OUT - Open wastewater tank

CADSTACK.OUT - Carbon adsorption bed stack

ASHx_y.OUT - Ash Handling stack

x = A for mass-weighted pollutant distribution
B for surface area-weighted pollutant distribution
C for vapor pollutant

y = C for concentration output
W for wet flux output
D for dry flux output
2 for total (wet+dry) flux output

(e.g., ASHA_W.OUT is the mass-weighted distribution run generating wet flux output).

```
 *** ISCOMDEP VERSION 94227 ***     ***  WTI stack modeling, EPA Region V, Project 1363, Base Case          ***          08/25/94
                                   ***  One source; 936 receptors up to 50KM away; Mass wt.               ***          17:37:03
                                                                                                                       PAGE    1
 *** MODELING OPTIONS USED:  CONC   RURAL  ELEV          DFAULT                                                 DRYDPL WETDPL

                                          ***     MODEL SETUP OPTIONS SUMMARY       ***
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

**Intermediate Terrain Processing is Selected

**Model Is Setup For Calculation of Average CONCentration Values.

  --  SCAVENGING/DEPOSITION LOGIC --
**Model Uses DRY DEPLETION.  DDPLETE =  T
**Model Uses WET DEPLETION.  WDPLETE =  T
**SCAVENGING Data Provided.  LMGAS,LWPART =  F T
**Model Uses GRIDDED TERRAIN Data for Depletion Calculations

**Model Uses RURAL Dispersion.

**Model Uses Regulatory DEFAULT Options:
          1. Final Plume Rise.
          2. Stack-tip Downwash.
          3. Buoyancy-induced Dispersion.
          4. Use Calms Processing Routine.
          5. Not Use Missing Data Processing Routine.
          6. Default Wind Profile Exponents.
          7. Default Vertical Potential Temperature Gradients.
          8. 'Upper Bound' Values for Supersquat Buildings.
          9. No Exponential Decay for RURAL Mode

**Model Accepts Receptors on ELEV Terrain.

**Model Assumes No FLAGPOLE Receptor Heights.

**Model Accepting Temperature Profile Data.
  Number of Levels :          3
    (m AGL)          30.0000
    (m AGL)          45.7000
    (m AGL)          152.400

**Model Accepting Wind Profile Data.
  Number of Levels :          5
    (m AGL)          30.0000
    (m AGL)          45.7000
    (m AGL)          80.8000
    (m AGL)          111.300
    (m AGL)          152.400

**Model Calculates  1 Short Term Average(s) of:   1-HR
    and Calculates PERIOD Averages

**This Run Includes:    1 Source(s);      1 Source Group(s); and    936 Receptor(s)

**The Model Assumes A Pollutant Type of:  LEAD

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
         Model Outputs Tables of PERIOD Averages by Receptor
         Model Outputs Tables of Highest Short Term Values by Receptor (RECTABLE Keyword)
         Model Outputs Tables of Overall Maximum Short Term Values (MAXTABLE Keyword)
         Model Outputs External File(s) of High Values for Plotting (PLOTFILE Keyword)

**NOTE:  The Following Flags May Appear Following CONC Values:  c for Calm Hours
                                                                m for Missing Hours
                                                                b for Both Calm and Missing Hours

**Misc. Inputs:  Anem. Hgt. (m) =    30.00 ;    Decay Coef. =   0.0000     ;    Rot. Angle =     0.0
                 Emission Units = GRAMS/SEC                                ;  Emission Rate Unit Factor =   0.10000E+07
                 Output Units   = MICROGRAMS/M**3

**Input Runstream File: basea.inc                                  ;  **Output Print File: basea.con
**Detailed Error/Message File:   ERRORS.OUT
```

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** POINT SOURCE DATA ***

SOURCE ID	NUMBER PART. CATS.	EMISSION RATE (GRAMS/SEC)	X (METERS)	Y (METERS)	BASE ELEV. (METERS)	STACK HEIGHT (METERS)	STACK TEMP. (DEG.K)	STACK EXIT VEL. (M/SEC)	STACK DIAMETER (METERS)	BUILDING EXISTS	EMISSION RATE SCALAR VARY BY
WTISTACK	10	0.10000E+01	0.0	0.0	212.1	45.70	367.00	17.74	1.83	YES	

```
*** ISCOMDEP VERSION 94227 ***     *** WTI stack modeling, EPA Region V, Project 1363, Base Case          ***        08/25/94
                                   *** One source; 936 receptors up to 50KM away; Mass wt.               ***        17:37:03
                                                                                                                    PAGE   3
*** MODELING OPTIONS USED:  CONC   RURAL  ELEV          DFAULT                                          DRYDPL WETDPL
```

*** SOURCE IDs DEFINING SOURCE GROUPS ***

GROUP ID	SOURCE IDs
ALL	WTISTACK,

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/25/94
*** One source; 936 receptors up to 50KM away; Mass wt. *** 17:37:03
PAGE 4

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** SOURCE PARTICULATE/GAS DATA ***

*** SOURCE ID = WTISTACK; SOURCE TYPE = POINT ***

MASS FRACTION =
0.04260, 0.08510, 0.17020, 0.19150, 0.19150, 0.11910, 0.10000, 0.05000, 0.04000, 0.01000,

PARTICLE DIAMETER (MICRONS) =
2.97000, 1.89000, 0.93000, 0.55000, 0.40000, 0.27000, 0.18000, 0.12000, 0.06200, 0.03000,

PARTICLE DENSITY (G/CM**3) =
1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000,

SCAV COEF [LIQ] 1/(S-MM/HR)=
0.21E-03,0.14E-03,0.50E-04,0.50E-04,0.60E-04,0.90E-04,0.13E-03,0.15E-03,0.20E-03,0.22E-03,

SCAV COEF [ICE] 1/(S-MM/HR)=
0.70E-04,0.47E-04,0.17E-04,0.17E-04,0.20E-04,0.30E-04,0.43E-04,0.50E-04,0.67E-04,0.73E-04,

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/25/94
*** One source; 936 receptors up to 50KM away; Mass wt. *** 17:37:03
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** DIRECTION SPECIFIC BUILDING DIMENSIONS ***

SOURCE ID: WTISTACK

IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK
1	29.1,	26.9,	0	2	29.1,	24.7,	0	3	29.1,	21.8,	0	4	25.8,	27.6,	0	5	24.4,	27.0,	0	6	24.4,	24.6,	0
7	24.4,	26.0,	0	8	29.1,	22.6,	0	9	29.1,	25.8,	0	10	29.1,	28.8,	0	11	29.1,	30.9,	0	12	29.1,	32.1,	0
13	29.1,	32.3,	0	14	29.1,	31.8,	0	15	29.1,	30.9,	0	16	29.1,	29.6,	0	17	29.1,	29.3,	0	18	29.1,	28.2,	0
19	29.1,	26.9,	0	20	29.1,	24.7,	0	21	29.1,	21.8,	0	22	25.8,	27.6,	0	23	25.8,	26.1,	0	24	25.8,	23.8,	0
25	24.4,	26.0,	0	26	25.8,	24.8,	0	27	29.1,	25.8,	0	28	29.1,	28.8,	0	29	29.1,	30.9,	0	30	29.1,	32.1,	0
31	29.1,	32.3,	0	32	29.1,	31.8,	0	33	29.1,	30.9,	0	34	29.1,	29.6,	0	35	29.1,	29.3,	0	36	29.1,	28.2,	0

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/25/94
*** One source; 936 receptors up to 50KM away; Mass wt. *** 17:37:03
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(17.4,	98.5,	213.4,	0.0);	(34.7,	197.0,	225.6,	0.0);
(52.1,	295.4,	225.6,	0.0);	(69.5,	393.9,	225.6,	0.0);
(86.8,	492.4,	225.6,	0.0);	(104.2,	590.9,	225.6,	0.0);
(121.6,	689.4,	243.8,	0.0);	(138.9,	787.8,	256.0,	0.0);
(156.3,	886.3,	280.4,	0.0);	(173.6,	984.8,	286.5,	0.0);
(217.1,	1231.0,	353.6,	0.0);	(260.5,	1477.2,	353.6,	0.0);
(303.9,	1723.4,	310.9,	0.0);	(347.3,	1969.6,	347.5,	0.0);
(390.7,	2215.8,	353.6,	0.0);	(434.1,	2462.0,	359.7,	0.0);
(520.9,	2954.4,	347.5,	0.0);	(694.6,	3939.2,	341.4,	0.0);
(868.2,	4924.0,	341.4,	0.0);	(1302.4,	7386.1,	365.8,	0.0);
(1736.5,	9848.1,	360.0,	0.0);	(2604.7,	14772.1,	340.0,	0.0);
(3473.0,	19696.2,	340.0,	0.0);	(5209.4,	29544.2,	360.0,	0.0);
(6945.9,	39392.3,	350.0,	0.0);	(8682.4,	49240.4,	360.0,	0.0);
(34.2,	94.0,	213.4,	0.0);	(68.4,	187.9,	225.6,	0.0);
(102.6,	281.9,	225.6,	0.0);	(136.8,	375.9,	225.6,	0.0);
(171.0,	469.8,	225.6,	0.0);	(205.2,	563.8,	225.6,	0.0);
(239.4,	657.8,	237.7,	0.0);	(273.6,	751.8,	243.8,	0.0);
(307.8,	845.7,	256.0,	0.0);	(342.0,	939.7,	286.5,	0.0);
(427.5,	1174.6,	329.2,	0.0);	(513.0,	1409.5,	347.5,	0.0);
(598.5,	1644.5,	335.3,	0.0);	(684.0,	1879.4,	347.5,	0.0);
(769.5,	2114.3,	353.6,	0.0);	(855.1,	2349.2,	359.7,	0.0);
(1026.1,	2819.1,	362.4,	0.0);	(1368.1,	3758.8,	329.2,	0.0);
(1710.1,	4698.5,	359.7,	0.0);	(2565.2,	7047.7,	369.7,	0.0);
(3420.2,	9396.9,	385.9,	0.0);	(5130.3,	14095.4,	340.0,	0.0);
(6840.4,	18793.9,	340.0,	0.0);	(10260.6,	28190.8,	360.0,	0.0);
(13680.8,	37587.7,	380.0,	0.0);	(17101.0,	46984.6,	390.0,	0.0);
(50.0,	86.6,	213.4,	0.0);	(100.0,	173.2,	219.5,	0.0);
(150.0,	259.8,	225.6,	0.0);	(200.0,	346.4,	225.6,	0.0);
(250.0,	433.0,	225.6,	0.0);	(300.0,	519.6,	225.6,	0.0);
(350.0,	606.2,	225.6,	0.0);	(400.0,	692.8,	231.6,	0.0);
(450.0,	779.4,	243.8,	0.0);	(500.0,	866.0,	262.1,	0.0);
(625.0,	1082.5,	225.6,	0.0);	(750.0,	1299.0,	347.5,	0.0);
(875.0,	1515.5,	359.7,	0.0);	(1000.0,	1732.1,	353.6,	0.0);
(1125.0,	1948.6,	353.6,	0.0);	(1250.0,	2165.1,	329.2,	0.0);
(1500.0,	2598.1,	323.1,	0.0);	(2000.0,	3464.1,	361.2,	0.0);
(2500.0,	4330.1,	366.7,	0.0);	(3750.0,	6495.2,	378.0,	0.0);
(5000.0,	8660.3,	396.2,	0.0);	(7500.0,	12990.4,	320.0,	0.0);
(10000.0,	17320.5,	360.0,	0.0);	(15000.0,	25980.8,	380.0,	0.0);
(20000.0,	34641.0,	370.0,	0.0);	(25000.0,	43301.3,	400.0,	0.0);
(64.3,	76.6,	213.4,	0.0);	(128.6,	153.2,	213.4,	0.0);
(192.8,	229.8,	225.6,	0.0);	(257.1,	306.4,	225.6,	0.0);
(321.4,	383.0,	225.6,	0.0);	(385.7,	459.6,	225.6,	0.0);
(450.0,	536.2,	225.6,	0.0);	(514.2,	612.8,	225.6,	0.0);
(578.5,	689.4,	225.6,	0.0);	(642.8,	766.0,	243.8,	0.0);
(803.5,	957.6,	280.4,	0.0);	(964.2,	1149.1,	353.6,	0.0);

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(1124.9,	1340.6,	361.5,	0.0);	(1285.6,	1532.1,	353.6,	0.0);
(1446.3,	1723.6,	353.6,	0.0);	(1607.0,	1915.1,	353.6,	0.0);
(1928.4,	2298.1,	335.3,	0.0);	(2571.2,	3064.2,	353.9,	0.0);
(3213.9,	3830.2,	353.0,	0.0);	(4820.9,	5745.3,	378.0,	0.0);
(6427.9,	7660.4,	398.4,	0.0);	(9641.8,	11490.7,	376.0,	0.0);
(12855.8,	15320.9,	380.0,	0.0);	(19283.6,	22981.3,	360.0,	0.0);
(25711.5,	30641.8,	420.0,	0.0);	(32139.4,	38302.2,	420.0,	0.0);
(76.6,	64.3,	213.4,	0.0);	(153.2,	128.6,	207.3,	0.0);
(229.8,	192.8,	213.4,	0.0);	(306.4,	257.1,	219.5,	0.0);
(383.0,	321.4,	219.5,	0.0);	(459.6,	385.7,	219.5,	0.0);
(536.2,	450.0,	219.5,	0.0);	(612.8,	514.2,	219.5,	0.0);
(689.4,	578.5,	225.6,	0.0);	(766.0,	642.8,	219.5,	0.0);
(957.6,	803.5,	219.5,	0.0);	(1149.1,	964.2,	323.1,	0.0);
(1340.6,	1124.9,	353.6,	0.0);	(1532.1,	1285.6,	353.6,	0.0);
(1723.6,	1446.3,	335.3,	0.0);	(1915.1,	1607.0,	347.5,	0.0);
(2298.1,	1928.4,	347.5,	0.0);	(3064.2,	2571.2,	341.4,	0.0);
(3830.2,	3213.9,	335.3,	0.0);	(5745.3,	4820.9,	373.1,	0.0);
(7660.4,	6427.9,	396.2,	0.0);	(11490.7,	9641.8,	360.0,	0.0);
(15320.9,	12855.8,	380.0,	0.0);	(22981.3,	19283.6,	380.0,	0.0);
(30641.8,	25711.5,	420.0,	0.0);	(38302.2,	32139.4,	420.0,	0.0);
(86.6,	50.0,	213.4,	0.0);	(173.2,	100.0,	207.3,	0.0);
(259.8,	150.0,	207.3,	0.0);	(346.4,	200.0,	201.2,	0.0);
(433.0,	250.0,	207.3,	0.0);	(519.6,	300.0,	213.4,	0.0);
(606.2,	350.0,	213.4,	0.0);	(692.8,	400.0,	213.4,	0.0);
(779.4,	450.0,	213.4,	0.0);	(866.0,	500.0,	219.5,	0.0);
(1082.5,	625.0,	225.6,	0.0);	(1299.0,	750.0,	219.5,	0.0);
(1515.5,	875.0,	243.8,	0.0);	(1732.1,	1000.0,	292.6,	0.0);
(1948.6,	1125.0,	310.9,	0.0);	(2165.1,	1250.0,	323.1,	0.0);
(2598.1,	1500.0,	317.0,	0.0);	(3464.1,	2000.0,	323.1,	0.0);
(4330.1,	2500.0,	359.7,	0.0);	(6495.2,	3750.0,	378.9,	0.0);
(8660.3,	5000.0,	408.7,	0.0);	(12990.4,	7500.0,	380.0,	0.0);
(17320.5,	10000.0,	360.0,	0.0);	(25980.8,	15000.0,	380.0,	0.0);
(34641.0,	20000.0,	380.0,	0.0);	(43301.3,	25000.0,	420.0,	0.0);
(94.0,	34.2,	207.3,	0.0);	(187.9,	68.4,	201.2,	0.0);
(281.9,	102.6,	202.7,	0.0);	(375.9,	136.8,	202.7,	0.0);
(469.8,	171.0,	207.3,	0.0);	(563.8,	205.2,	207.3,	0.0);
(657.8,	239.4,	207.3,	0.0);	(751.8,	273.6,	213.4,	0.0);
(845.7,	307.8,	213.4,	0.0);	(939.7,	342.0,	213.4,	0.0);
(1174.6,	427.5,	213.4,	0.0);	(1409.5,	513.0,	213.4,	0.0);
(1644.5,	598.5,	213.4,	0.0);	(1879.4,	684.0,	213.4,	0.0);
(2114.3,	769.5,	213.4,	0.0);	(2349.2,	855.1,	231.6,	0.0);
(2819.1,	1026.1,	231.6,	0.0);	(3758.8,	1368.1,	310.9,	0.0);
(4698.5,	1710.1,	384.0,	0.0);	(7047.7,	2565.2,	384.0,	0.0);
(9396.9,	3420.2,	370.3,	0.0);	(14095.4,	5130.3,	360.0,	0.0);
(18793.9,	6840.4,	380.0,	0.0);	(28190.8,	10260.6,	400.0,	0.0);

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(37587.7,	13680.8,	360.0,	0.0);	(46984.6,	17101.0,	400.0,	0.0);
(98.5,	17.4,	207.3,	0.0);	(197.0,	34.7,	202.7,	0.0);
(295.4,	52.1,	202.7,	0.0);	(393.9,	69.5,	202.7,	0.0);
(492.4,	86.8,	202.7,	0.0);	(590.9,	104.2,	202.7,	0.0);
(689.4,	121.6,	202.7,	0.0);	(787.8,	138.9,	202.7,	0.0);
(886.3,	156.3,	202.7,	0.0);	(984.8,	173.6,	202.7,	0.0);
(1231.0,	217.1,	202.7,	0.0);	(1477.2,	260.5,	202.7,	0.0);
(1723.4,	303.9,	213.4,	0.0);	(1969.6,	347.3,	207.3,	0.0);
(2215.8,	390.7,	207.3,	0.0);	(2462.0,	434.1,	231.6,	0.0);
(2954.4,	520.9,	304.8,	0.0);	(3939.2,	694.6,	346.6,	0.0);
(4924.0,	868.2,	365.8,	0.0);	(7386.1,	1302.4,	384.0,	0.0);
(9848.1,	1736.5,	371.9,	0.0);	(14772.1,	2604.7,	320.0,	0.0);
(19696.2,	3473.0,	360.0,	0.0);	(29544.2,	5209.4,	380.0,	0.0);
(39392.3,	6945.9,	380.0,	0.0);	(49240.4,	8682.4,	400.0,	0.0);
(100.0,	0.0,	207.3,	0.0);	(200.0,	0.0,	202.7,	0.0);
(300.0,	0.0,	202.7,	0.0);	(400.0,	0.0,	202.7,	0.0);
(500.0,	0.0,	202.7,	0.0);	(600.0,	0.0,	202.7,	0.0);
(700.0,	0.0,	202.7,	0.0);	(800.0,	0.0,	202.7,	0.0);
(900.0,	0.0,	202.7,	0.0);	(1000.0,	0.0,	202.7,	0.0);
(1250.0,	0.0,	243.8,	0.0);	(1500.0,	0.0,	341.4,	0.0);
(1750.0,	0.0,	323.1,	0.0);	(2000.0,	0.0,	341.4,	0.0);
(2250.0,	0.0,	304.8,	0.0);	(2500.0,	0.0,	292.6,	0.0);
(3000.0,	0.0,	310.9,	0.0);	(4000.0,	0.0,	359.7,	0.0);
(5000.0,	0.0,	402.3,	0.0);	(7500.0,	0.0,	347.5,	0.0);
(10000.0,	0.0,	380.1,	0.0);	(15000.0,	0.0,	360.0,	0.0);
(20000.0,	0.0,	360.0,	0.0);	(30000.0,	0.0,	380.0,	0.0);
(40000.0,	0.0,	400.0,	0.0);	(50000.0,	0.0,	360.0,	0.0);
(98.5,	-17.4,	207.3,	0.0);	(197.0,	-34.7,	202.7,	0.0);
(295.4,	-52.1,	202.7,	0.0);	(393.9,	-69.5,	202.7,	0.0);
(492.4,	-86.8,	202.7,	0.0);	(590.9,	-104.2,	202.7,	0.0);
(689.4,	-121.6,	202.7,	0.0);	(787.8,	-138.9,	219.5,	0.0);
(886.3,	-156.3,	225.6,	0.0);	(984.8,	-173.6,	329.2,	0.0);
(1231.0,	-217.1,	347.5,	0.0);	(1477.2,	-260.5,	353.6,	0.0);
(1723.4,	-303.9,	323.1,	0.0);	(1969.6,	-347.3,	341.4,	0.0);
(2215.8,	-390.7,	341.4,	0.0);	(2462.0,	-434.1,	323.1,	0.0);
(2954.4,	-520.9,	347.5,	0.0);	(3939.2,	-694.6,	353.6,	0.0);
(4924.0,	-868.2,	386.5,	0.0);	(7386.1,	-1302.4,	353.6,	0.0);
(9848.1,	-1736.5,	360.0,	0.0);	(14772.1,	-2604.7,	340.0,	0.0);
(19696.2,	-3473.0,	380.0,	0.0);	(29544.2,	-5209.4,	380.0,	0.0);
(39392.3,	-6945.9,	380.0,	0.0);	(49240.4,	-8682.4,	400.0,	0.0);
(94.0,	-34.2,	207.3,	0.0);	(187.9,	-68.4,	202.7,	0.0);
(281.9,	-102.6,	202.7,	0.0);	(375.9,	-136.8,	202.7,	0.0);
(469.8,	-171.0,	202.7,	0.0);	(563.8,	-205.2,	213.4,	0.0);
(657.8,	-239.4,	256.0,	0.0);	(751.8,	-273.6,	298.7,	0.0);
(845.7,	-307.8,	286.5,	0.0);	(939.7,	-342.0,	323.1,	0.0);

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/25/94
*** One source; 936 receptors up to 50KM away; Mass wt. *** 17:37:03
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(1174.6,	-427.5,	347.5,	0.0);	(1409.5,	-513.0,	347.5,	0.0);
(1644.5,	-598.5,	310.9,	0.0);	(1879.4,	-684.0,	353.6,	0.0);
(2114.3,	-769.5,	350.2,	0.0);	(2349.2,	-855.1,	347.5,	0.0);
(2819.1,	-1026.1,	347.5,	0.0);	(3758.8,	-1368.1,	345.9,	0.0);
(4698.5,	-1710.1,	371.9,	0.0);	(7047.7,	-2565.2,	365.8,	0.0);
(9396.9,	-3420.2,	408.4,	0.0);	(14095.4,	-5130.3,	380.0,	0.0);
(18793.9,	-6840.4,	360.0,	0.0);	(28190.8,	-10260.6,	360.0,	0.0);
(37587.7,	-13680.8,	360.0,	0.0);	(46984.6,	-17101.0,	360.0,	0.0);
(86.6,	-50.0,	207.3,	0.0);	(173.2,	-100.0,	202.7,	0.0);
(259.8,	-150.0,	202.7,	0.0);	(346.4,	-200.0,	202.7,	0.0);
(433.0,	-250.0,	213.4,	0.0);	(519.6,	-300.0,	268.2,	0.0);
(606.2,	-350.0,	317.0,	0.0);	(692.8,	-400.0,	347.5,	0.0);
(779.4,	-450.0,	353.6,	0.0);	(866.0,	-500.0,	347.5,	0.0);
(1082.5,	-625.0,	310.9,	0.0);	(1299.0,	-750.0,	359.7,	0.0);
(1515.5,	-875.0,	335.3,	0.0);	(1732.1,	-1000.0,	359.7,	0.0);
(1948.6,	-1125.0,	359.7,	0.0);	(2165.1,	-1250.0,	347.5,	0.0);
(2598.1,	-1500.0,	365.8,	0.0);	(3464.1,	-2000.0,	359.7,	0.0);
(4330.1,	-2500.0,	353.6,	0.0);	(6495.2,	-3750.0,	402.3,	0.0);
(8660.3,	-5000.0,	396.2,	0.0);	(12990.4,	-7500.0,	380.0,	0.0);
(17320.5,	-10000.0,	380.0,	0.0);	(25980.8,	-15000.0,	360.0,	0.0);
(34641.0,	-20000.0,	360.0,	0.0);	(43301.3,	-25000.0,	360.0,	0.0);
(76.6,	-64.3,	207.3,	0.0);	(153.2,	-128.6,	202.7,	0.0);
(229.8,	-192.8,	202.7,	0.0);	(306.4,	-257.1,	202.7,	0.0);
(383.0,	-321.4,	243.8,	0.0);	(459.6,	-385.7,	298.7,	0.0);
(536.2,	-450.0,	323.1,	0.0);	(612.8,	-514.2,	353.6,	0.0);
(689.4,	-578.5,	353.6,	0.0);	(766.0,	-642.8,	353.6,	0.0);
(957.6,	-803.5,	353.6,	0.0);	(1149.1,	-964.2,	359.7,	0.0);
(1340.6,	-1124.9,	341.4,	0.0);	(1532.1,	-1285.6,	353.6,	0.0);
(1723.6,	-1446.3,	353.6,	0.0);	(1915.1,	-1607.0,	341.4,	0.0);
(2298.1,	-1928.4,	359.7,	0.0);	(3064.2,	-2571.2,	359.7,	0.0);
(3830.2,	-3213.9,	359.7,	0.0);	(5745.3,	-4820.9,	408.4,	0.0);
(7660.4,	-6427.9,	408.4,	0.0);	(11490.7,	-9641.8,	380.0,	0.0);
(15320.9,	-12855.8,	360.0,	0.0);	(22981.3,	-19283.6,	360.0,	0.0);
(30641.8,	-25711.5,	360.0,	0.0);	(38302.2,	-32139.4,	360.0,	0.0);
(64.3,	-76.6,	207.3,	0.0);	(128.6,	-153.2,	202.7,	0.0);
(192.8,	-229.8,	202.7,	0.0);	(257.1,	-306.4,	202.7,	0.0);
(321.4,	-383.0,	268.2,	0.0);	(385.7,	-459.6,	304.8,	0.0);
(450.0,	-536.2,	310.9,	0.0);	(514.2,	-612.8,	323.1,	0.0);
(578.5,	-689.4,	329.2,	0.0);	(642.8,	-766.0,	323.1,	0.0);
(803.5,	-957.6,	347.5,	0.0);	(964.2,	-1149.1,	359.7,	0.0);
(1124.9,	-1340.6,	329.2,	0.0);	(1285.6,	-1532.1,	359.7,	0.0);
(1446.3,	-1723.6,	353.6,	0.0);	(1607.0,	-1915.1,	359.7,	0.0);
(1928.4,	-2298.1,	408.4,	0.0);	(2571.2,	-3064.2,	420.6,	0.0);
(3213.9,	-3830.2,	371.9,	0.0);	(4820.9,	-5745.3,	392.0,	0.0);
(6427.9,	-7660.4,	390.1,	0.0);	(9641.8,	-11490.7,	340.0,	0.0);

*** ISCOMMSP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/25/94
*** One source; 936 receptors up to 50KM away; Mass wt. *** 17:37:03
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(12855.8,	-15320.9,	380.0,	0.0);	(19283.6,	-22981.3,	400.0,	0.0);
(25711.5,	-30641.8,	400.0,	0.0);	(32139.4,	-38302.2,	380.0,	0.0);
(50.0,	-86.6,	207.3,	0.0);	(100.0,	-173.2,	202.7,	0.0);
(150.0,	-259.8,	202.7,	0.0);	(200.0,	-346.4,	213.4,	0.0);
(250.0,	-433.0,	268.2,	0.0);	(300.0,	-519.6,	298.7,	0.0);
(350.0,	-606.2,	310.9,	0.0);	(400.0,	-692.8,	323.1,	0.0);
(450.0,	-779.4,	323.1,	0.0);	(500.0,	-866.0,	329.2,	0.0);
(625.0,	-1082.5,	298.7,	0.0);	(750.0,	-1299.0,	341.4,	0.0);
(875.0,	-1515.5,	341.4,	0.0);	(1000.0,	-1732.1,	359.7,	0.0);
(1125.0,	-1948.6,	365.8,	0.0);	(1250.0,	-2165.1,	371.9,	0.0);
(1500.0,	-2598.1,	408.4,	0.0);	(2000.0,	-3464.1,	420.6,	0.0);
(2500.0,	-4330.1,	408.4,	0.0);	(3750.0,	-6495.2,	408.4,	0.0);
(5000.0,	-8660.3,	396.2,	0.0);	(7500.0,	-12990.4,	340.0,	0.0);
(10000.0,	-17320.5,	360.0,	0.0);	(15000.0,	-25980.8,	420.0,	0.0);
(20000.0,	-34641.0,	400.0,	0.0);	(25000.0,	-43301.3,	400.0,	0.0);
(34.2,	-94.0,	207.3,	0.0);	(68.4,	-187.9,	202.7,	0.0);
(102.6,	-281.9,	202.7,	0.0);	(136.8,	-375.9,	207.3,	0.0);
(171.0,	-469.8,	268.2,	0.0);	(205.2,	-563.8,	292.6,	0.0);
(239.4,	-657.8,	304.8,	0.0);	(273.6,	-751.8,	304.8,	0.0);
(307.8,	-845.7,	286.5,	0.0);	(342.0,	-939.7,	286.5,	0.0);
(427.5,	-1174.6,	304.8,	0.0);	(513.0,	-1409.5,	310.9,	0.0);
(598.5,	-1644.5,	304.8,	0.0);	(684.0,	-1879.4,	335.3,	0.0);
(769.5,	-2114.3,	359.7,	0.0);	(855.1,	-2349.2,	378.0,	0.0);
(1026.1,	-2819.1,	396.2,	0.0);	(1368.1,	-3758.8,	402.3,	0.0);
(1710.1,	-4698.5,	411.5,	0.0);	(2565.2,	-7047.7,	402.3,	0.0);
(3420.2,	-9396.9,	408.1,	0.0);	(5130.3,	-14095.4,	360.0,	0.0);
(6840.4,	-18793.9,	360.0,	0.0);	(10260.6,	-28190.8,	420.0,	0.0);
(13680.8,	-37587.7,	400.0,	0.0);	(17101.0,	-46984.6,	420.0,	0.0);
(17.4,	-98.5,	207.3,	0.0);	(34.7,	-197.0,	202.7,	0.0);
(52.1,	-295.4,	202.7,	0.0);	(69.5,	-393.9,	202.7,	0.0);
(86.8,	-492.4,	249.9,	0.0);	(104.2,	-590.9,	286.5,	0.0);
(121.6,	-689.4,	280.4,	0.0);	(138.9,	-787.8,	274.3,	0.0);
(156.3,	-886.3,	286.5,	0.0);	(173.6,	-984.8,	286.5,	0.0);
(217.1,	-1231.0,	298.7,	0.0);	(260.5,	-1477.2,	304.8,	0.0);
(303.9,	-1723.4,	304.8,	0.0);	(347.3,	-1969.6,	298.7,	0.0);
(390.7,	-2215.8,	298.7,	0.0);	(434.1,	-2462.0,	365.8,	0.0);
(520.9,	-2954.4,	402.3,	0.0);	(694.6,	-3939.2,	390.1,	0.0);
(868.2,	-4924.0,	414.5,	0.0);	(1302.4,	-7386.1,	408.4,	0.0);
(1736.5,	-9848.1,	398.1,	0.0);	(2604.7,	-14772.1,	380.0,	0.0);
(3473.0,	-19696.2,	360.0,	0.0);	(5209.4,	-29544.2,	400.0,	0.0);
(6945.9,	-39392.3,	400.0,	0.0);	(8682.4,	-49240.4,	400.0,	0.0);
(0.0,	-100.0,	207.3,	0.0);	(0.0,	-200.0,	202.7,	0.0);
(0.0,	-300.0,	202.7,	0.0);	(0.0,	-400.0,	202.7,	0.0);
(0.0,	-500.0,	219.5,	0.0);	(0.0,	-600.0,	274.3,	0.0);
(0.0,	-700.0,	280.4,	0.0);	(0.0,	-800.0,	274.3,	0.0);

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/25/94
*** One source; 936 receptors up to 50KM away; Mass wt. *** 17:37:03
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

0.0,	-900.0,	243.8,	0.0);	0.0,	-1000.0,	298.7,	0.0);
0.0,	-1250.0,	304.8,	0.0);	0.0,	-1500.0,	304.8,	0.0);
0.0,	-1750.0,	304.8,	0.0);	0.0,	-2000.0,	292.6,	0.0);
0.0,	-2250.0,	298.7,	0.0);	0.0,	-2500.0,	365.8,	0.0);
0.0,	-3000.0,	406.3,	0.0);	0.0,	-4000.0,	402.3,	0.0);
0.0,	-5000.0,	396.2,	0.0);	0.0,	-7500.0,	390.1,	0.0);
0.0,	-10000.0,	396.2,	0.0);	0.0,	-15000.0,	380.0,	0.0);
0.0,	-20000.0,	360.0,	0.0);	0.0,	-30000.0,	380.0,	0.0);
0.0,	-40000.0,	380.0,	0.0);	0.0,	-50000.0,	400.0,	0.0);
-17.4,	-98.5,	207.3,	0.0);	-34.7,	-197.0,	202.7,	0.0);
-52.1,	-295.4,	202.7,	0.0);	-69.5,	-393.9,	202.7,	0.0);
-86.8,	-492.4,	202.7,	0.0);	-104.2,	-590.9,	225.6,	0.0);
-121.6,	-689.4,	274.3,	0.0);	-138.9,	-787.8,	274.3,	0.0);
-156.3,	-886.3,	237.7,	0.0);	-173.6,	-984.8,	292.6,	0.0);
-217.1,	-1231.0,	304.8,	0.0);	-260.5,	-1477.2,	286.5,	0.0);
-303.9,	-1723.4,	292.6,	0.0);	-347.3,	-1969.6,	280.4,	0.0);
-390.7,	-2215.8,	304.8,	0.0);	-434.1,	-2462.0,	353.6,	0.0);
-520.9,	-2954.4,	384.0,	0.0);	-694.6,	-3939.2,	396.2,	0.0);
-868.2,	-4924.0,	415.4,	0.0);	-1302.4,	-7386.1,	390.1,	0.0);
-1736.5,	-9848.1,	392.0,	0.0);	-2604.7,	-14772.1,	360.0,	0.0);
-3473.0,	-19696.2,	340.0,	0.0);	-5209.4,	-29544.2,	340.0,	0.0);
-6945.9,	-39392.3,	360.0,	0.0);	-8682.4,	-49240.4,	380.0,	0.0);
-34.2,	-94.0,	213.4,	0.0);	-68.4,	-187.9,	202.7,	0.0);
-102.6,	-281.9,	202.7,	0.0);	-136.8,	-375.9,	202.7,	0.0);
-171.0,	-469.8,	202.7,	0.0);	-205.2,	-563.8,	202.7,	0.0);
-239.4,	-657.8,	219.5,	0.0);	-273.6,	-751.8,	249.9,	0.0);
-307.8,	-845.7,	219.5,	0.0);	-342.0,	-939.7,	280.4,	0.0);
-427.5,	-1174.6,	280.4,	0.0);	-513.0,	-1409.5,	280.4,	0.0);
-598.5,	-1644.5,	280.4,	0.0);	-684.0,	-1879.4,	262.1,	0.0);
-769.5,	-2114.3,	298.7,	0.0);	-855.1,	-2349.2,	353.6,	0.0);
-1026.1,	-2819.1,	371.9,	0.0);	-1368.1,	-3758.8,	402.3,	0.0);
-1710.1,	-4698.5,	397.2,	0.0);	-2565.2,	-7047.7,	384.0,	0.0);
-3420.2,	-9396.9,	384.0,	0.0);	-5130.3,	-14095.4,	340.0,	0.0);
-6840.4,	-18793.9,	340.0,	0.0);	-10260.6,	-28190.8,	360.0,	0.0);
-13680.8,	-37587.7,	380.0,	0.0);	-17101.0,	-46984.6,	380.0,	0.0);
-50.0,	-86.6,	213.4,	0.0);	-100.0,	-173.2,	202.7,	0.0);
-150.0,	-259.8,	202.7,	0.0);	-200.0,	-346.4,	202.7,	0.0);
-250.0,	-433.0,	202.7,	0.0);	-300.0,	-519.6,	202.7,	0.0);
-350.0,	-606.2,	202.7,	0.0);	-400.0,	-692.8,	202.7,	0.0);
-450.0,	-779.4,	202.7,	0.0);	-500.0,	-866.0,	219.5,	0.0);
-625.0,	-1082.5,	219.5,	0.0);	-750.0,	-1299.0,	213.4,	0.0);
-875.0,	-1515.5,	213.4,	0.0);	-1000.0,	-1732.1,	231.6,	0.0);
-1125.0,	-1948.6,	231.6,	0.0);	-1250.0,	-2165.1,	292.6,	0.0);
-1500.0,	-2598.1,	359.7,	0.0);	-2000.0,	-3464.1,	396.2,	0.0);
-2500.0,	-4330.1,	414.5,	0.0);	-3750.0,	-6495.2,	396.2,	0.0);

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(-5000.0,	-8660.3,	392.6,	0.0);	(-7500.0,	-12990.4,	360.0,	0.0);
(-10000.0,	-17320.5,	380.0,	0.0);	(-15000.0,	-25980.8,	360.0,	0.0);
(-20000.0,	-34641.0,	360.0,	0.0);	(-25000.0,	-43301.3,	380.0,	0.0);
(-64.3,	-76.6,	213.4,	0.0);	(-128.6,	-153.2,	202.7,	0.0);
(-192.8,	-229.8,	202.7,	0.0);	(-257.1,	-306.4,	202.7,	0.0);
(-321.4,	-383.0,	202.7,	0.0);	(-385.7,	-459.6,	202.7,	0.0);
(-450.0,	-536.2,	202.7,	0.0);	(-514.2,	-612.8,	202.7,	0.0);
(-578.5,	-689.4,	202.7,	0.0);	(-642.8,	-766.0,	202.7,	0.0);
(-803.5,	-957.6,	202.7,	0.0);	(-964.2,	-1149.1,	213.4,	0.0);
(-1124.9,	-1340.6,	213.4,	0.0);	(-1285.6,	-1532.1,	213.4,	0.0);
(-1446.3,	-1723.6,	213.4,	0.0);	(-1607.0,	-1915.1,	213.4,	0.0);
(-1928.4,	-2298.1,	371.9,	0.0);	(-2571.2,	-3064.2,	378.0,	0.0);
(-3213.9,	-3830.2,	396.2,	0.0);	(-4820.9,	-5745.3,	396.2,	0.0);
(-6427.9,	-7660.4,	378.0,	0.0);	(-9641.8,	-11490.7,	349.0,	0.0);
(-12855.8,	-15320.9,	360.0,	0.0);	(-19283.6,	-22981.3,	360.0,	0.0);
(-25711.5,	-30641.8,	380.0,	0.0);	(-32139.4,	-38302.2,	360.0,	0.0);
(-76.6,	-64.3,	213.4,	0.0);	(-153.2,	-128.6,	201.2,	0.0);
(-229.8,	-192.8,	207.3,	0.0);	(-306.4,	-257.1,	207.3,	0.0);
(-383.0,	-321.4,	202.7,	0.0);	(-459.6,	-385.7,	202.7,	0.0);
(-536.2,	-450.0,	202.7,	0.0);	(-612.8,	-514.2,	202.7,	0.0);
(-689.4,	-578.5,	207.3,	0.0);	(-766.0,	-642.8,	207.3,	0.0);
(-957.6,	-803.5,	207.3,	0.0);	(-1149.1,	-964.2,	207.3,	0.0);
(-1340.6,	-1124.9,	207.3,	0.0);	(-1532.1,	-1285.6,	213.4,	0.0);
(-1723.6,	-1446.3,	213.4,	0.0);	(-1915.1,	-1607.0,	256.0,	0.0);
(-2298.1,	-1928.4,	323.1,	0.0);	(-3064.2,	-2571.2,	359.7,	0.0);
(-3830.2,	-3213.9,	384.0,	0.0);	(-5745.3,	-4820.9,	378.0,	0.0);
(-7660.4,	-6427.9,	378.0,	0.0);	(-11490.7,	-9641.8,	360.0,	0.0);
(-15320.9,	-12855.8,	380.0,	0.0);	(-22981.3,	-19283.6,	400.0,	0.0);
(-30641.8,	-25711.5,	400.0,	0.0);	(-38302.2,	-32139.4,	380.0,	0.0);
(-86.6,	-50.0,	213.4,	0.0);	(-173.2,	-100.0,	213.4,	0.0);
(-259.8,	-150.0,	213.4,	0.0);	(-346.4,	-200.0,	207.3,	0.0);
(-433.0,	-250.0,	213.4,	0.0);	(-519.6,	-300.0,	213.4,	0.0);
(-606.2,	-350.0,	213.4,	0.0);	(-692.8,	-400.0,	213.4,	0.0);
(-779.4,	-450.0,	213.4,	0.0);	(-866.0,	-500.0,	213.4,	0.0);
(-1082.5,	-625.0,	225.6,	0.0);	(-1299.0,	-750.0,	274.3,	0.0);
(-1515.5,	-875.0,	329.2,	0.0);	(-1732.1,	-1000.0,	310.9,	0.0);
(-1948.6,	-1125.0,	286.5,	0.0);	(-2165.1,	-1250.0,	256.0,	0.0);
(-2598.1,	-1500.0,	243.8,	0.0);	(-3464.1,	-2000.0,	365.8,	0.0);
(-4330.1,	-2500.0,	372.5,	0.0);	(-6495.2,	-3750.0,	378.0,	0.0);
(-8660.3,	-5000.0,	402.3,	0.0);	(-12990.4,	-7500.0,	360.0,	0.0);
(-17320.5,	-10000.0,	380.0,	0.0);	(-25980.8,	-15000.0,	380.0,	0.0);
(-34641.0,	-20000.0,	400.0,	0.0);	(-43301.3,	-25000.0,	360.0,	0.0);
(-94.0,	-34.2,	213.4,	0.0);	(-187.9,	-68.4,	213.4,	0.0);
(-281.9,	-102.6,	213.4,	0.0);	(-375.9,	-136.8,	213.4,	0.0);
(-469.8,	-171.0,	213.4,	0.0);	(-563.8,	-205.2,	213.4,	0.0);

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDFL WETDFL

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(-657.8,	-239.4,	213.4,	0.0);	(-751.8,	-273.6,	219.5,	0.0);
(-845.7,	-307.8,	219.5,	0.0);	(-939.7,	-342.0,	213.4,	0.0);
(-1174.6,	-427.5,	353.6,	0.0);	(-1409.5,	-513.0,	353.6,	0.0);
(-1644.5,	-598.5,	341.4,	0.0);	(-1879.4,	-684.0,	335.3,	0.0);
(-2114.3,	-769.5,	353.6,	0.0);	(-2349.2,	-855.1,	304.8,	0.0);
(-2819.1,	-1026.1,	243.8,	0.0);	(-3758.8,	-1368.1,	298.7,	0.0);
(-4698.5,	-1710.1,	359.7,	0.0);	(-7047.7,	-2565.2,	365.8,	0.0);
(-9396.9,	-3420.2,	402.3,	0.0);	(-14095.4,	-5130.3,	380.0,	0.0);
(-18793.9,	-6840.4,	400.0,	0.0);	(-28190.8,	-10260.6,	380.0,	0.0);
(-37587.7,	-13680.8,	400.0,	0.0);	(-46984.6,	-17101.0,	360.0,	0.0);
(-98.5,	-17.4,	213.4,	0.0);	(-197.0,	-34.7,	213.4,	0.0);
(-295.4,	-52.1,	213.4,	0.0);	(-393.9,	-69.5,	213.4,	0.0);
(-492.4,	-86.8,	213.4,	0.0);	(-590.9,	-104.2,	213.4,	0.0);
(-689.4,	-121.6,	213.4,	0.0);	(-787.8,	-138.9,	219.5,	0.0);
(-886.3,	-156.3,	225.6,	0.0);	(-984.8,	-173.6,	310.9,	0.0);
(-1231.0,	-217.1,	359.7,	0.0);	(-1477.2,	-260.5,	359.7,	0.0);
(-1723.4,	-303.9,	365.8,	0.0);	(-1969.6,	-347.3,	371.9,	0.0);
(-2215.8,	-390.7,	353.6,	0.0);	(-2462.0,	-434.1,	371.9,	0.0);
(-2954.4,	-520.9,	353.6,	0.0);	(-3939.2,	-694.6,	365.8,	0.0);
(-4924.0,	-868.2,	365.8,	0.0);	(-7386.1,	-1302.4,	390.1,	0.0);
(-9848.1,	-1736.5,	339.9,	0.0);	(-14772.1,	-2604.7,	360.0,	0.0);
(-19696.2,	-3473.0,	380.0,	0.0);	(-29544.2,	-5209.4,	420.0,	0.0);
(-39392.3,	-6945.9,	400.0,	0.0);	(-49240.4,	-8682.4,	400.0,	0.0);
(-100.0,	0.0,	213.4,	0.0);	(-200.0,	0.0,	213.4,	0.0);
(-300.0,	0.0,	213.4,	0.0);	(-400.0,	0.0,	213.4,	0.0);
(-500.0,	0.0,	213.4,	0.0);	(-600.0,	0.0,	213.4,	0.0);
(-700.0,	0.0,	213.4,	0.0);	(-800.0,	0.0,	213.4,	0.0);
(-900.0,	0.0,	243.8,	0.0);	(-1000.0,	0.0,	298.7,	0.0);
(-1250.0,	0.0,	304.8,	0.0);	(-1500.0,	0.0,	304.8,	0.0);
(-1750.0,	0.0,	335.3,	0.0);	(-2000.0,	0.0,	341.4,	0.0);
(-2250.0,	0.0,	371.9,	0.0);	(-2500.0,	0.0,	371.9,	0.0);
(-3000.0,	0.0,	371.9,	0.0);	(-4000.0,	0.0,	378.0,	0.0);
(-5000.0,	0.0,	371.9,	0.0);	(-7500.0,	0.0,	371.9,	0.0);
(-10000.0,	0.0,	360.0,	0.0);	(-15000.0,	0.0,	340.0,	0.0);
(-20000.0,	0.0,	360.0,	0.0);	(-30000.0,	0.0,	380.0,	0.0);
(-40000.0,	0.0,	380.0,	0.0);	(-50000.0,	0.0,	400.0,	0.0);
(-98.5,	17.4,	213.4,	0.0);	(-197.0,	34.7,	213.4,	0.0);
(-295.4,	52.1,	213.4,	0.0);	(-393.9,	69.5,	213.4,	0.0);
(-492.4,	86.8,	213.4,	0.0);	(-590.9,	104.2,	225.6,	0.0);
(-689.4,	121.6,	225.6,	0.0);	(-787.8,	138.9,	237.7,	0.0);
(-886.3,	156.3,	243.8,	0.0);	(-984.8,	173.6,	280.4,	0.0);
(-1231.0,	217.1,	317.0,	0.0);	(-1477.2,	260.5,	304.8,	0.0);
(-1723.4,	303.9,	298.7,	0.0);	(-1969.6,	347.3,	341.4,	0.0);
(-2215.8,	390.7,	371.9,	0.0);	(-2462.0,	434.1,	353.6,	0.0);
(-2954.4,	520.9,	365.8,	0.0);	(-3939.2,	694.6,	353.6,	0.0);

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(-4924.0,	868.2,	378.0,	0.0);	(-7386.1,	1302.4,	384.0,	0.0);
(-9848.1,	1736.5,	389.2,	0.0);	(-14772.1,	2604.7,	400.0,	0.0);
(-19696.2,	3473.0,	420.0,	0.0);	(-29544.2,	5209.4,	380.0,	0.0);
(-39392.3,	6945.9,	380.0,	0.0);	(-49240.4,	8682.4,	400.0,	0.0);
(-94.0,	34.2,	213.4,	0.0);	(-187.9,	68.4,	213.4,	0.0);
(-281.9,	102.6,	213.4,	0.0);	(-375.9,	136.8,	219.5,	0.0);
(-469.8,	171.0,	225.6,	0.0);	(-563.8,	205.2,	225.6,	0.0);
(-657.8,	239.4,	243.8,	0.0);	(-751.8,	273.6,	274.3,	0.0);
(-845.7,	307.8,	286.5,	0.0);	(-939.7,	342.0,	298.7,	0.0);
(-1174.6,	427.5,	317.0,	0.0);	(-1409.5,	513.0,	298.7,	0.0);
(-1644.5,	598.5,	298.7,	0.0);	(-1879.4,	684.0,	359.7,	0.0);
(-2114.3,	769.5,	384.0,	0.0);	(-2349.2,	855.1,	378.0,	0.0);
(-2819.1,	1026.1,	378.0,	0.0);	(-3758.8,	1368.1,	378.0,	0.0);
(-4698.5,	1710.1,	378.0,	0.0);	(-7047.7,	2565.2,	371.9,	0.0);
(-9396.9,	3420.2,	424.9,	0.0);	(-14095.4,	5130.3,	420.0,	0.0);
(-18793.9,	6840.4,	360.0,	0.0);	(-28190.8,	10260.6,	400.0,	0.0);
(-37587.7,	13680.8,	380.0,	0.0);	(-46984.6,	17101.0,	400.0,	0.0);
(-86.6,	50.0,	213.4,	0.0);	(-173.2,	100.0,	213.4,	0.0);
(-259.8,	150.0,	219.5,	0.0);	(-346.4,	200.0,	231.6,	0.0);
(-433.0,	250.0,	225.6,	0.0);	(-519.6,	300.0,	231.6,	0.0);
(-606.2,	350.0,	268.2,	0.0);	(-692.8,	400.0,	304.8,	0.0);
(-779.4,	450.0,	310.9,	0.0);	(-866.0,	500.0,	304.8,	0.0);
(-1082.5,	625.0,	292.6,	0.0);	(-1299.0,	750.0,	323.1,	0.0);
(-1515.5,	875.0,	359.7,	0.0);	(-1732.1,	1000.0,	371.9,	0.0);
(-1948.6,	1125.0,	371.9,	0.0);	(-2165.1,	1250.0,	378.0,	0.0);
(-2598.1,	1500.0,	378.0,	0.0);	(-3464.1,	2000.0,	378.0,	0.0);
(-4330.1,	2500.0,	384.0,	0.0);	(-6495.2,	3750.0,	384.0,	0.0);
(-8660.3,	5000.0,	426.7,	0.0);	(-12990.4,	7500.0,	400.0,	0.0);
(-17320.5,	10000.0,	400.0,	0.0);	(-25980.8,	15000.0,	420.0,	0.0);
(-34641.0,	20000.0,	400.0,	0.0);	(-43301.3,	25000.0,	350.0,	0.0);
(-76.6,	64.3,	213.4,	0.0);	(-153.2,	128.6,	213.4,	0.0);
(-229.8,	192.8,	225.6,	0.0);	(-306.4,	257.1,	231.6,	0.0);
(-383.0,	321.4,	225.6,	0.0);	(-459.6,	385.7,	231.6,	0.0);
(-536.2,	450.0,	268.2,	0.0);	(-612.8,	514.2,	304.8,	0.0);
(-689.4,	578.5,	316.4,	0.0);	(-766.0,	642.8,	317.0,	0.0);
(-957.6,	803.5,	304.8,	0.0);	(-1149.1,	964.2,	341.4,	0.0);
(-1340.6,	1124.9,	353.6,	0.0);	(-1532.1,	1285.6,	365.8,	0.0);
(-1723.6,	1446.3,	371.9,	0.0);	(-1915.1,	1607.0,	378.0,	0.0);
(-2298.1,	1928.4,	384.0,	0.0);	(-3064.2,	2571.2,	359.7,	0.0);
(-3830.2,	3213.9,	384.0,	0.0);	(-5745.3,	4820.9,	378.0,	0.0);
(-7660.4,	6427.9,	379.2,	0.0);	(-11490.7,	9641.8,	360.0,	0.0);
(-15320.9,	12855.8,	400.0,	0.0);	(-22981.3,	19283.6,	400.0,	0.0);
(-30641.8,	25711.5,	400.0,	0.0);	(-38302.2,	32139.4,	370.0,	0.0);
(-64.3,	76.6,	213.4,	0.0);	(-128.6,	153.2,	225.6,	0.0);
(-192.8,	229.8,	231.6,	0.0);	(-257.1,	306.4,	231.6,	0.0);

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(-321.4,	383.0,	225.6,	0.0);	(-385.7,	459.6,	231.6,	0.0);
(-450.0,	536.2,	274.3,	0.0);	(-514.2,	612.8,	304.8,	0.0);
(-578.5,	689.4,	310.9,	0.0);	(-642.8,	766.0,	310.9,	0.0);
(-803.5,	957.6,	317.0,	0.0);	(-964.2,	1149.1,	347.5,	0.0);
(-1124.9,	1340.6,	353.6,	0.0);	(-1285.6,	1532.1,	353.6,	0.0);
(-1446.3,	1723.6,	359.7,	0.0);	(-1607.0,	1915.1,	365.8,	0.0);
(-1928.4,	2298.1,	384.0,	0.0);	(-2571.2,	3064.2,	384.0,	0.0);
(-3213.9,	3830.2,	378.0,	0.0);	(-4820.9,	5745.3,	378.0,	0.0);
(-6427.9,	7660.4,	378.0,	0.0);	(-9641.8,	11490.7,	380.0,	0.0);
(-12855.8,	15320.9,	400.0,	0.0);	(-19283.6,	22981.3,	400.0,	0.0);
(-25711.5,	30641.8,	360.0,	0.0);	(-32139.4,	38302.2,	360.0,	0.0);
(-50.0,	86.6,	213.4,	0.0);	(-100.0,	173.2,	225.6,	0.0);
(-150.0,	259.8,	231.6,	0.0);	(-200.0,	346.4,	231.6,	0.0);
(-250.0,	433.0,	225.6,	0.0);	(-300.0,	519.6,	243.8,	0.0);
(-350.0,	606.2,	249.9,	0.0);	(-400.0,	692.8,	243.8,	0.0);
(-450.0,	779.4,	304.8,	0.0);	(-500.0,	866.0,	304.8,	0.0);
(-625.0,	1082.5,	286.5,	0.0);	(-750.0,	1299.0,	329.2,	0.0);
(-875.0,	1515.5,	347.5,	0.0);	(-1000.0,	1732.1,	353.6,	0.0);
(-1125.0,	1948.6,	353.6,	0.0);	(-1250.0,	2165.1,	384.0,	0.0);
(-1500.0,	2598.1,	384.0,	0.0);	(-2000.0,	3464.1,	384.0,	0.0);
(-2500.0,	4330.1,	378.0,	0.0);	(-3750.0,	6495.2,	365.8,	0.0);
(-5000.0,	8660.3,	371.9,	0.0);	(-7500.0,	12990.4,	360.0,	0.0);
(-10000.0,	17320.5,	360.0,	0.0);	(-15000.0,	25980.8,	340.0,	0.0);
(-20000.0,	34641.0,	380.0,	0.0);	(-25000.0,	43301.3,	350.0,	0.0);
(-34.2,	94.0,	213.4,	0.0);	(-68.4,	187.9,	225.6,	0.0);
(-102.6,	281.9,	225.6,	0.0);	(-136.8,	375.9,	225.6,	0.0);
(-171.0,	469.8,	225.6,	0.0);	(-205.2,	563.8,	243.8,	0.0);
(-239.4,	657.8,	262.1,	0.0);	(-273.6,	751.8,	286.5,	0.0);
(-307.8,	845.7,	280.4,	0.0);	(-342.0,	939.7,	292.6,	0.0);
(-427.5,	1174.6,	323.1,	0.0);	(-513.0,	1409.5,	353.6,	0.0);
(-598.5,	1644.5,	359.7,	0.0);	(-684.0,	1879.4,	359.7,	0.0);
(-769.5,	2114.3,	329.2,	0.0);	(-855.1,	2349.2,	347.5,	0.0);
(-1026.1,	2819.1,	378.0,	0.0);	(-1368.1,	3758.8,	385.0,	0.0);
(-1710.1,	4698.5,	371.9,	0.0);	(-2565.2,	7047.7,	329.2,	0.0);
(-3420.2,	9396.9,	349.0,	0.0);	(-5130.3,	14095.4,	360.0,	0.0);
(-6840.4,	18793.9,	360.0,	0.0);	(-10260.6,	28190.8,	340.0,	0.0);
(-13680.8,	37587.7,	370.0,	0.0);	(-17101.0,	46984.6,	350.0,	0.0);
(-17.4,	98.5,	213.4,	0.0);	(-34.7,	197.0,	225.6,	0.0);
(-52.1,	295.4,	225.6,	0.0);	(-69.5,	393.9,	225.6,	0.0);
(-86.8,	492.4,	225.6,	0.0);	(-104.2,	590.9,	243.8,	0.0);
(-121.6,	689.4,	262.1,	0.0);	(-138.9,	787.8,	292.6,	0.0);
(-156.3,	886.3,	298.7,	0.0);	(-173.6,	984.8,	298.7,	0.0);
(-217.1,	1231.0,	335.3,	0.0);	(-260.5,	1477.2,	365.8,	0.0);
(-303.9,	1723.4,	359.7,	0.0);	(-347.3,	1969.6,	359.7,	0.0);
(-390.7,	2215.8,	341.4,	0.0);	(-434.1,	2462.0,	378.0,	0.0);

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(	-520.9,	2954.4,	384.0,	0.0);	(	-694.6,	3939.2,	378.0,	0.0);
(	-868.2,	4924.0,	365.8,	0.0);	(	-1302.4,	7386.1,	341.4,	0.0);
(	-1736.5,	9848.1,	339.9,	0.0);	(	-2604.7,	14772.1,	340.0,	0.0);
(	-3473.0,	19696.2,	360.0,	0.0);	(	-5209.5,	29544.2,	340.0,	0.0);
(	-6945.9,	39392.3,	330.0,	0.0);	(	-8682.4,	49240.4,	320.0,	0.0);
(	0.0,	100.0,	213.4,	0.0);	(	0.0,	200.0,	225.6,	0.0);
(	0.0,	300.0,	225.6,	0.0);	(	0.0,	400.0,	225.6,	0.0);
(	0.0,	500.0,	225.6,	0.0);	(	0.0,	600.0,	237.7,	0.0);
(	0.0,	700.0,	256.0,	0.0);	(	0.0,	800.0,	280.4,	0.0);
(	0.0,	900.0,	298.7,	0.0);	(	0.0,	1000.0,	292.6,	0.0);
(	0.0,	1250.0,	353.6,	0.0);	(	0.0,	1500.0,	323.1,	0.0);
(	0.0,	1750.0,	341.4,	0.0);	(	0.0,	2000.0,	317.0,	0.0);
(	0.0,	2250.0,	359.7,	0.0);	(	0.0,	2500.0,	359.7,	0.0);
(	0.0,	3000.0,	378.0,	0.0);	(	0.0,	4000.0,	383.4,	0.0);
(	0.0,	5000.0,	359.7,	0.0);	(	0.0,	7500.0,	371.9,	0.0);
(	0.0,	10000.0,	380.1,	0.0);	(	0.0,	15000.0,	360.0,	0.0);
(	0.0,	20000.0,	340.0,	0.0);	(	0.0,	30000.0,	380.0,	0.0);
(	0.0,	40000.0,	350.0,	0.0);	(	0.0,	50000.0,	350.0,	0.0);

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/25/94
*** One source; 936 receptors up to 50KM away; Mass wt. *** 17:37:03
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** METEOROLOGICAL DAYS SELECTED FOR PROCESSING ***
(1=YES; 0=NO)

1 1 1

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/25/94
*** One source; 936 receptors up to 50KM away; Mass wt. *** 17:37:03
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** THE FIRST 24 HOURS OF METEOROLOGICAL DATA ***

FILE: depbin.met FORMAT: (4I2,2F9.4,F6.1,I2,2F7.1,f9.4,f10.1,f8.4,f5.1,i4,f7.2)
SURFACE STATION NO.: 94823 UPPER AIR STATION NO.: 94823
NAME: WTI NAME: WTI
YEAR: 1993 YEAR: 1993

YEAR	MONTH	DAY	HOUR	FLOW VECTOR	SPEED (M/S)	TEMP (K)	STAB CLASS	MIXING HEIGHT (M) RURAL	MIXING HEIGHT (M) URBAN	USTAR (M/S)	M-O LENGTH (M)	Z-0 (M)	Zd (M)	IPCODE	PRATE (mm/HR)
93	1	1	1	104.0	4.47	275.4	4	601.6	601.6	0.3366	176.8	0.3000	1.5	13	0.00
93	1	1	2	112.0	5.36	274.8	4	617.6	617.6	0.4269	283.7	0.3000	1.5	0	0.25
93	1	1	3	106.0	4.47	274.0	4	633.5	633.5	0.3363	175.6	0.3000	1.5	0	0.00
93	1	1	4	115.0	4.47	273.9	4	649.5	649.5	0.3363	175.4	0.3000	1.5	28	0.00
93	1	1	5	120.0	4.02	273.8	4	665.4	665.4	0.2874	128.1	0.3000	1.5	28	0.00
93	1	1	6	123.0	5.36	273.3	4	681.4	681.4	0.4266	281.8	0.3000	1.5	28	0.00
93	1	1	7	130.0	4.92	272.5	4	697.3	697.3	0.3820	225.3	0.3000	1.5	28	0.00
93	1	1	8	124.0	4.92	271.9	4	713.3	713.3	0.3819	224.6	0.3000	1.5	28	0.00
93	1	1	9	115.0	4.47	271.0	4	729.2	729.2	0.3355	172.9	0.3000	1.5	28	0.00
93	1	1	10	107.0	4.02	270.9	4	745.2	745.2	0.3534	-999.0	0.3000	1.5	28	0.00
93	1	1	11	113.0	4.02	270.6	4	761.1	761.1	0.3534	-999.0	0.3000	1.5	28	0.00
93	1	1	12	108.0	4.47	270.9	4	777.1	777.1	0.3926	-999.0	0.3000	1.5	28	0.00
93	1	1	13	114.0	5.36	271.1	4	793.0	793.0	0.4712	-999.0	0.3000	1.5	28	0.00
93	1	1	14	107.0	4.92	271.0	4	809.0	809.0	0.4319	-999.0	0.3000	1.5	28	0.00
93	1	1	15	120.0	4.92	270.8	4	809.0	809.0	0.3817	223.4	0.3000	1.5	28	0.00
93	1	1	16	119.0	4.47	270.5	4	809.0	809.0	0.3354	172.4	0.3000	1.5	28	0.00
93	1	1	17	118.0	3.58	270.4	4	809.0	809.0	0.2310	81.7	0.3000	1.5	28	0.00
93	1	1	18	124.0	2.68	270.4	4	809.0	809.0	0.1178	29.4	0.3000	1.5	28	0.00
93	1	1	19	124.0	2.68	270.1	4	809.0	809.0	0.1178	29.4	0.3000	1.5	28	0.00
93	1	1	20	113.0	2.23	270.3	4	809.0	809.0	0.0982	29.4	0.3000	1.5	28	0.00
93	1	1	21	97.0	2.68	270.3	4	809.0	809.0	0.1178	29.4	0.3000	1.5	0	0.00
93	1	1	22	113.0	3.13	270.3	4	809.0	809.0	0.1374	29.4	0.3000	1.5	28	0.00
93	1	1	23	117.0	3.13	270.4	4	809.0	809.0	0.1374	29.4	0.3000	1.5	0	0.00
93	1	1	24	152.0	2.68	269.9	4	809.0	809.0	0.1178	29.4	0.3000	1.5	28	0.00

*** NOTES: STABILITY CLASS 1=A, 2=B, 3=C, 4=D, 5=E AND 6=F.
FLOW VECTOR IS DIRECTION TOWARD WHICH WIND IS BLOWING.

```
 *** ISCOMDEP VERSION 94227 ***     ***  WTI stack modeling, EPA Region V, Project 1363, Base Case          ***        08/25/94
                                   ***  One source; 936 receptors up to 50KM away; Surface wt.            ***        17:50:05
                                                                                                                     PAGE    1
 *** MODELING OPTIONS USED:  CONC   RURAL  ELEV          DFAULT                                                DRYDPL WETDPL

                                          ***     MODEL SETUP OPTIONS SUMMARY       ***
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

**Intermediate Terrain Processing is Selected

**Model Is Setup For Calculation of Average CONCentration Values.

  --  SCAVENGING/DEPOSITION LOGIC --
**Model Uses DRY DEPLETION.  DDPLETE =  T
**Model Uses WET DEPLETION.  WDPLETE =  T
**SCAVENGING Data Provided.  LWGAS,LWPART =  F T
**Model Uses GRIDDED TERRAIN Data for Depletion Calculations

**Model Uses RURAL Dispersion.

**Model Uses Regulatory DEFAULT Options:
          1. Final Plume Rise.
          2. Stack-tip Downwash.
          3. Buoyancy-induced Dispersion.
          4. Use Calms Processing Routine.
          5. Not Use Missing Data Processing Routine.
          6. Default Wind Profile Exponents.
          7. Default Vertical Potential Temperature Gradients.
          8. 'Upper Bound' Values for Supersquat Buildings.
          9. No Exponential Decay for RURAL Mode

**Model Accepts Receptors on ELEV Terrain.

**Model Assumes No FLAGPOLE Receptor Heights.

**Model Accepting Temperature Profile Data.
  Number of Levels :            3
    (m AGL)          30.0000
    (m AGL)          45.7000
    (m AGL)          152.400

**Model Accepting Wind Profile Data.
  Number of Levels :            5
    (m AGL)          30.0000
    (m AGL)          45.7000
    (m AGL)          80.8000
    (m AGL)          111.300
    (m AGL)          152.400

**Model Calculates  1 Short Term Average(s) of:   1-HR
   and Calculates PERIOD Averages

**This Run Includes:    1 Source(s);      1 Source Group(s); and    936 Receptor(s)

**The Model Assumes A Pollutant Type of:  LEAD

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
        Model Outputs Tables of PERIOD Averages by Receptor
        Model Outputs Tables of Highest Short Term Values by Receptor (RECTABLE Keyword)
        Model Outputs Tables of Overall Maximum Short Term Values (MAXTABLE Keyword)
        Model Outputs External File(s) of High Values for Plotting (PLOTFILE Keyword)

**NOTE:  The Following Flags May Appear Following CONC Values:  c for Calm Hours
                                                                m for Missing Hours
                                                                b for Both Calm and Missing Hours

**Misc. Inputs:  Anem. Hgt. (m) =    30.00 ;    Decay Coef. =   0.0000     ;    Rot. Angle =     0.0
                 Emission Units = GRAMS/SEC                                ;  Emission Rate Unit Factor =   0.10000E+07
                 Output Units   = MICROGRAMS/M**3

**Input Runstream File: baseb.inc                              ;  **Output Print File: baseb.con
**Detailed Error/Message File:   ERRORS.OUT
```

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/25/94
*** One source; 936 receptors up to 50KM away; Surface wt. *** 17:50:05
PAGE 2

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** POINT SOURCE DATA ***

SOURCE ID	NUMBER PART. CATS.	EMISSION RATE (GRAMS/SEC)	X (METERS)	Y (METERS)	BASE ELEV. (METERS)	STACK HEIGHT (METERS)	STACK TEMP. (DEG.K)	STACK EXIT VEL. (M/SEC)	STACK DIAMETER (METERS)	BUILDING EXISTS	EMISSION RATE SCALAR VARY BY
WTISTACK	10	0.10000E+01	0.0	0.0	212.1	45.70	367.00	17.74	1.83	YES	

```
*** ISCOMDEP VERSION 94227 ***     ***  WTI stack modeling, EPA Region V, Project 1363, Base Case          ***        08/25/94
                                   ***  One source; 936 receptors up to 50KM away; Surface wt.            ***        17:50:05
                                                                                                                     PAGE    3
*** MODELING OPTIONS USED:  CONC   RURAL  ELEV          DFAULT                                          DRYDPL WETDPL


                                        *** SOURCE IDs DEFINING SOURCE GROUPS ***

GROUP ID                                              SOURCE IDs


ALL        WTISTACK,
```

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/25/94
*** One source; 936 receptors up to 50KM away; Surface wt. *** 17:50:05
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** SOURCE PARTICULATE/GAS DATA ***

*** SOURCE ID = WTISTACK; SOURCE TYPE = POINT ***

MASS FRACTION =
0.00414, 0.01301, 0.05288, 0.10060, 0.13832, 0.12745, 0.16051, 0.12038, 0.18640, 0.09631,

PARTICLE DIAMETER (MICRONS) =
2.97000, 1.89000, 0.93000, 0.55000, 0.40000, 0.27000, 0.18000, 0.12000, 0.06200, 0.03000,

PARTICLE DENSITY (G/CM**3) =
1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000,

SCAV COEF [LIQ] 1/(S-MM/HR)=
0.21E-03,0.14E-03,0.50E-04,0.50E-04,0.60E-04,0.90E-04,0.13E-03,0.15E-03,0.20E-03,0.22E-03,

SCAV COEF [ICE] 1/(S-MM/HR)=
0.70E-04,0.47E-04,0.17E-04,0.17E-04,0.20E-04,0.30E-04,0.43E-04,0.50E-04,0.67E-04,0.73E-04,

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/25/94
*** One source; 936 receptors up to 50KM away; Surface wt. *** 17:50:05
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** DIRECTION SPECIFIC BUILDING DIMENSIONS ***

SOURCE ID: WTISTACK

IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK
1	29.1,	26.9,	0	2	29.1,	24.7,	0	3	29.1,	21.8,	0	4	25.8,	27.6,	0	5	24.4,	27.0,	0	6	24.4,	24.6,	0
7	24.4,	26.0,	0	8	29.1,	22.6,	0	9	29.1,	25.8,	0	10	29.1,	28.8,	0	11	29.1,	30.9,	0	12	29.1,	32.1,	0
13	29.1,	32.3,	0	14	29.1,	31.8,	0	15	29.1,	30.9,	0	16	29.1,	29.6,	0	17	29.1,	29.3,	0	18	29.1,	28.2,	0
19	29.1,	26.9,	0	20	29.1,	24.7,	0	21	29.1,	21.8,	0	22	25.8,	27.6,	0	23	25.8,	26.1,	0	24	25.8,	23.8,	0
25	24.4,	26.0,	0	26	25.8,	24.8,	0	27	29.1,	25.8,	0	28	29.1,	28.8,	0	29	29.1,	30.9,	0	30	29.1,	32.1,	0
31	29.1,	32.3,	0	32	29.1,	31.8,	0	33	29.1,	30.9,	0	34	29.1,	29.6,	0	35	29.1,	29.3,	0	36	29.1,	28.2,	0

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDFL WETDFL

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(17.4,	98.5,	213.4,	0.0);	(34.7,	197.0,	225.6,	0.0);
(52.1,	295.4,	225.6,	0.0);	(69.5,	393.9,	225.6,	0.0);
(86.8,	492.4,	225.6,	0.0);	(104.2,	590.9,	225.6,	0.0);
(121.6,	689.4,	243.8,	0.0);	(138.9,	787.8,	256.0,	0.0);
(156.3,	886.3,	280.4,	0.0);	(173.6,	984.8,	286.5,	0.0);
(217.1,	1231.0,	353.6,	0.0);	(260.5,	1477.2,	353.6,	0.0);
(303.9,	1723.4,	310.9,	0.0);	(347.3,	1969.6,	347.5,	0.0);
(390.7,	2215.8,	353.6,	0.0);	(434.1,	2462.0,	359.7,	0.0);
(520.9,	2954.4,	347.5,	0.0);	(694.6,	3939.2,	341.4,	0.0);
(868.2,	4924.0,	341.4,	0.0);	(1302.4,	7386.1,	365.8,	0.0);
(1736.5,	9848.1,	360.0,	0.0);	(2604.7,	14772.1,	340.0,	0.0);
(3473.0,	19696.2,	340.0,	0.0);	(5209.4,	29544.2,	360.0,	0.0);
(6945.9,	39392.3,	350.0,	0.0);	(8682.4,	49240.4,	360.0,	0.0);
(34.2,	94.0,	213.4,	0.0);	(68.4,	187.9,	225.6,	0.0);
(102.6,	281.9,	225.6,	0.0);	(136.8,	375.9,	225.6,	0.0);
(171.0,	469.8,	225.6,	0.0);	(205.2,	563.8,	225.6,	0.0);
(239.4,	657.8,	237.7,	0.0);	(273.6,	751.8,	243.8,	0.0);
(307.8,	845.7,	256.0,	0.0);	(342.0,	939.7,	286.5,	0.0);
(427.5,	1174.6,	329.2,	0.0);	(513.0,	1409.5,	347.5,	0.0);
(598.5,	1644.5,	335.3,	0.0);	(684.0,	1879.4,	347.5,	0.0);
(769.5,	2114.3,	353.6,	0.0);	(855.1,	2349.2,	359.7,	0.0);
(1026.1,	2819.1,	362.4,	0.0);	(1368.1,	3758.8,	329.2,	0.0);
(1710.1,	4698.5,	359.7,	0.0);	(2565.2,	7047.7,	369.7,	0.0);
(3420.2,	9396.9,	385.9,	0.0);	(5130.3,	14095.4,	340.0,	0.0);
(6840.4,	18793.9,	340.0,	0.0);	(10260.6,	28190.8,	360.0,	0.0);
(13680.8,	37587.7,	380.0,	0.0);	(17101.0,	46984.6,	390.0,	0.0);
(50.0,	86.6,	213.4,	0.0);	(100.0,	173.2,	219.5,	0.0);
(150.0,	259.8,	225.6,	0.0);	(200.0,	346.4,	225.6,	0.0);
(250.0,	433.0,	225.6,	0.0);	(300.0,	519.6,	225.6,	0.0);
(350.0,	606.2,	225.6,	0.0);	(400.0,	692.8,	231.6,	0.0);
(450.0,	779.4,	243.8,	0.0);	(500.0,	866.0,	262.1,	0.0);
(625.0,	1082.5,	225.6,	0.0);	(750.0,	1299.0,	347.5,	0.0);
(875.0,	1515.5,	359.7,	0.0);	(1000.0,	1732.1,	353.6,	0.0);
(1125.0,	1948.6,	353.6,	0.0);	(1250.0,	2165.1,	329.2,	0.0);
(1500.0,	2598.1,	323.1,	0.0);	(2000.0,	3464.1,	361.2,	0.0);
(2500.0,	4330.1,	366.7,	0.0);	(3750.0,	6495.2,	378.0,	0.0);
(5000.0,	8660.3,	396.2,	0.0);	(7500.0,	12990.4,	320.0,	0.0);
(10000.0,	17320.5,	360.0,	0.0);	(15000.0,	25980.8,	380.0,	0.0);
(20000.0,	34641.0,	370.0,	0.0);	(25000.0,	43301.3,	400.0,	0.0);
(64.3,	76.6,	213.4,	0.0);	(128.6,	153.2,	213.4,	0.0);
(192.8,	229.8,	225.6,	0.0);	(257.1,	306.4,	225.6,	0.0);
(321.4,	383.0,	225.6,	0.0);	(385.7,	459.6,	225.6,	0.0);
(450.0,	536.2,	225.6,	0.0);	(514.2,	612.8,	225.6,	0.0);
(578.5,	689.4,	225.6,	0.0);	(642.8,	766.0,	243.8,	0.0);
(803.5,	957.6,	280.4,	0.0);	(964.2,	1149.1,	353.6,	0.0);

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/25/94
*** One source; 936 receptors up to 50KM away; Surface wt. *** 17:50:05
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(1124.9,	1340.6,	361.5,	0.0);	(1285.6,	1532.1,	353.6,	0.0);
(1446.3,	1723.6,	353.6,	0.0);	(1607.0,	1915.1,	353.6,	0.0);
(1928.4,	2298.1,	335.3,	0.0);	(2571.2,	3064.2,	353.9,	0.0);
(3213.9,	3830.2,	353.0,	0.0);	(4820.9,	5745.3,	378.0,	0.0);
(6427.9,	7660.4,	398.4,	0.0);	(9641.8,	11490.7,	376.0,	0.0);
(12855.8,	15320.9,	380.0,	0.0);	(19283.6,	22981.3,	360.0,	0.0);
(25711.5,	30641.8,	420.0,	0.0);	(32139.4,	38302.2,	420.0,	0.0);
(76.6,	64.3,	213.4,	0.0);	(153.2,	128.6,	207.3,	0.0);
(229.8,	192.8,	213.4,	0.0);	(306.4,	257.1,	219.5,	0.0);
(383.0,	321.4,	219.5,	0.0);	(459.6,	385.7,	219.5,	0.0);
(536.2,	450.0,	219.5,	0.0);	(612.8,	514.2,	219.5,	0.0);
(689.4,	578.5,	225.6,	0.0);	(766.0,	642.8,	219.5,	0.0);
(957.6,	803.5,	219.5,	0.0);	(1149.1,	964.2,	323.1,	0.0);
(1340.6,	1124.9,	353.6,	0.0);	(1532.1,	1285.6,	353.6,	0.0);
(1723.6,	1446.3,	335.3,	0.0);	(1915.1,	1607.0,	347.5,	0.0);
(2298.1,	1928.4,	347.5,	0.0);	(3064.2,	2571.2,	341.4,	0.0);
(3830.2,	3213.9,	335.3,	0.0);	(5745.3,	4820.9,	373.1,	0.0);
(7660.4,	6427.9,	396.2,	0.0);	(11490.7,	9641.8,	360.0,	0.0);
(15320.9,	12855.8,	380.0,	0.0);	(22981.3,	19283.6,	380.0,	0.0);
(30641.8,	25711.5,	420.0,	0.0);	(38302.2,	32139.4,	420.0,	0.0);
(86.6,	50.0,	213.4,	0.0);	(173.2,	100.0,	207.3,	0.0);
(259.8,	150.0,	207.3,	0.0);	(346.4,	200.0,	201.2,	0.0);
(433.0,	250.0,	207.3,	0.0);	(519.6,	300.0,	213.4,	0.0);
(606.2,	350.0,	213.4,	0.0);	(692.8,	400.0,	213.4,	0.0);
(779.4,	450.0,	213.4,	0.0);	(866.0,	500.0,	219.5,	0.0);
(1082.5,	625.0,	225.6,	0.0);	(1299.0,	750.0,	219.5,	0.0);
(1515.5,	875.0,	243.8,	0.0);	(1732.1,	1000.0,	292.6,	0.0);
(1948.6,	1125.0,	310.9,	0.0);	(2165.1,	1250.0,	323.1,	0.0);
(2598.1,	1500.0,	317.0,	0.0);	(3464.1,	2000.0,	323.1,	0.0);
(4330.1,	2500.0,	359.7,	0.0);	(6495.2,	3750.0,	378.9,	0.0);
(8660.3,	5000.0,	408.7,	0.0);	(12990.4,	7500.0,	380.0,	0.0);
(17320.5,	10000.0,	360.0,	0.0);	(25980.8,	15000.0,	380.0,	0.0);
(34641.0,	20000.0,	380.0,	0.0);	(43301.3,	25000.0,	420.0,	0.0);
(94.0,	34.2,	207.3,	0.0);	(187.9,	68.4,	201.2,	0.0);
(281.9,	102.6,	202.7,	0.0);	(375.9,	136.8,	202.7,	0.0);
(469.8,	171.0,	207.3,	0.0);	(563.8,	205.2,	207.3,	0.0);
(657.8,	239.4,	207.3,	0.0);	(751.8,	273.6,	213.4,	0.0);
(845.7,	307.8,	213.4,	0.0);	(939.7,	342.0,	213.4,	0.0);
(1174.6,	427.5,	213.4,	0.0);	(1409.5,	513.0,	213.4,	0.0);
(1644.5,	598.5,	213.4,	0.0);	(1879.4,	684.0,	213.4,	0.0);
(2114.3,	769.5,	213.4,	0.0);	(2349.2,	855.1,	231.6,	0.0);
(2819.1,	1026.1,	231.6,	0.0);	(3758.8,	1368.1,	310.9,	0.0);
(4698.5,	1710.1,	384.0,	0.0);	(7047.7,	2565.2,	384.0,	0.0);
(9396.9,	3420.2,	370.3,	0.0);	(14095.4,	5130.3,	360.0,	0.0);
(18793.9,	6840.4,	380.0,	0.0);	(28190.8,	10260.6,	400.0,	0.0);

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/25/94
*** One source; 936 receptors up to 50KM away; Surface wt. *** 17:50:05
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(37587.7,	13680.8,	360.0,	0.0);	(46984.6,	17101.0,	400.0,	0.0);
(98.5,	17.4,	207.3,	0.0);	(197.0,	34.7,	202.7,	0.0);
(295.4,	52.1,	202.7,	0.0);	(393.9,	69.5,	202.7,	0.0);
(492.4,	86.8,	202.7,	0.0);	(590.9,	104.2,	202.7,	0.0);
(689.4,	121.6,	202.7,	0.0);	(787.8,	138.9,	202.7,	0.0);
(886.3,	156.3,	202.7,	0.0);	(984.8,	173.6,	202.7,	0.0);
(1231.0,	217.1,	202.7,	0.0);	(1477.2,	260.5,	202.7,	0.0);
(1723.4,	303.9,	213.4,	0.0);	(1969.6,	347.3,	207.3,	0.0);
(2215.8,	390.7,	207.3,	0.0);	(2462.0,	434.1,	231.6,	0.0);
(2954.4,	520.9,	304.8,	0.0);	(3939.2,	694.6,	346.6,	0.0);
(4924.0,	868.2,	365.8,	0.0);	(7386.1,	1302.4,	384.0,	0.0);
(9848.1,	1736.5,	371.9,	0.0);	(14772.1,	2604.7,	320.0,	0.0);
(19696.2,	3473.0,	360.0,	0.0);	(29544.2,	5209.4,	380.0,	0.0);
(39392.3,	6945.9,	380.0,	0.0);	(49240.4,	8682.4,	400.0,	0.0);
(100.0,	0.0,	207.3,	0.0);	(200.0,	0.0,	202.7,	0.0);
(300.0,	0.0,	202.7,	0.0);	(400.0,	0.0,	202.7,	0.0);
(500.0,	0.0,	202.7,	0.0);	(600.0,	0.0,	202.7,	0.0);
(700.0,	0.0,	202.7,	0.0);	(800.0,	0.0,	202.7,	0.0);
(900.0,	0.0,	202.7,	0.0);	(1000.0,	0.0,	202.7,	0.0);
(1250.0,	0.0,	243.8,	0.0);	(1500.0,	0.0,	341.4,	0.0);
(1750.0,	0.0,	323.1,	0.0);	(2000.0,	0.0,	341.4,	0.0);
(2250.0,	0.0,	304.8,	0.0);	(2500.0,	0.0,	292.6,	0.0);
(3000.0,	0.0,	310.9,	0.0);	(4000.0,	0.0,	359.7,	0.0);
(5000.0,	0.0,	402.3,	0.0);	(7500.0,	0.0,	347.5,	0.0);
(10000.0,	0.0,	380.1,	0.0);	(15000.0,	0.0,	360.0,	0.0);
(20000.0,	0.0,	360.0,	0.0);	(30000.0,	0.0,	380.0,	0.0);
(40000.0,	0.0,	400.0,	0.0);	(50000.0,	0.0,	360.0,	0.0);
(98.5,	-17.4,	207.3,	0.0);	(197.0,	-34.7,	202.7,	0.0);
(295.4,	-52.1,	202.7,	0.0);	(393.9,	-69.5,	202.7,	0.0);
(492.4,	-86.8,	202.7,	0.0);	(590.9,	-104.2,	202.7,	0.0);
(689.4,	-121.6,	202.7,	0.0);	(787.8,	-138.9,	219.5,	0.0);
(886.3,	-156.3,	225.6,	0.0);	(984.8,	-173.6,	329.2,	0.0);
(1231.0,	-217.1,	347.5,	0.0);	(1477.2,	-260.5,	353.6,	0.0);
(1723.4,	-303.9,	323.1,	0.0);	(1969.6,	-347.3,	341.4,	0.0);
(2215.8,	-390.7,	341.4,	0.0);	(2462.0,	-434.1,	323.1,	0.0);
(2954.4,	-520.9,	347.5,	0.0);	(3939.2,	-694.6,	353.6,	0.0);
(4924.0,	-868.2,	386.5,	0.0);	(7386.1,	-1302.4,	353.6,	0.0);
(9848.1,	-1736.5,	360.0,	0.0);	(14772.1,	-2604.7,	340.0,	0.0);
(19696.2,	-3473.0,	380.0,	0.0);	(29544.2,	-5209.4,	380.0,	0.0);
(39392.3,	-6945.9,	380.0,	0.0);	(49240.4,	-8682.4,	400.0,	0.0);
(94.0,	-34.2,	207.3,	0.0);	(187.9,	-68.4,	202.7,	0.0);
(281.9,	-102.6,	202.7,	0.0);	(375.9,	-136.8,	202.7,	0.0);
(469.8,	-171.0,	202.7,	0.0);	(563.8,	-205.2,	213.4,	0.0);
(657.8,	-239.4,	256.0,	0.0);	(751.8,	-273.6,	298.7,	0.0);
(845.7,	-307.8,	286.5,	0.0);	(939.7,	-342.0,	323.1,	0.0);

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/25/94
*** One source; 936 receptors up to 50KM away; Surface wt. *** 17:50:05
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(1174.6,	-427.5,	347.5,	0.0);	(1409.5,	-513.0,	347.5,	0.0);
(1644.5,	-598.5,	310.9,	0.0);	(1879.4,	-684.0,	353.6,	0.0);
(2114.3,	-769.5,	350.2,	0.0);	(2349.2,	-855.1,	347.5,	0.0);
(2819.1,	-1026.1,	347.5,	0.0);	(3758.8,	-1368.1,	345.9,	0.0);
(4698.5,	-1710.1,	371.9,	0.0);	(7047.7,	-2565.2,	365.8,	0.0);
(9396.9,	-3420.2,	408.4,	0.0);	(14095.4,	-5130.3,	380.0,	0.0);
(18793.9,	-6840.4,	360.0,	0.0);	(28190.8,	-10260.6,	360.0,	0.0);
(37587.7,	-13680.8,	360.0,	0.0);	(46984.6,	-17101.0,	360.0,	0.0);
(86.6,	-50.0,	207.3,	0.0);	(173.2,	-100.0,	202.7,	0.0);
(259.8,	-150.0,	202.7,	0.0);	(346.4,	-200.0,	202.7,	0.0);
(433.0,	-250.0,	213.4,	0.0);	(519.6,	-300.0,	268.2,	0.0);
(606.2,	-350.0,	317.0,	0.0);	(692.8,	-400.0,	347.5,	0.0);
(779.4,	-450.0,	353.6,	0.0);	(866.0,	-500.0,	347.5,	0.0);
(1082.5,	-625.0,	310.9,	0.0);	(1299.0,	-750.0,	359.7,	0.0);
(1515.5,	-875.0,	335.3,	0.0);	(1732.1,	-1000.0,	359.7,	0.0);
(1948.6,	-1125.0,	359.7,	0.0);	(2165.1,	-1250.0,	347.5,	0.0);
(2598.1,	-1500.0,	365.8,	0.0);	(3464.1,	-2000.0,	359.7,	0.0);
(4330.1,	-2500.0,	353.6,	0.0);	(6495.2,	-3750.0,	402.3,	0.0);
(8660.3,	-5000.0,	396.2,	0.0);	(12990.4,	-7500.0,	380.0,	0.0);
(17320.5,	-10000.0,	380.0,	0.0);	(25980.8,	-15000.0,	360.0,	0.0);
(34641.0,	-20000.0,	360.0,	0.0);	(43301.3,	-25000.0,	360.0,	0.0);
(76.6,	-64.3,	207.3,	0.0);	(153.2,	-128.6,	202.7,	0.0);
(229.8,	-192.8,	202.7,	0.0);	(306.4,	-257.1,	202.7,	0.0);
(383.0,	-321.4,	243.8,	0.0);	(459.6,	-385.7,	298.7,	0.0);
(536.2,	-450.0,	323.1,	0.0);	(612.8,	-514.2,	353.6,	0.0);
(689.4,	-578.5,	353.6,	0.0);	(766.0,	-642.8,	353.6,	0.0);
(957.6,	-803.5,	353.6,	0.0);	(1149.1,	-964.2,	359.7,	0.0);
(1340.6,	-1124.9,	341.4,	0.0);	(1532.1,	-1285.6,	353.6,	0.0);
(1723.6,	-1446.3,	353.6,	0.0);	(1915.1,	-1607.0,	341.4,	0.0);
(2298.1,	-1928.4,	359.7,	0.0);	(3064.2,	-2571.2,	359.7,	0.0);
(3830.2,	-3213.9,	359.7,	0.0);	(5745.3,	-4820.9,	408.4,	0.0);
(7660.4,	-6427.9,	408.4,	0.0);	(11490.7,	-9641.8,	380.0,	0.0);
(15320.9,	-12855.8,	360.0,	0.0);	(22981.3,	-19283.6,	360.0,	0.0);
(30641.8,	-25711.5,	360.0,	0.0);	(38302.2,	-32139.4,	360.0,	0.0);
(64.3,	-76.6,	207.3,	0.0);	(128.6,	-153.2,	202.7,	0.0);
(192.8,	-229.8,	202.7,	0.0);	(257.1,	-306.4,	202.7,	0.0);
(321.4,	-383.0,	268.2,	0.0);	(385.7,	-459.6,	304.8,	0.0);
(450.0,	-536.2,	310.9,	0.0);	(514.2,	-612.8,	323.1,	0.0);
(578.5,	-689.4,	329.2,	0.0);	(642.8,	-766.0,	323.1,	0.0);
(803.5,	-957.6,	347.5,	0.0);	(964.2,	-1149.1,	359.7,	0.0);
(1124.9,	-1340.6,	329.2,	0.0);	(1285.6,	-1532.1,	359.7,	0.0);
(1446.3,	-1723.6,	353.6,	0.0);	(1607.0,	-1915.1,	359.7,	0.0);
(1928.4,	-2298.1,	408.4,	0.0);	(2571.2,	-3064.2,	420.6,	0.0);
(3213.9,	-3830.2,	371.9,	0.0);	(4820.9,	-5745.3,	392.0,	0.0);
(6427.9,	-7660.4,	390.1,	0.0);	(9641.8,	-11490.7,	340.0,	0.0);

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/25/94
*** One source; 936 receptors up to 50KM away; Surface wt. *** 17:50:05
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(12855.8,	-15320.9,	380.0,	0.0);	(19283.6,	-22981.3,	400.0,	0.0);
(25711.5,	-30641.8,	400.0,	0.0);	(32139.4,	-38302.2,	380.0,	0.0);
(50.0,	-86.6,	207.3,	0.0);	(100.0,	-173.2,	202.7,	0.0);
(150.0,	-259.8,	202.7,	0.0);	(200.0,	-346.4,	213.4,	0.0);
(250.0,	-433.0,	268.2,	0.0);	(300.0,	-519.6,	298.7,	0.0);
(350.0,	-606.2,	310.9,	0.0);	(400.0,	-692.8,	323.1,	0.0);
(450.0,	-779.4,	323.1,	0.0);	(500.0,	-866.0,	329.2,	0.0);
(625.0,	-1082.5,	298.7,	0.0);	(750.0,	-1299.0,	341.4,	0.0);
(875.0,	-1515.5,	341.4,	0.0);	(1000.0,	-1732.1,	359.7,	0.0);
(1125.0,	-1948.6,	365.8,	0.0);	(1250.0,	-2165.1,	371.9,	0.0);
(1500.0,	-2598.1,	408.4,	0.0);	(2000.0,	-3464.1,	420.6,	0.0);
(2500.0,	-4330.1,	408.4,	0.0);	(3750.0,	-6495.2,	408.4,	0.0);
(5000.0,	-8660.3,	396.2,	0.0);	(7500.0,	-12990.4,	340.0,	0.0);
(10000.0,	-17320.5,	360.0,	0.0);	(15000.0,	-25980.8,	420.0,	0.0);
(20000.0,	-34641.0,	400.0,	0.0);	(25000.0,	-43301,3,	400.0,	0.0);
(34.2,	-94.0,	207.3,	0.0);	(68.4,	-187.9,	202.7,	0.0);
(102.6,	-281.9,	202.7,	0.0);	(136.8,	-375.9,	207.3,	0.0);
(171.0,	-469.8,	268.2,	0.0);	(205.2,	-563.8,	292.6,	0.0);
(239.4,	-657.8,	304.8,	0.0);	(273.6,	-751.8,	304.8,	0.0);
(307.8,	-845.7,	286.5,	0.0);	(342.0,	-939.7,	286.5,	0.0);
(427.5,	-1174.6,	304.8,	0.0);	(513.0,	-1409.5,	310.9,	0.0);
(598.5,	-1644.5,	304.8,	0.0);	(684.0,	-1879.4,	335.3,	0.0);
(769.5,	-2114.3,	359.7,	0.0);	(855.1,	-2349.2,	378.0,	0.0);
(1026.1,	-2819.1,	396.2,	0.0);	(1368.1,	-3758.8,	402.3,	0.0);
(1710.1,	-4698.5,	411.5,	0.0);	(2565.2,	-7047.7,	402.3,	0.0);
(3420.2,	-9396.9,	408.1,	0.0);	(5130.3,	-14095.4,	360.0,	0.0);
(6840.4,	-18793.9,	360.0,	0.0);	(10260.6,	-28190.8,	420.0,	0.0);
(13680.8,	-37587.7,	400.0,	0.0);	(17101.0,	-46984.6,	420.0,	0.0);
(17.4,	-98.5,	207.3,	0.0);	(34.7,	-197.0,	202.7,	0.0);
(52.1,	-295.4,	202.7,	0.0);	(69.5,	-393.9,	202.7,	0.0);
(86.8,	-492.4,	249.9,	0.0);	(104.2,	-590.9,	286.5,	0.0);
(121.6,	-689.4,	280.4,	0.0);	(138.9,	-787.8,	274.3,	0.0);
(156.3,	-886.3,	286.5,	0.0);	(173.6,	-984.8,	286.5,	0.0);
(217.1,	-1231.0,	298.7,	0.0);	(260.5,	-1477.2,	304.8,	0.0);
(303.9,	-1723.4,	304.8,	0.0);	(347.3,	-1969.6,	298.7,	0.0);
(390.7,	-2215.8,	298.7,	0.0);	(434.1,	-2462.0,	365.8,	0.0);
(520.9,	-2954.4,	402.3,	0.0);	(694.6,	-3939.2,	390.1,	0.0);
(868.2,	-4924.0,	414.5,	0.0);	(1302.4,	-7386.1,	408.4,	0.0);
(1736.5,	-9848.1,	398.1,	0.0);	(2604.7,	-14772.1,	380.0,	0.0);
(3473.0,	-19696.2,	360.0,	0.0);	(5209.4,	-29544.2,	400.0,	0.0);
(6945.9,	-39392.3,	400.0,	0.0);	(8682.4,	-49240.4,	400.0,	0.0);
(0.0,	-100.0,	207.3,	0.0);	(0.0,	-200.0,	202.7,	0.0);
(0.0,	-300.0,	202.7,	0.0);	(0.0,	-400.0,	202.7,	0.0);
(0.0,	-500.0,	219.5,	0.0);	(0.0,	-600.0,	274.3,	0.0);
(0.0,	-700.0,	280.4,	0.0);	(0.0,	-800.0,	274.3,	0.0);

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/25/94
*** One source; 936 receptors up to 50KM away; Surface wt. *** 17:50:05
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(0.0,	-900.0,	243.8,	0.0);	(0.0,	-1000.0,	298.7,	0.0);
(0.0,	-1250.0,	304.8,	0.0);	(0.0,	-1500.0,	304.8,	0.0);
(0.0,	-1750.0,	304.8,	0.0);	(0.0,	-2000.0,	292.6,	0.0);
(0.0,	-2250.0,	298.7,	0.0);	(0.0,	-2500.0,	365.8,	0.0);
(0.0,	-3000.0,	406.3,	0.0);	(0.0,	-4000.0,	402.3,	0.0);
(0.0,	-5000.0,	396.2,	0.0);	(0.0,	-7500.0,	390.1,	0.0);
(0.0,	-10000.0,	396.2,	0.0);	(0.0,	-15000.0,	380.0,	0.0);
(0.0,	-20000.0,	360.0,	0.0);	(0.0,	-30000.0,	380.0,	0.0);
(0.0,	-40000.0,	380.0,	0.0);	(0.0,	-50000.0,	400.0,	0.0);
(-17.4,	-98.5,	207.3,	0.0);	(-34.7,	-197.0,	202.7,	0.0);
(-52.1,	-295.4,	202.7,	0.0);	(-69.5,	-393.9,	202.7,	0.0);
(-86.8,	-492.4,	202.7,	0.0);	(-104.2,	-590.9,	225.6,	0.0);
(-121.6,	-689.4,	274.3,	0.0);	(-138.9,	-787.8,	274.3,	0.0);
(-156.3,	-886.3,	237.7,	0.0);	(-173.6,	-984.8,	292.6,	0.0);
(-217.1,	-1231.0,	304.8,	0.0);	(-260.5,	-1477.2,	286.5,	0.0);
(-303.9,	-1723.4,	292.6,	0.0);	(-347.3,	-1969.6,	280.4,	0.0);
(-390.7,	-2215.8,	304.8,	0.0);	(-434.1,	-2462.0,	353.6,	0.0);
(-520.9,	-2954.4,	384.0,	0.0);	(-694.6,	-3939.2,	396.2,	0.0);
(-868.2,	-4924.0,	415.4,	0.0);	(-1302.4,	-7386.1,	390.1,	0.0);
(-1736.5,	-9848.1,	392.0,	0.0);	(-2604.7,	-14772.1,	360.0,	0.0);
(-3473.0,	-19696.2,	340.0,	0.0);	(-5209.4,	-29544.2,	340.0,	0.0);
(-6945.9,	-39392.3,	360.0,	0.0);	(-8682.4,	-49240.4,	380.0,	0.0);
(-34.2,	-94.0,	213.4,	0.0);	(-68.4,	-187.9,	202.7,	0.0);
(-102.6,	-281.9,	202.7,	0.0);	(-136.8,	-375.9,	202.7,	0.0);
(-171.0,	-469.8,	202.7,	0.0);	(-205.2,	-563.8,	202.7,	0.0);
(-239.4,	-657.8,	219.5,	0.0);	(-273.6,	-751.8,	249.9,	0.0);
(-307.8,	-845.7,	219.5,	0.0);	(-342.0,	-939.7,	280.4,	0.0);
(-427.5,	-1174.6,	280.4,	0.0);	(-513.0,	-1409.5,	280.4,	0.0);
(-598.5,	-1644.5,	280.4,	0.0);	(-684.0,	-1879.4,	262.1,	0.0);
(-769.5,	-2114.3,	298.7,	0.0);	(-855.1,	-2349.2,	353.6,	0.0);
(-1026.1,	-2819.1,	371.9,	0.0);	(-1368.1,	-3758.8,	402.3,	0.0);
(-1710.1,	-4698.5,	397.2,	0.0);	(-2565.2,	-7047.7,	384.0,	0.0);
(-3420.2,	-9396.9,	384.0,	0.0);	(-5130.3,	-14095.4,	340.0,	0.0);
(-6840.4,	-18793.9,	340.0,	0.0);	(-10260.6,	-28190.8,	360.0,	0.0);
(-13680.8,	-37587.7,	380.0,	0.0);	(-17101.0,	-46984.6,	380.0,	0.0);
(-50.0,	-86.6,	213.4,	0.0);	(-100.0,	-173.2,	202.7,	0.0);
(-150.0,	-259.8,	202.7,	0.0);	(-200.0,	-346.4,	202.7,	0.0);
(-250.0,	-433.0,	202.7,	0.0);	(-300.0,	-519.6,	202.7,	0.0);
(-350.0,	-606.2,	202.7,	0.0);	(-400.0,	-692.8,	202.7,	0.0);
(-450.0,	-779.4,	202.7,	0.0);	(-500.0,	-866.0,	219.5,	0.0);
(-625.0,	-1082.5,	219.5,	0.0);	(-750.0,	-1299.0,	213.4,	0.0);
(-875.0,	-1515.5,	213.4,	0.0);	(-1000.0,	-1732.1,	231.6,	0.0);
(-1125.0,	-1948.6,	231.6,	0.0);	(-1250.0,	-2165.1,	292.6,	0.0);
(-1500.0,	-2598.1,	359.7,	0.0);	(-2000.0,	-3464.1,	396.2,	0.0);
(-2500.0,	-4330.1,	414.5,	0.0);	(-3750.0,	-6495.2,	396.2,	0.0);

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/25/94
*** One source; 936 receptors up to 50KM away; Surface wt. *** 17:50:05
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(-5000.0,	-8660.3,	392.6,	0.0);	(-7500.0,	-12990.4,	360.0,	0.0);
(-10000.0,	-17320.5,	380.0,	0.0);	(-15000.0,	-25980.8,	360.0,	0.0);
(-20000.0,	-34641.0,	360.0,	0.0);	(-25000.0,	-43301.3,	380.0,	0.0);
(-64.3,	-76.6,	213.4,	0.0);	(-128.6,	-153.2,	202.7,	0.0);
(-192.8,	-229.8,	202.7,	0.0);	(-257.1,	-306.4,	202.7,	0.0);
(-321.4,	-383.0,	202.7,	0.0);	(-385.7,	-459.6,	202.7,	0.0);
(-450.0,	-536.2,	202.7,	0.0);	(-514.2,	-612.8,	202.7,	0.0);
(-578.5,	-689.4,	202.7,	0.0);	(-642.8,	-766.0,	202.7,	0.0);
(-803.5,	-957.6,	202.7,	0.0);	(-964.2,	-1149.1,	213.4,	0.0);
(-1124.9,	-1340.6,	213.4,	0.0);	(-1285.6,	-1532.1,	213.4,	0.0);
(-1446.3,	-1723.6,	213.4,	0.0);	(-1607.0,	-1915.1,	213.4,	0.0);
(-1928.4,	-2298.1,	371.9,	0.0);	(-2571.2,	-3064.2,	378.0,	0.0);
(-3213.9,	-3830.2,	396.2,	0.0);	(-4820.9,	-5745.3,	396.2,	0.0);
(-6427.9,	-7660.4,	378.0,	0.0);	(-9641.8,	-11490.7,	349.0,	0.0);
(-12855.8,	-15320.9,	360.0,	0.0);	(-19283.6,	-22981.3,	360.0,	0.0);
(-25711.5,	-30641.8,	380.0,	0.0);	(-32139.4,	-38302.2,	360.0,	0.0);
(-76.6,	-64.3,	213.4,	0.0);	(-153.2,	-128.6,	201.2,	0.0);
(-229.8,	-192.8,	207.3,	0.0);	(-306.4,	-257.1,	207.3,	0.0);
(-383.0,	-321.4,	202.7,	0.0);	(-459.6,	-385.7,	202.7,	0.0);
(-536.2,	-450.0,	202.7,	0.0);	(-612.8,	-514.2,	202.7,	0.0);
(-689.4,	-578.5,	207.3,	0.0);	(-766.0,	-642.8,	207.3,	0.0);
(-957.6,	-803.5,	207.3,	0.0);	(-1149.1,	-964.2,	207.3,	0.0);
(-1340.6,	-1124.9,	207.3,	0.0);	(-1532.1,	-1285.6,	213.4,	0.0);
(-1723.6,	-1446.3,	213.4,	0.0);	(-1915.1,	-1607.0,	256.0,	0.0);
(-2298.1,	-1928.4,	323.1,	0.0);	(-3064.2,	-2571.2,	359.7,	0.0);
(-3830.2,	-3213.9,	384.0,	0.0);	(-5745.3,	-4820.9,	378.0,	0.0);
(-7660.4,	-6427.9,	378.0,	0.0);	(-11490.7,	-9641.8,	360.0,	0.0);
(-15320.9,	-12855.8,	380.0,	0.0);	(-22981.3,	-19283.6,	400.0,	0.0);
(-30641.8,	-25711.5,	400.0,	0.0);	(-38302.2,	-32139.4,	380.0,	0.0);
(-86.6,	-50.0,	213.4,	0.0);	(-173.2,	-100.0,	213.4,	0.0);
(-259.8,	-150.0,	213.4,	0.0);	(-346.4,	-200.0,	207.3,	0.0);
(-433.0,	-250.0,	213.4,	0.0);	(-519.6,	-300.0,	213.4,	0.0);
(-606.2,	-350.0,	213.4,	0.0);	(-692.8,	-400.0,	213.4,	0.0);
(-779.4,	-450.0,	213.4,	0.0);	(-866.0,	-500.0,	213.4,	0.0);
(-1082.5,	-625.0,	225.6,	0.0);	(-1299.0,	-750.0,	274.3,	0.0);
(-1515.5,	-875.0,	329.2,	0.0);	(-1732.1,	-1000.0,	310.9,	0.0);
(-1948.6,	-1125.0,	286.5,	0.0);	(-2165.1,	-1250.0,	256.0,	0.0);
(-2598.1,	-1500.0,	243.8,	0.0);	(-3464.1,	-2000.0,	365.8,	0.0);
(-4330.1,	-2500.0,	372.5,	0.0);	(-6495.2,	-3750.0,	378.0,	0.0);
(-8660.3,	-5000.0,	402.3,	0.0);	(-12990.4,	-7500.0,	360.0,	0.0);
(-17320.5,	-10000.0,	380.0,	0.0);	(-25980.8,	-15000.0,	380.0,	0.0);
(-34641.0,	-20000.0,	400.0,	0.0);	(-43301.3,	-25000.0,	360.0,	0.0);
(-94.0,	-34.2,	213.4,	0.0);	(-187.9,	-68.4,	213.4,	0.0);
(-281.9,	-102.6,	213.4,	0.0);	(-375.9,	-136.8,	213.4,	0.0);
(-469.8,	-171.0,	213.4,	0.0);	(-563.8,	-205.2,	213.4,	0.0);

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/25/94
*** One source; 936 receptors up to 50KM away; Surface wt. *** 17:50:05
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(-657.8,	-239.4,	213.4,	0.0);	(-751.8,	-273.6,	219.5,	0.0);
(-845.7,	-307.8,	219.5,	0.0);	(-939.7,	-342.0,	213.4,	0.0);
(-1174.6,	-427.5,	353.6,	0.0);	(-1409.5,	-513.0,	353.6,	0.0);
(-1644.5,	-598.5,	341.4,	0.0);	(-1879.4,	-684.0,	335.3,	0.0);
(-2114.3,	-769.5,	353.6,	0.0);	(-2349.2,	-855.1,	304.8,	0.0);
(-2819.1,	-1026.1,	243.8,	0.0);	(-3758.8,	-1368.1,	298.7,	0.0);
(-4698.5,	-1710.1,	359.7,	0.0);	(-7047.7,	-2565.2,	365.8,	0.0);
(-9396.9,	-3420.2,	402.3,	0.0);	(-14095.4,	-5130.3,	380.0,	0.0);
(-18793.9,	-6840.4,	400.0,	0.0);	(-28190.8,	-10260.6,	380.0,	0.0);
(-37587.7,	-13680.8,	400.0,	0.0);	(-46984.6,	-17101.0,	360.0,	0.0);
(-98.5,	-17.4,	213.4,	0.0);	(-197.0,	-34.7,	213.4,	0.0);
(-295.4,	-52.1,	213.4,	0.0);	(-393.9,	-69.5,	213.4,	0.0);
(-492.4,	-86.8,	213.4,	0.0);	(-590.9,	-104.2,	213.4,	0.0);
(-689.4,	-121.6,	213.4,	0.0);	(-787.8,	-138.9,	219.5,	0.0);
(-886.3,	-156.3,	225.6,	0.0);	(-984.8,	-173.6,	310.9,	0.0);
(-1231.0,	-217.1,	359.7,	0.0);	(-1477.2,	-260.5,	359.7,	0.0);
(-1723.4,	-303.9,	365.8,	0.0);	(-1969.6,	-347.3,	371.9,	0.0);
(-2215.8,	-390.7,	353.6,	0.0);	(-2462.0,	-434.1,	371.9,	0.0);
(-2954.4,	-520.9,	353.6,	0.0);	(-3939.2,	-694.6,	365.8,	0.0);
(-4924.0,	-868.2,	365.8,	0.0);	(-7386.1,	-1302.4,	390.1,	0.0);
(-9848.1,	-1736.5,	339.9,	0.0);	(-14772.1,	-2604.7,	360.0,	0.0);
(-19696.2,	-3473.0,	380.0,	0.0);	(-29544.2,	-5209.4,	420.0,	0.0);
(-39392.3,	-6945.9,	400.0,	0.0);	(-49240.4,	-8682.4,	400.0,	0.0);
(-100.0,	0.0,	213.4,	0.0);	(-200.0,	0.0,	213.4,	0.0);
(-300.0,	0.0,	213.4,	0.0);	(-400.0,	0.0,	213.4,	0.0);
(-500.0,	0.0,	213.4,	0.0);	(-600.0,	0.0,	213.4,	0.0);
(-700.0,	0.0,	213.4,	0.0);	(-800.0,	0.0,	213.4,	0.0);
(-900.0,	0.0,	243.8,	0.0);	(-1000.0,	0.0,	298.7,	0.0);
(-1250.0,	0.0,	304.8,	0.0);	(-1500.0,	0.0,	304.8,	0.0);
(-1750.0,	0.0,	335.3,	0.0);	(-2000.0,	0.0,	341.4,	0.0);
(-2250.0,	0.0,	371.9,	0.0);	(-2500.0,	0.0,	371.9,	0.0);
(-3000.0,	0.0,	371.9,	0.0);	(-4000.0,	0.0,	378.0,	0.0);
(-5000.0,	0.0,	371.9,	0.0);	(-7500.0,	0.0,	371.9,	0.0);
(-10000.0,	0.0,	360.0,	0.0);	(-15000.0,	0.0,	340.0,	0.0);
(-20000.0,	0.0,	360.0,	0.0);	(-30000.0,	0.0,	380.0,	0.0);
(-40000.0,	0.0,	380.0,	0.0);	(-50000.0,	0.0,	400.0,	0.0);
(-98.5,	17.4,	213.4,	0.0);	(-197.0,	34.7,	213.4,	0.0);
(-295.4,	52.1,	213.4,	0.0);	(-393.9,	69.5,	213.4,	0.0);
(-492.4,	86.8,	213.4,	0.0);	(-590.9,	104.2,	225.6,	0.0);
(-689.4,	121.6,	225.6,	0.0);	(-787.8,	138.9,	237.7,	0.0);
(-886.3,	156.3,	243.8,	0.0);	(-984.8,	173.6,	280.4,	0.0);
(-1231.0,	217.1,	317.0,	0.0);	(-1477.2,	260.5,	304.8,	0.0);
(-1723.4,	303.9,	298.7,	0.0);	(-1969.6,	347.3,	341.4,	0.0);
(-2215.8,	390.7,	371.9,	0.0);	(-2462.0,	434.1,	353.6,	0.0);
(-2954.4,	520.9,	365.8,	0.0);	(-3939.2,	694.6,	353.6,	0.0);

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(-4924.0,	868.2,	378.0,	0.0);	(-7386.1,	1302.4,	384.0,	0.0);
(-9848.1,	1736.5,	389.2,	0.0);	(-14772.1,	2604.7,	400.0,	0.0);
(-19696.2,	3473.0,	420.0,	0.0);	(-29544.2,	5209.4,	380.0,	0.0);
(-39392.3,	6945.9,	380.0,	0.0);	(-49240.4,	8682.4,	400.0,	0.0);
(-94.0,	34.2,	213.4,	0.0);	(-187.9,	68.4,	213.4,	0.0);
(-281.9,	102.6,	213.4,	0.0);	(-375.9,	136.8,	219.5,	0.0);
(-469.8,	171.0,	225.6,	0.0);	(-563.8,	205.2,	225.6,	0.0);
(-657.8,	239.4,	243.8,	0.0);	(-751.8,	273.6,	274.3,	0.0);
(-845.7,	307.8,	286.5,	0.0);	(-939.7,	342.0,	298.7,	0.0);
(-1174.6,	427.5,	317.0,	0.0);	(-1409.5,	513.0,	298.7,	0.0);
(-1644.5,	598.5,	298.7,	0.0);	(-1879.4,	684.0,	359.7,	0.0);
(-2114.3,	769.5,	384.0,	0.0);	(-2349.2,	855.1,	378.0,	0.0);
(-2819.1,	1026.1,	378.0,	0.0);	(-3758.8,	1368.1,	378.0,	0.0);
(-4698.5,	1710.1,	378.0,	0.0);	(-7047.7,	2565.2,	371.9,	0.0);
(-9396.9,	3420.2,	424.9,	0.0);	(-14095.4,	5130.3,	420.0,	0.0);
(-18793.9,	6840.4,	360.0,	0.0);	(-28190.8,	10260.6,	400.0,	0.0);
(-37587.7,	13680.8,	380.0,	0.0);	(-46984.6,	17101.0,	400.0,	0.0);
(-86.6,	50.0,	213.4,	0.0);	(-173.2,	100.0,	213.4,	0.0);
(-259.8,	150.0,	219.5,	0.0);	(-346.4,	200.0,	231.6,	0.0);
(-433.0,	250.0,	225.6,	0.0);	(-519.6,	300.0,	231.6,	0.0);
(-606.2,	350.0,	268.2,	0.0);	(-692.8,	400.0,	304.8,	0.0);
(-779.4,	450.0,	310.9,	0.0);	(-866.0,	500.0,	304.8,	0.0);
(-1082.5,	625.0,	292.6,	0.0);	(-1299.0,	750.0,	323.1,	0.0);
(-1515.5,	875.0,	359.7,	0.0);	(-1732.1,	1000.0,	371.9,	0.0);
(-1948.6,	1125.0,	371.9,	0.0);	(-2165.1,	1250.0,	378.0,	0.0);
(-2598.1,	1500.0,	378.0,	0.0);	(-3464.1,	2000.0,	378.0,	0.0);
(-4330.1,	2500.0,	384.0,	0.0);	(-6495.2,	3750.0,	384.0,	0.0);
(-8660.3,	5000.0,	426.7,	0.0);	(-12990.4,	7500.0,	400.0,	0.0);
(-17320.5,	10000.0,	400.0,	0.0);	(-25980.8,	15000.0,	420.0,	0.0);
(-34641.0,	20000.0,	400.0,	0.0);	(-43301.3,	25000.0,	350.0,	0.0);
(-76.6,	64.3,	213.4,	0.0);	(-153.2,	128.6,	213.4,	0.0);
(-229.8,	192.8,	225.6,	0.0);	(-306.4,	257.1,	231.6,	0.0);
(-383.0,	321.4,	225.6,	0.0);	(-459.6,	385.7,	231.6,	0.0);
(-536.2,	450.0,	268.2,	0.0);	(-612.8,	514.2,	304.8,	0.0);
(-689.4,	578.5,	316.4,	0.0);	(-766.0,	642.8,	317.0,	0.0);
(-957.6,	803.5,	304.8,	0.0);	(-1149.1,	964.2,	341.4,	0.0);
(-1340.6,	1124.9,	353.6,	0.0);	(-1532.1,	1285.6,	365.8,	0.0);
(-1723.6,	1446.3,	371.9,	0.0);	(-1915.1,	1607.0,	378.0,	0.0);
(-2298.1,	1928.4,	384.0,	0.0);	(-3064.2,	2571.2,	359.7,	0.0);
(-3830.2,	3213.9,	384.0,	0.0);	(-5745.3,	4820.9,	378.0,	0.0);
(-7660.4,	6427.9,	379.2,	0.0);	(-11490.7,	9641.8,	360.0,	0.0);
(-15320.9,	12855.8,	400.0,	0.0);	(-22981.3,	19283.6,	400.0,	0.0);
(-30641.8,	25711.5,	400.0,	0.0);	(-38302.2,	32139.4,	370.0,	0.0);
(-64.3,	76.6,	213.4,	0.0);	(-128.6,	153.2,	225.6,	0.0);
(-192.8,	229.8,	231.6,	0.0);	(-257.1,	306.4,	231.6,	0.0);

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/25/94
*** One source; 936 receptors up to 50KM away; Surface wt. *** 17:50:05
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(-321.4,	383.0,	225.6,	0.0);	(-385.7,	459.6,	231.6,	0.0);
(-450.0,	536.2,	274.3,	0.0);	(-514.2,	612.8,	304.8,	0.0);
(-578.5,	689.4,	310.9,	0.0);	(-642.8,	766.0,	310.9,	0.0);
(-803.5,	957.6,	317.0,	0.0);	(-964.2,	1149.1,	347.5,	0.0);
(-1124.9,	1340.6,	353.6,	0.0);	(-1285.6,	1532.1,	353.6,	0.0);
(-1446.3,	1723.6,	359.7,	0.0);	(-1607.0,	1915.1,	365.8,	0.0);
(-1928.4,	2298.1,	384.0,	0.0);	(-2571.2,	3064.2,	384.0,	0.0);
(-3213.9,	3830.2,	378.0,	0.0);	(-4820.9,	5745.3,	378.0,	0.0);
(-6427.9,	7660.4,	378.0,	0.0);	(-9641.8,	11490.7,	380.0,	0.0);
(-12855.8,	15320.9,	400.0,	0.0);	(-19283.6,	22981.3,	400.0,	0.0);
(-25711.5,	30641.8,	360.0,	0.0);	(-32139.4,	38302.2,	360.0,	0.0);
(-50.0,	86.6,	213.4,	0.0);	(-100.0,	173.2,	225.6,	0.0);
(-150.0,	259.8,	231.6,	0.0);	(-200.0,	346.4,	231.6,	0.0);
(-250.0,	433.0,	225.6,	0.0);	(-300.0,	519.6,	243.8,	0.0);
(-350.0,	606.2,	249.9,	0.0);	(-400.0,	692.8,	243.8,	0.0);
(-450.0,	779.4,	304.8,	0.0);	(-500.0,	866.0,	304.8,	0.0);
(-625.0,	1082.5,	286.5,	0.0);	(-750.0,	1299.0,	329.2,	0.0);
(-875.0,	1515.5,	347.5,	0.0);	(-1000.0,	1732.1,	353.6,	0.0);
(-1125.0,	1948.6,	353.6,	0.0);	(-1250.0,	2165.1,	384.0,	0.0);
(-1500.0,	2598.1,	384.0,	0.0);	(-2000.0,	3464.1,	384.0,	0.0);
(-2500.0,	4330.1,	378.0,	0.0);	(-3750.0,	6495.2,	365.8,	0.0);
(-5000.0,	8660.3,	371.9,	0.0);	(-7500.0,	12990.4,	360.0,	0.0);
(-10000.0,	17320.5,	360.0,	0.0);	(-15000.0,	25980.8,	340.0,	0.0);
(-20000.0,	34641.0,	380.0,	0.0);	(-25000.0,	43301.3,	350.0,	0.0);
(-34.2,	94.0,	213.4,	0.0);	(-68.4,	187.9,	225.6,	0.0);
(-102.6,	281.9,	225.6,	0.0);	(-136.8,	375.9,	225.6,	0.0);
(-171.0,	469.8,	225.6,	0.0);	(-205.2,	563.8,	243.8,	0.0);
(-239.4,	657.8,	262.1,	0.0);	(-273.6,	751.8,	286.5,	0.0);
(-307.8,	845.7,	280.4,	0.0);	(-342.0,	939.7,	292.6,	0.0);
(-427.5,	1174.6,	323.1,	0.0);	(-513.0,	1409.5,	353.6,	0.0);
(-598.5,	1644.5,	359.7,	0.0);	(-684.0,	1879.4,	359.7,	0.0);
(-769.5,	2114.3,	329.2,	0.0);	(-855.1,	2349.2,	347.5,	0.0);
(-1026.1,	2819.1,	378.0,	0.0);	(-1368.1,	3758.8,	385.0,	0.0);
(-1710.1,	4698.5,	371.9,	0.0);	(-2565.2,	7047.7,	329.2,	0.0);
(-3420.2,	9396.9,	349.0,	0.0);	(-5130.3,	14095.4,	360.0,	0.0);
(-6840.4,	18793.9,	360.0,	0.0);	(-10260.6,	28190.8,	340.0,	0.0);
(-13680.8,	37587.7,	370.0,	0.0);	(-17101.0,	46984.6,	350.0,	0.0);
(-17.4,	98.5,	213.4,	0.0);	(-34.7,	197.0,	225.6,	0.0);
(-52.1,	295.4,	225.6,	0.0);	(-69.5,	393.9,	225.6,	0.0);
(-86.8,	492.4,	225.6,	0.0);	(-104.2,	590.9,	243.8,	0.0);
(-121.6,	689.4,	262.1,	0.0);	(-138.9,	787.8,	292.6,	0.0);
(-156.3,	886.3,	298.7,	0.0);	(-173.6,	984.8,	298.7,	0.0);
(-217.1,	1231.0,	335.3,	0.0);	(-260.5,	1477.2,	365.8,	0.0);
(-303.9,	1723.4,	359.7,	0.0);	(-347.3,	1969.6,	359.7,	0.0);
(-390.7,	2215.8,	341.4,	0.0);	(-434.1,	2462.0,	378.0,	0.0);

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(	-520.9,	2954.4,	384.0,	0.0);	(	-694.6,	3939.2,	378.0,	0.0);
(	-868.2,	4924.0,	365.8,	0.0);	(	-1302.4,	7386.1,	341.4,	0.0);
(	-1736.5,	9848.1,	339.9,	0.0);	(	-2604.7,	14772.1,	340.0,	0.0);
(	-3473.0,	19696.2,	360.0,	0.0);	(	-5209.5,	29544.2,	340.0,	0.0);
(	-6945.9,	39392.3,	330.0,	0.0);	(	-8682.4,	49240.4,	320.0,	0.0);
(	0.0,	100.0,	213.4,	0.0);	(	0.0,	200.0,	225.6,	0.0);
(	0.0,	300.0,	225.6,	0.0);	(	0.0,	400.0,	225.6,	0.0);
(	0.0,	500.0,	225.6,	0.0);	(	0.0,	600.0,	237.7,	0.0);
(	0.0,	700.0,	256.0,	0.0);	(	0.0,	800.0,	280.4,	0.0);
(	0.0,	900.0,	298.7,	0.0);	(	0.0,	1000.0,	292.6,	0.0);
(	0.0,	1250.0,	353.6,	0.0);	(	0.0,	1500.0,	323.1,	0.0);
(	0.0,	1750.0,	341.4,	0.0);	(	0.0,	2000.0,	317.0,	0.0);
(	0.0,	2250.0,	359.7,	0.0);	(	0.0,	2500.0,	359.7,	0.0);
(	0.0,	3000.0,	378.0,	0.0);	(	0.0,	4000.0,	383.4,	0.0);
(	0.0,	5000.0,	359.7,	0.0);	(	0.0,	7500.0,	371.9,	0.0);
(	0.0,	10000.0,	380.1,	0.0);	(	0.0,	15000.0,	360.0,	0.0);
(	0.0,	20000.0,	340.0,	0.0);	(	0.0,	30000.0,	380.0,	0.0);
(	0.0,	40000.0,	350.0,	0.0);	(	0.0,	50000.0,	350.0,	0.0);

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/25/94
*** One source; 936 receptors up to 50KM away; Surface wt. *** 17:50:05
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** METEOROLOGICAL DAYS SELECTED FOR PROCESSING ***
(1=YES; 0=NO)

1 1 1

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/25/94
*** One source; 936 receptors up to 50KM away; Surface wt. *** 17:50:05
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*** MODELING OPTIONS USED: COMC RURAL ELEV DFAULT DRYDPL WETDPL

*** THE FIRST 24 HOURS OF METEOROLOGICAL DATA ***

FILE: depbin.met FORMAT: (4I2,2F9.4,F6.1,I2,2F7.1,f9.4,f10.1,f8.4,f5.1,i4,f7.2)
SURFACE STATION NO.: 94823 UPPER AIR STATION NO.: 94823
NAME: WTI NAME: WTI
YEAR: 1993 YEAR: 1993

YEAR	MONTH	DAY	HOUR	FLOW VECTOR	SPEED (M/S)	TEMP (K)	STAB CLASS	MIXING HEIGHT (M) RURAL	MIXING HEIGHT (M) URBAN	USTAR (M/S)	M-O LENGTH (M)	Z-0 (M)	Zd (M)	IPCODE	PRATE (mm/HR)
93	1	1	1	104.0	4.47	275.4	4	601.6	601.6	0.3366	176.8	0.3000	1.5	13	0.00
93	1	1	2	112.0	5.36	274.8	4	617.6	617.6	0.4269	283.7	0.3000	1.5	0	0.25
93	1	1	3	106.0	4.47	274.0	4	633.5	633.5	0.3363	175.6	0.3000	1.5	0	0.00
93	1	1	4	115.0	4.47	273.9	4	649.5	649.5	0.3363	175.4	0.3000	1.5	28	0.00
93	1	1	5	120.0	4.02	273.8	4	665.4	665.4	0.2874	128.1	0.3000	1.5	28	0.00
93	1	1	6	123.0	5.36	273.3	4	681.4	681.4	0.4266	281.8	0.3000	1.5	28	0.00
93	1	1	7	130.0	4.92	272.5	4	697.3	697.3	0.3820	225.3	0.3000	1.5	28	0.00
93	1	1	8	124.0	4.92	271.9	4	713.3	713.3	0.3819	224.6	0.3000	1.5	28	0.00
93	1	1	9	115.0	4.47	271.0	4	729.2	729.2	0.3355	172.9	0.3000	1.5	28	0.00
93	1	1	10	107.0	4.02	270.9	4	745.2	745.2	0.3534	-999.0	0.3000	1.5	28	0.00
93	1	1	11	113.0	4.02	270.6	4	761.1	761.1	0.3534	-999.0	0.3000	1.5	28	0.00
93	1	1	12	108.0	4.47	270.9	4	777.1	777.1	0.3926	-999.0	0.3000	1.5	28	0.00
93	1	1	13	114.0	5.36	271.1	4	793.0	793.0	0.4712	-999.0	0.3000	1.5	28	0.00
93	1	1	14	107.0	4.92	271.0	4	809.0	809.0	0.4319	-999.0	0.3000	1.5	28	0.00
93	1	1	15	120.0	4.92	270.8	4	809.0	809.0	0.3817	223.4	0.3000	1.5	28	0.00
93	1	1	16	119.0	4.47	270.5	4	809.0	809.0	0.3354	172.4	0.3000	1.5	28	0.00
93	1	1	17	118.0	3.58	270.4	4	809.0	809.0	0.2310	81.7	0.3000	1.5	28	0.00
93	1	1	18	124.0	2.68	270.4	4	809.0	809.0	0.1178	29.4	0.3000	1.5	28	0.00
93	1	1	19	124.0	2.68	270.1	4	809.0	809.0	0.1178	29.4	0.3000	1.5	28	0.00
93	1	1	20	113.0	2.23	270.3	4	809.0	809.0	0.0982	29.4	0.3000	1.5	28	0.00
93	1	1	21	97.0	2.68	270.3	4	809.0	809.0	0.1178	29.4	0.3000	1.5	0	0.00
93	1	1	22	113.0	3.13	270.3	4	809.0	809.0	0.1374	29.4	0.3000	1.5	28	0.00
93	1	1	23	117.0	3.13	270.4	4	809.0	809.0	0.1374	29.4	0.3000	1.5	0	0.00
93	1	1	24	152.0	2.68	269.9	4	809.0	809.0	0.1178	29.4	0.3000	1.5	28	0.00

*** NOTES: STABILITY CLASS 1=A, 2=B, 3=C, 4=D, 5=E AND 6=F.
FLOW VECTOR IS DIRECTION TOWARD WHICH WIND IS BLOWING.

```
 *** ISCOMDEP VERSION 94227 ***     ***  WTI stack modeling, EPA Region V, Project 1363, Base Case          ***        08/29/94
                                   ***  One source; 936 receptors up to 50KM away; Vapor.                 ***        10:56:41
                                                                                                                     PAGE   1
 *** MODELING OPTIONS USED:  CONC   RURAL  ELEV          DFAULT

                                          ***     MODEL SETUP OPTIONS SUMMARY       ***
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

**Intermediate Terrain Processing is Selected

**Model Is Setup For Calculation of Average CONCentration Values.

  --  SCAVENGING/DEPOSITION LOGIC --
**Model Uses NO DRY DEPLETION.  DDPLETE =  F
**Model Uses NO WET DEPLETION.  WDPLETE =  F
**NO WET SCAVENGING Data Provided.
**Model Uses GRIDDED TERRAIN Data for Depletion Calculations

**Model Uses RURAL Dispersion.

**Model Uses Regulatory DEFAULT Options:
          1. Final Plume Rise.
          2. Stack-tip Downwash.
          3. Buoyancy-induced Dispersion.
          4. Use Calms Processing Routine.
          5. Not Use Missing Data Processing Routine.
          6. Default Wind Profile Exponents.
          7. Default Vertical Potential Temperature Gradients.
          8. 'Upper Bound' Values for Supersquat Buildings.
          9. No Exponential Decay for RURAL Mode

**Model Accepts Receptors on ELEV Terrain.

**Model Assumes No FLAGPOLE Receptor Heights.

**Model Accepting Temperature Profile Data.
  Number of Levels :          3
    (m AGL)          30.0000
    (m AGL)          45.7000
    (m AGL)          152.400

**Model Accepting Wind Profile Data.
  Number of Levels :          5
    (m AGL)          30.0000
    (m AGL)          45.7000
    (m AGL)          80.8000
    (m AGL)          111.300
    (m AGL)          152.400

**Model Calculates  1 Short Term Average(s) of:   1-HR
    and Calculates PERIOD Averages

**This Run Includes:     1 Source(s);      1 Source Group(s); and    936 Receptor(s)

**The Model Assumes A Pollutant Type of:  LEAD

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
        Model Outputs Tables of PERIOD Averages by Receptor
        Model Outputs Tables of Highest Short Term Values by Receptor (RECTABLE Keyword)
        Model Outputs Tables of Overall Maximum Short Term Values (MAXTABLE Keyword)
        Model Outputs External File(s) of High Values for Plotting (PLOTFILE Keyword)

**NOTE:  The Following Flags May Appear Following CONC Values:  c for Calm Hours
                                                                m for Missing Hours
                                                                b for Both Calm and Missing Hours

**Misc. Inputs:  Anem. Hgt. (m) =   30.00 ;   Decay Coef. =   0.0000     ;   Rot. Angle =     0.0
                 Emission Units = GRAMS/SEC                               ;  Emission Rate Unit Factor =   0.10000E+07
                 Output Units   = MICROGRAMS/M**3

**Input Runstream File: basec.inc                                  ;  **Output Print File: basec.con
**Detailed Error/Message File:   ERRORS.OUT
```

*** ISCOMMDP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/29/94
*** One source; 936 receptors up to 50KM away; Vapor. *** 10:56:41
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** POINT SOURCE DATA ***

SOURCE ID	NUMBER PART. CATS.	EMISSION RATE (GRAMS/SEC)	X (METERS)	Y (METERS)	BASE ELEV. (METERS)	STACK HEIGHT (METERS)	STACK TEMP. (DEG.K)	STACK EXIT VEL. (M/SEC)	STACK DIAMETER (METERS)	BUILDING EXISTS	EMISSION RATE SCALAR VARY BY
WTISTACK	0	0.10000E+01	0.0	0.0	212.1	45.70	367.00	17.74	1.83	YES	

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/29/94
*** One source; 936 receptors up to 50KM away; Vapor. *** 10:56:41
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** SOURCE IDs DEFINING SOURCE GROUPS ***

GROUP ID	SOURCE IDs
ALL	WTISTACK,

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/29/94
*** One source; 936 receptors up to 50KM away; Vapor. *** 10:56:41
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** SOURCE PARTICULATE/GAS DATA ***

*** SOURCE ID = WTISTACK; SOURCE TYPE = POINT ***

SCAV COEF [LIQ] 1/(S-MM/HR)=
0.00E+00,

SCAV COEF [ICE] 1/(S-MM/HR)=
0.00E+00,

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/29/94
*** One source; 936 receptors up to 50KM away; Vapor. *** 10:56:41
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** DIRECTION SPECIFIC BUILDING DIMENSIONS ***

SOURCE ID: WTISTACK

IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK
1	29.1,	26.9,	0	2	29.1,	24.7,	0	3	29.1,	21.8,	0	4	25.8,	27.6,	0	5	24.4,	27.0,	0	6	24.4,	24.6,	0
7	24.4,	26.0,	0	8	29.1,	22.6,	0	9	29.1,	25.8,	0	10	29.1,	28.8,	0	11	29.1,	30.9,	0	12	29.1,	32.1,	0
13	29.1,	32.3,	0	14	29.1,	31.8,	0	15	29.1,	30.9,	0	16	29.1,	29.6,	0	17	29.1,	29.3,	0	18	29.1,	28.2,	0
19	29.1,	26.9,	0	20	29.1,	24.7,	0	21	29.1,	21.8,	0	22	25.8,	27.6,	0	23	25.8,	26.1,	0	24	25.8,	23.8,	0
25	24.4,	26.0,	0	26	25.8,	24.8,	0	27	29.1,	25.8,	0	28	29.1,	28.8,	0	29	29.1,	30.9,	0	30	29.1,	32.1,	0
31	29.1,	32.3,	0	32	29.1,	31.8,	0	33	29.1,	30.9,	0	34	29.1,	29.6,	0	35	29.1,	29.3,	0	36	29.1,	28.2,	0

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/29/94
*** One source; 936 receptors up to 50KM away; Vapor. *** 10:56:41
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(17.4,	98.5,	213.4,	0.0);	(34.7,	197.0,	225.6,	0.0);
(52.1,	295.4,	225.6,	0.0);	(69.5,	393.9,	225.6,	0.0);
(86.8,	492.4,	225.6,	0.0);	(104.2,	590.9,	225.6,	0.0);
(121.6,	689.4,	243.8,	0.0);	(138.9,	787.8,	256.0,	0.0);
(156.3,	886.3,	280.4,	0.0);	(173.6,	984.8,	286.5,	0.0);
(217.1,	1231.0,	353.6,	0.0);	(260.5,	1477.2,	353.6,	0.0);
(303.9,	1723.4,	310.9,	0.0);	(347.3,	1969.6,	347.5,	0.0);
(390.7,	2215.8,	353.6,	0.0);	(434.1,	2462.0,	359.7,	0.0);
(520.9,	2954.4,	347.5,	0.0);	(694.6,	3939.2,	341.4,	0.0);
(868.2,	4924.0,	341.4,	0.0);	(1302.4,	7386.1,	365.8,	0.0);
(1736.5,	9848.1,	360.0,	0.0);	(2604.7,	14772.1,	340.0,	0.0);
(3473.0,	19696.2,	340.0,	0.0);	(5209.4,	29544.2,	360.0,	0.0);
(6945.9,	39392.3,	350.0,	0.0);	(8682.4,	49240.4,	360.0,	0.0);
(34.2,	94.0,	213.4,	0.0);	(68.4,	187.9,	225.6,	0.0);
(102.6,	281.9,	225.6,	0.0);	(136.8,	375.9,	225.6,	0.0);
(171.0,	469.8,	225.6,	0.0);	(205.2,	563.8,	225.6,	0.0);
(239.4,	657.8,	237.7,	0.0);	(273.6,	751.8,	243.8,	0.0);
(307.8,	845.7,	256.0,	0.0);	(342.0,	939.7,	286.5,	0.0);
(427.5,	1174.6,	329.2,	0.0);	(513.0,	1409.5,	347.5,	0.0);
(598.5,	1644.5,	335.3,	0.0);	(684.0,	1879.4,	347.5,	0.0);
(769.5,	2114.3,	353.6,	0.0);	(855.1,	2349.2,	359.7,	0.0);
(1026.1,	2819.1,	362.4,	0.0);	(1368.1,	3758.8,	329.2,	0.0);
(1710.1,	4698.5,	359.7,	0.0);	(2565.2,	7047.7,	369.7,	0.0);
(3420.2,	9396.9,	385.9,	0.0);	(5130.3,	14095.4,	340.0,	0.0);
(6840.4,	18793.9,	340.0,	0.0);	(10260.6,	28190.8,	360.0,	0.0);
(13680.8,	37587.7,	380.0,	0.0);	(17101.0,	46984.6,	390.0,	0.0);
(50.0,	86.6,	213.4,	0.0);	(100.0,	173.2,	219.5,	0.0);
(150.0,	259.8,	225.6,	0.0);	(200.0,	346.4,	225.6,	0.0);
(250.0,	433.0,	225.6,	0.0);	(300.0,	519.6,	225.6,	0.0);
(350.0,	606.2,	225.6,	0.0);	(400.0,	692.8,	231.6,	0.0);
(450.0,	779.4,	243.8,	0.0);	(500.0,	866.0,	262.1,	0.0);
(625.0,	1082.5,	225.6,	0.0);	(750.0,	1299.0,	347.5,	0.0);
(875.0,	1515.5,	359.7,	0.0);	(1000.0,	1732.1,	353.6,	0.0);
(1125.0,	1948.6,	353.6,	0.0);	(1250.0,	2165.1,	329.2,	0.0);
(1500.0,	2598.1,	323.1,	0.0);	(2000.0,	3464.1,	361.2,	0.0);
(2500.0,	4330.1,	366.7,	0.0);	(3750.0,	6495.2,	378.0,	0.0);
(5000.0,	8660.3,	396.2,	0.0);	(7500.0,	12990.4,	320.0,	0.0);
(10000.0,	17320.5,	360.0,	0.0);	(15000.0,	25980.8,	380.0,	0.0);
(20000.0,	34641.0,	370.0,	0.0);	(25000.0,	43301.3,	400.0,	0.0);
(64.3,	76.6,	213.4,	0.0);	(128.6,	153.2,	213.4,	0.0);
(192.8,	229.8,	225.6,	0.0);	(257.1,	306.4,	225.6,	0.0);
(321.4,	383.0,	225.6,	0.0);	(385.7,	459.6,	225.6,	0.0);
(450.0,	536.2,	225.6,	0.0);	(514.2,	612.8,	225.6,	0.0);
(578.5,	689.4,	225.6,	0.0);	(642.8,	766.0,	243.8,	0.0);
(803.5,	957.6,	280.4,	0.0);	(964.2,	1149.1,	353.6,	0.0);

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/29/94
*** One source; 936 receptors up to 50KM away; Vapor. *** 10:56:41
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(1124.9,	1340.6,	361.5,	0.0);	(1285.6,	1532.1,	353.6,	0.0);
(1446.3,	1723.6,	353.6,	0.0);	(1607.0,	1915.1,	353.6,	0.0);
(1928.4,	2298.1,	335.3,	0.0);	(2571.2,	3064.2,	353.9,	0.0);
(3213.9,	3830.2,	353.0,	0.0);	(4820.9,	5745.3,	378.0,	0.0);
(6427.9,	7660.4,	398.4,	0.0);	(9641.8,	11490.7,	376.0,	0.0);
(12855.8,	15320.9,	380.0,	0.0);	(19283.6,	22981.3,	360.0,	0.0);
(25711.5,	30641.8,	420.0,	0.0);	(32139.4,	38302.2,	420.0,	0.0);
(76.6,	64.3,	213.4,	0.0);	(153.2,	128.6,	207.3,	0.0);
(229.8,	192.8,	213.4,	0.0);	(306.4,	257.1,	219.5,	0.0);
(383.0,	321.4,	219.5,	0.0);	(459.6,	385.7,	219.5,	0.0);
(536.2,	450.0,	219.5,	0.0);	(612.8,	514.2,	219.5,	0.0);
(689.4,	578.5,	225.6,	0.0);	(766.0,	642.8,	219.5,	0.0);
(957.6,	803.5,	219.5,	0.0);	(1149.1,	964.2,	323.1,	0.0);
(1340.6,	1124.9,	353.6,	0.0);	(1532.1,	1285.6,	353.6,	0.0);
(1723.6,	1446.3,	335.3,	0.0);	(1915.1,	1607.0,	347.5,	0.0);
(2298.1,	1928.4,	347.5,	0.0);	(3064.2,	2571.2,	341.4,	0.0);
(3830.2,	3213.9,	335.3,	0.0);	(5745.3,	4820.9,	373.1,	0.0);
(7660.4,	6427.9,	396.2,	0.0);	(11490.7,	9641.8,	360.0,	0.0);
(15320.9,	12855.8,	380.0,	0.0);	(22981.3,	19283.6,	380.0,	0.0);
(30641.8,	25711.5,	420.0,	0.0);	(38302.2,	32139.4,	420.0,	0.0);
(86.6,	50.0,	213.4,	0.0);	(173.2,	100.0,	207.3,	0.0);
(259.8,	150.0,	207.3,	0.0);	(346.4,	200.0,	201.2,	0.0);
(433.0,	250.0,	207.3,	0.0);	(519.6,	300.0,	213.4,	0.0);
(606.2,	350.0,	213.4,	0.0);	(692.8,	400.0,	213.4,	0.0);
(779.4,	450.0,	213.4,	0.0);	(866.0,	500.0,	219.5,	0.0);
(1082.5,	625.0,	225.6,	0.0);	(1299.0,	750.0,	219.5,	0.0);
(1515.5,	875.0,	243.8,	0.0);	(1732.1,	1000.0,	292.6,	0.0);
(1948.6,	1125.0,	310.9,	0.0);	(2165.1,	1250.0,	323.1,	0.0);
(2598.1,	1500.0,	317.0,	0.0);	(3464.1,	2000.0,	323.1,	0.0);
(4330.1,	2500.0,	359.7,	0.0);	(6495.2,	3750.0,	378.9,	0.0);
(8660.3,	5000.0,	408.7,	0.0);	(12990.4,	7500.0,	380.0,	0.0);
(17320.5,	10000.0,	360.0,	0.0);	(25980.8,	15000.0,	380.0,	0.0);
(34641.0,	20000.0,	380.0,	0.0);	(43301.3,	25000.0,	420.0,	0.0);
(94.0,	34.2,	207.3,	0.0);	(187.9,	68.4,	201.2,	0.0);
(281.9,	102.6,	202.7,	0.0);	(375.9,	136.8,	202.7,	0.0);
(469.8,	171.0,	207.3,	0.0);	(563.8,	205.2,	207.3,	0.0);
(657.8,	239.4,	207.3,	0.0);	(751.8,	273.6,	213.4,	0.0);
(845.7,	307.8,	213.4,	0.0);	(939.7,	342.0,	213.4,	0.0);
(1174.6,	427.5,	213.4,	0.0);	(1409.5,	513.0,	213.4,	0.0);
(1644.5,	598.5,	213.4,	0.0);	(1879.4,	684.0,	213.4,	0.0);
(2114.3,	769.5,	213.4,	0.0);	(2349.2,	855.1,	231.6,	0.0);
(2819.1,	1026.1,	231.6,	0.0);	(3758.8,	1368.1,	310.9,	0.0);
(4698.5,	1710.1,	384.0,	0.0);	(7047.7,	2565.2,	384.0,	0.0);
(9396.9,	3420.2,	370.3,	0.0);	(14095.4,	5130.3,	360.0,	0.0);
(18793.9,	6840.4,	380.0,	0.0);	(28190.8,	10260.6,	400.0,	0.0);

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/29/94
*** One source; 936 receptors up to 50KM away; Vapor. *** 10:56:41
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(37587.7,	13680.8,	360.0,	0.0);	(46984.6,	17101.0,	400.0,	0.0);
(98.5,	17.4,	207.3,	0.0);	(197.0,	34.7,	202.7,	0.0);
(295.4,	52.1,	202.7,	0.0);	(393.9,	69.5,	202.7,	0.0);
(492.4,	86.8,	202.7,	0.0);	(590.9,	104.2,	202.7,	0.0);
(689.4,	121.6,	202.7,	0.0);	(787.8,	138.9,	202.7,	0.0);
(886.3,	156.3,	202.7,	0.0);	(984.8,	173.6,	202.7,	0.0);
(1231.0,	217.1,	202.7,	0.0);	(1477.2,	260.5,	202.7,	0.0);
(1723.4,	303.9,	213.4,	0.0);	(1969.6,	347.3,	207.3,	0.0);
(2215.8,	390.7,	207.3,	0.0);	(2462.0,	434.1,	231.6,	0.0);
(2954.4,	520.9,	304.8,	0.0);	(3939.2,	694.6,	346.6,	0.0);
(4924.0,	868.2,	365.8,	0.0);	(7386.1,	1302.4,	384.0,	0.0);
(9848.1,	1736.5,	371.9,	0.0);	(14772.1,	2604.7,	320.0,	0.0);
(19696.2,	3473.0,	360.0,	0.0);	(29544.2,	5209.4,	380.0,	0.0);
(39392.3,	6945.9,	380.0,	0.0);	(49240.4,	8682.4,	400.0,	0.0);
(100.0,	0.0,	207.3,	0.0);	(200.0,	0.0,	202.7,	0.0);
(300.0,	0.0,	202.7,	0.0);	(400.0,	0.0,	202.7,	0.0);
(500.0,	0.0,	202.7,	0.0);	(600.0,	0.0,	202.7,	0.0);
(700.0,	0.0,	202.7,	0.0);	(800.0,	0.0,	202.7,	0.0);
(900.0,	0.0,	202.7,	0.0);	(1000.0,	0.0,	202.7,	0.0);
(1250.0,	0.0,	243.8,	0.0);	(1500.0,	0.0,	341.4,	0.0);
(1750.0,	0.0,	323.1,	0.0);	(2000.0,	0.0,	341.4,	0.0);
(2250.0,	0.0,	304.8,	0.0);	(2500.0,	0.0,	292.6,	0.0);
(3000.0,	0.0,	310.9,	0.0);	(4000.0,	0.0,	359.7,	0.0);
(5000.0,	0.0,	402.3,	0.0);	(7500.0,	0.0,	347.5,	0.0);
(10000.0,	0.0,	380.1,	0.0);	(15000.0,	0.0,	360.0,	0.0);
(20000.0,	0.0,	360.0,	0.0);	(30000.0,	0.0,	380.0,	0.0);
(40000.0,	0.0,	400.0,	0.0);	(50000.0,	0.0,	360.0,	0.0);
(98.5,	-17.4,	207.3,	0.0);	(197.0,	-34.7,	202.7,	0.0);
(295.4,	-52.1,	202.7,	0.0);	(393.9,	-69.5,	202.7,	0.0);
(492.4,	-86.8,	202.7,	0.0);	(590.9,	-104.2,	202.7,	0.0);
(689.4,	-121.6,	202.7,	0.0);	(787.8,	-138.9,	219.5,	0.0);
(886.3,	-156.3,	225.6,	0.0);	(984.8,	-173.6,	329.2,	0.0);
(1231.0,	-217.1,	347.5,	0.0);	(1477.2,	-260.5,	353.6,	0.0);
(1723.4,	-303.9,	323.1,	0.0);	(1969.6,	-347.3,	341.4,	0.0);
(2215.8,	-390.7,	341.4,	0.0);	(2462.0,	-434.1,	323.1,	0.0);
(2954.4,	-520.9,	347.5,	0.0);	(3939.2,	-694.6,	353.6,	0.0);
(4924.0,	-868.2,	386.5,	0.0);	(7386.1,	-1302.4,	353.6,	0.0);
(9848.1,	-1736.5,	360.0,	0.0);	(14772.1,	-2604.7,	340.0,	0.0);
(19696.2,	-3473.0,	380.0,	0.0);	(29544.2,	-5209.4,	380.0,	0.0);
(39392.3,	-6945.9,	380.0,	0.0);	(49240.4,	-8682.4,	400.0,	0.0);
(94.0,	-34.2,	207.3,	0.0);	(187.9,	-68.4,	202.7,	0.0);
(281.9,	-102.6,	202.7,	0.0);	(375.9,	-136.8,	202.7,	0.0);
(469.8,	-171.0,	202.7,	0.0);	(563.8,	-205.2,	213.4,	0.0);
(657.8,	-239.4,	256.0,	0.0);	(751.8,	-273.6,	298.7,	0.0);
(845.7,	-307.8,	286.5,	0.0);	(939.7,	-342.0,	323.1,	0.0);

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/29/94
*** One source; 936 receptors up to 50KM away; Vapor. *** 10:56:41
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(1174.6,	-427.5,	347.5,	0.0);	(1409.5,	-513.0,	347.5,	0.0);
(1644.5,	-598.5,	310.9,	0.0);	(1879.4,	-684.0,	353.6,	0.0);
(2114.3,	-769.5,	350.2,	0.0);	(2349.2,	-855.1,	347.5,	0.0);
(2819.1,	-1026.1,	347.5,	0.0);	(3758.8,	-1368.1,	345.9,	0.0);
(4698.5,	-1710.1,	371.9,	0.0);	(7047.7,	-2565.2,	365.8,	0.0);
(9396.9,	-3420.2,	408.4,	0.0);	(14095.4,	-5130.3,	380.0,	0.0);
(18793.9,	-6840.4,	360.0,	0.0);	(28190.8,	-10260.6,	360.0,	0.0);
(37587.7,	-13680.8,	360.0,	0.0);	(46984.6,	-17101.0,	360.0,	0.0);
(86.6,	-50.0,	207.3,	0.0);	(173.2,	-100.0,	202.7,	0.0);
(259.8,	-150.0,	202.7,	0.0);	(346.4,	-200.0,	202.7,	0.0);
(433.0,	-250.0,	213.4,	0.0);	(519.6,	-300.0,	268.2,	0.0);
(606.2,	-350.0,	317.0,	0.0);	(692.8,	-400.0,	347.5,	0.0);
(779.4,	-450.0,	353.6,	0.0);	(866.0,	-500.0,	347.5,	0.0);
(1082.5,	-625.0,	310.9,	0.0);	(1299.0,	-750.0,	359.7,	0.0);
(1515.5,	-875.0,	335.3,	0.0);	(1732.1,	-1000.0,	359.7,	0.0);
(1948.6,	-1125.0,	359.7,	0.0);	(2165.1,	-1250.0,	347.5,	0.0);
(2598.1,	-1500.0,	365.8,	0.0);	(3464.1,	-2000.0,	359.7,	0.0);
(4330.1,	-2500.0,	353.6,	0.0);	(6495.2,	-3750.0,	402.3,	0.0);
(8660.3,	-5000.0,	396.2,	0.0);	(12990.4,	-7500.0,	380.0,	0.0);
(17320.5,	-10000.0,	380.0,	0.0);	(25980.8,	-15000.0,	360.0,	0.0);
(34641.0,	-20000.0,	360.0,	0.0);	(43301.3,	-25000.0,	360.0,	0.0);
(76.6,	-64.3,	207.3,	0.0);	(153.2,	-128.6,	202.7,	0.0);
(229.8,	-192.8,	202.7,	0.0);	(306.4,	-257.1,	202.7,	0.0);
(383.0,	-321.4,	243.8,	0.0);	(459.6,	-385.7,	298.7,	0.0);
(536.2,	-450.0,	323.1,	0.0);	(612.8,	-514.2,	353.6,	0.0);
(689.4,	-578.5,	353.6,	0.0);	(766.0,	-642.8,	353.6,	0.0);
(957.6,	-803.5,	353.6,	0.0);	(1149.1,	-964.2,	359.7,	0.0);
(1340.6,	-1124.9,	341.4,	0.0);	(1532.1,	-1285.6,	353.6,	0.0);
(1723.6,	-1446.3,	353.6,	0.0);	(1915.1,	-1607.0,	341.4,	0.0);
(2298.1,	-1928.4,	359.7,	0.0);	(3064.2,	-2571.2,	359.7,	0.0);
(3830.2,	-3213.9,	359.7,	0.0);	(5745.3,	-4820.9,	408.4,	0.0);
(7660.4,	-6427.9,	408.4,	0.0);	(11490.7,	-9641.8,	380.0,	0.0);
(15320.9,	-12855.8,	360.0,	0.0);	(22981.3,	-19283.6,	360.0,	0.0);
(30641.8,	-25711.5,	360.0,	0.0);	(38302.2,	-32139.4,	360.0,	0.0);
(64.3,	-76.6,	207.3,	0.0);	(128.6,	-153.2,	202.7,	0.0);
(192.8,	-229.8,	202.7,	0.0);	(257.1,	-306.4,	202.7,	0.0);
(321.4,	-383.0,	268.2,	0.0);	(385.7,	-459.6,	304.8,	0.0);
(450.0,	-536.2,	310.9,	0.0);	(514.2,	-612.8,	323.1,	0.0);
(578.5,	-689.4,	329.2,	0.0);	(642.8,	-766.0,	323.1,	0.0);
(803.5,	-957.6,	347.5,	0.0);	(964.2,	-1149.1,	359.7,	0.0);
(1124.9,	-1340.6,	329.2,	0.0);	(1285.6,	-1532.1,	359.7,	0.0);
(1446.3,	-1723.6,	353.6,	0.0);	(1607.0,	-1915.1,	359.7,	0.0);
(1928.4,	-2298.1,	408.4,	0.0);	(2571.2,	-3064.2,	420.6,	0.0);
(3213.9,	-3830.2,	371.9,	0.0);	(4820.9,	-5745.3,	392.0,	0.0);
(6427.9,	-7660.4,	390.1,	0.0);	(9641.8,	-11490.7,	340.0,	0.0);

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(12855.8,	-15320.9,	380.0,	0.0);	(19283.6,	-22981.3,	400.0,	0.0);
(25711.5,	-30641.8,	400.0,	0.0);	(32139.4,	-38302.2,	380.0,	0.0);
(50.0,	-86.6,	207.3,	0.0);	(100.0,	-173.2,	202.7,	0.0);
(150.0,	-259.8,	202.7,	0.0);	(200.0,	-346.4,	213.4,	0.0);
(250.0,	-433.0,	268.2,	0.0);	(300.0,	-519.6,	298.7,	0.0);
(350.0,	-606.2,	310.9,	0.0);	(400.0,	-692.8,	323.1,	0.0);
(450.0,	-779.4,	323.1,	0.0);	(500.0,	-866.0,	329.2,	0.0);
(625.0,	-1082.5,	298.7,	0.0);	(750.0,	-1299.0,	341.4,	0.0);
(875.0,	-1515.5,	341.4,	0.0);	(1000.0,	-1732.1,	359.7,	0.0);
(1125.0,	-1948.6,	365.8,	0.0);	(1250.0,	-2165.1,	371.9,	0.0);
(1500.0,	-2598.1,	408.4,	0.0);	(2000.0,	-3464.1,	420.6,	0.0);
(2500.0,	-4330.1,	408.4,	0.0);	(3750.0,	-6495.2,	408.4,	0.0);
(5000.0,	-8660.3,	396.2,	0.0);	(7500.0,	-12990.4,	340.0,	0.0);
(10000.0,	-17320.5,	360.0,	0.0);	(15000.0,	-25980.8,	420.0,	0.0);
(20000.0,	-34641.0,	400.0,	0.0);	(25000.0,	-43301.3,	400.0,	0.0);
(34.2,	-94.0,	207.3,	0.0);	(68.4,	-187.9,	202.7,	0.0);
(102.6,	-281.9,	202.7,	0.0);	(136.8,	-375.9,	207.3,	0.0);
(171.0,	-469.8,	268.2,	0.0);	(205.2,	-563.8,	292.6,	0.0);
(239.4,	-657.8,	304.8,	0.0);	(273.6,	-751.8,	304.8,	0.0);
(307.8,	-845.7,	286.5,	0.0);	(342.0,	-939.7,	286.5,	0.0);
(427.5,	-1174.6,	304.8,	0.0);	(513.0,	-1409.5,	310.9,	0.0);
(598.5,	-1644.5,	304.8,	0.0);	(684.0,	-1879.4,	335.3,	0.0);
(769.5,	-2114.3,	359.7,	0.0);	(855.1,	-2349.2,	378.0,	0.0);
(1026.1,	-2819.1,	396.2,	0.0);	(1368.1,	-3758.8,	402.3,	0.0);
(1710.1,	-4698.5,	411.5,	0.0);	(2565.2,	-7047.7,	402.3,	0.0);
(3420.2,	-9396.9,	408.1,	0.0);	(5130.3,	-14095.4,	360.0,	0.0);
(6840.4,	-18793.9,	360.0,	0.0);	(10260.6,	-28190.8,	420.0,	0.0);
(13680.8,	-37587.7,	400.0,	0.0);	(17101.0,	-46984.6,	420.0,	0.0);
(17.4,	-98.5,	207.3,	0.0);	(34.7,	-197.0,	202.7,	0.0);
(52.1,	-295.4,	202.7,	0.0);	(69.5,	-393.9,	202.7,	0.0);
(86.8,	-492.4,	249.9,	0.0);	(104.2,	-590.9,	286.5,	0.0);
(121.6,	-689.4,	280.4,	0.0);	(138.9,	-787.8,	274.3,	0.0);
(156.3,	-886.3,	286.5,	0.0);	(173.6,	-984.8,	286.5,	0.0);
(217.1,	-1231.0,	298.7,	0.0);	(260.5,	-1477.2,	304.8,	0.0);
(303.9,	-1723.4,	304.8,	0.0);	(347.3,	-1969.6,	298.7,	0.0);
(390.7,	-2215.8,	298.7,	0.0);	(434.1,	-2462.0,	365.8,	0.0);
(520.9,	-2954.4,	402.3,	0.0);	(694.6,	-3939.2,	390.1,	0.0);
(868.2,	-4924.0,	414.5,	0.0);	(1302.4,	-7386.1,	408.4,	0.0);
(1736.5,	-9848.1,	398.1,	0.0);	(2604.7,	-14772.1,	380.0,	0.0);
(3473.0,	-19696.2,	360.0,	0.0);	(5209.4,	-29544.2,	400.0,	0.0);
(6945.9,	-39392.3,	400.0,	0.0);	(8682.4,	-49240.4,	400.0,	0.0);
(0.0,	-100.0,	207.3,	0.0);	(0.0,	-200.0,	202.7,	0.0);
(0.0,	-300.0,	202.7,	0.0);	(0.0,	-400.0,	202.7,	0.0);
(0.0,	-500.0,	219.5,	0.0);	(0.0,	-600.0,	274.3,	0.0);
(0.0,	-700.0,	280.4,	0.0);	(0.0,	-800.0,	274.3,	0.0);

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/29/94
*** One source; 936 receptors up to 50KM away; Vapor. *** 10:56:41
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(0.0,	-900.0,	243.8,	0.0);	(0.0,	-1000.0,	298.7,	0.0);
(0.0,	-1250.0,	304.8,	0.0);	(0.0,	-1500.0,	304.8,	0.0);
(0.0,	-1750.0,	304.8,	0.0);	(0.0,	-2000.0,	292.6,	0.0);
(0.0,	-2250.0,	298.7,	0.0);	(0.0,	-2500.0,	365.8,	0.0);
(0.0,	-3000.0,	406.3,	0.0);	(0.0,	-4000.0,	402.3,	0.0);
(0.0,	-5000.0,	396.2,	0.0);	(0.0,	-7500.0,	390.1,	0.0);
(0.0,	-10000.0,	396.2,	0.0);	(0.0,	-15000.0,	380.0,	0.0);
(0.0,	-20000.0,	360.0,	0.0);	(0.0,	-30000.0,	380.0,	0.0);
(0.0,	-40000.0,	380.0,	0.0);	(0.0,	-50000.0,	400.0,	0.0);
(-17.4,	-98.5,	207.3,	0.0);	(-34.7,	-197.0,	202.7,	0.0);
(-52.1,	-295.4,	202.7,	0.0);	(-69.5,	-393.9,	202.7,	0.0);
(-86.8,	-492.4,	202.7,	0.0);	(-104.2,	-590.9,	225.6,	0.0);
(-121.6,	-689.4,	274.3,	0.0);	(-138.9,	-787.8,	274.3,	0.0);
(-156.3,	-886.3,	237.7,	0.0);	(-173.6,	-984.8,	292.6,	0.0);
(-217.1,	-1231.0,	304.8,	0.0);	(-260.5,	-1477.2,	286.5,	0.0);
(-303.9,	-1723.4,	292.6,	0.0);	(-347.3,	-1969.6,	280.4,	0.0);
(-390.7,	-2215.8,	304.8,	0.0);	(-434.1,	-2462.0,	353.6,	0.0);
(-520.9,	-2954.4,	384.0,	0.0);	(-694.6,	-3939.2,	396.2,	0.0);
(-868.2,	-4924.0,	415.4,	0.0);	(-1302.4,	-7386.1,	390.1,	0.0);
(-1736.5,	-9848.1,	392.0,	0.0);	(-2604.7,	-14772.1,	360.0,	0.0);
(-3473.0,	-19696.2,	340.0,	0.0);	(-5209.4,	-29544.2,	340.0,	0.0);
(-6945.9,	-39392.3,	360.0,	0.0);	(-8682.4,	-49240.4,	380.0,	0.0);
(-34.2,	-94.0,	213.4,	0.0);	(-68.4,	-187.9,	202.7,	0.0);
(-102.6,	-281.9,	202.7,	0.0);	(-136.8,	-375.9,	202.7,	0.0);
(-171.0,	-469.8,	202.7,	0.0);	(-205.2,	-563.8,	202.7,	0.0);
(-239.4,	-657.8,	219.5,	0.0);	(-273.6,	-751.8,	249.9,	0.0);
(-307.8,	-845.7,	219.5,	0.0);	(-342.0,	-939.7,	280.4,	0.0);
(-427.5,	-1174.6,	280.4,	0.0);	(-513.0,	-1409.5,	280.4,	0.0);
(-598.5,	-1644.5,	280.4,	0.0);	(-684.0,	-1879.4,	262.1,	0.0);
(-769.5,	-2114.3,	298.7,	0.0);	(-855.1,	-2349.2,	353.6,	0.0);
(-1026.1,	-2819.1,	371.9,	0.0);	(-1368.1,	-3758.8,	402.3,	0.0);
(-1710.1,	-4698.5,	397.2,	0.0);	(-2565.2,	-7047.7,	384.0,	0.0);
(-3420.2,	-9396.9,	384.0,	0.0);	(-5130.3,	-14095.4,	340.0,	0.0);
(-6840.4,	-18793.9,	340.0,	0.0);	(-10260.6,	-28190.8,	360.0,	0.0);
(-13680.8,	-37587.7,	380.0,	0.0);	(-17101.0,	-46984.6,	380.0,	0.0);
(-50.0,	-86.6,	213.4,	0.0);	(-100.0,	-173.2,	202.7,	0.0);
(-150.0,	-259.8,	202.7,	0.0);	(-200.0,	-346.4,	202.7,	0.0);
(-250.0,	-433.0,	202.7,	0.0);	(-300.0,	-519.6,	202.7,	0.0);
(-350.0,	-606.2,	202.7,	0.0);	(-400.0,	-692.8,	202.7,	0.0);
(-450.0,	-779.4,	202.7,	0.0);	(-500.0,	-866.0,	219.5,	0.0);
(-625.0,	-1082.5,	219.5,	0.0);	(-750.0,	-1299.0,	213.4,	0.0);
(-875.0,	-1515.5,	213.4,	0.0);	(-1000.0,	-1732.1,	231.6,	0.0);
(-1125.0,	-1948.6,	231.6,	0.0);	(-1250.0,	-2165.1,	292.6,	0.0);
(-1500.0,	-2598.1,	359.7,	0.0);	(-2000.0,	-3464.1,	396.2,	0.0);
(-2500.0,	-4330.1,	414.5,	0.0);	(-3750.0,	-6495.2,	396.2,	0.0);

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/29/94
*** One source; 936 receptors up to 50KM away; Vapor. *** 10:56:41
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(-5000.0,	-8660.3,	392.6,	0.0);	(-7500.0,	-12990.4,	360.0,	0.0);
(-10000.0,	-17320.5,	380.0,	0.0);	(-15000.0,	-25980.8,	360.0,	0.0);
(-20000.0,	-34641.0,	360.0,	0.0);	(-25000.0,	-43301.3,	380.0,	0.0);
(-64.3,	-76.6,	213.4,	0.0);	(-128.6,	-153.2,	202.7,	0.0);
(-192.8,	-229.8,	202.7,	0.0);	(-257.1,	-306.4,	202.7,	0.0);
(-321.4,	-383.0,	202.7,	0.0);	(-385.7,	-459.6,	202.7,	0.0);
(-450.0,	-536.2,	202.7,	0.0);	(-514.2,	-612.8,	202.7,	0.0);
(-578.5,	-689.4,	202.7,	0.0);	(-642.8,	-766.0,	202.7,	0.0);
(-803.5,	-957.6,	202.7,	0.0);	(-964.2,	-1149.1,	213.4,	0.0);
(-1124.9,	-1340.6,	213.4,	0.0);	(-1285.6,	-1532.1,	213.4,	0.0);
(-1446.3,	-1723.6,	213.4,	0.0);	(-1607.0,	-1915.1,	213.4,	0.0);
(-1928.4,	-2298.1,	371.9,	0.0);	(-2571.2,	-3064.2,	378.0,	0.0);
(-3213.9,	-3830.2,	396.2,	0.0);	(-4820.9,	-5745.3,	396.2,	0.0);
(-6427.9,	-7660.4,	378.0,	0.0);	(-9641.8,	-11490.7,	349.0,	0.0);
(-12855.8,	-15320.9,	360.0,	0.0);	(-19283.6,	-22981.3,	360.0,	0.0);
(-25711.5,	-30641.8,	380.0,	0.0);	(-32139.4,	-38302.2,	360.0,	0.0);
(-76.6,	-64.3,	213.4,	0.0);	(-153.2,	-128.6,	201.2,	0.0);
(-229.8,	-192.8,	207.3,	0.0);	(-306.4,	-257.1,	207.3,	0.0);
(-383.0,	-321.4,	202.7,	0.0);	(-459.6,	-385.7,	202.7,	0.0);
(-536.2,	-450.0,	202.7,	0.0);	(-612.8,	-514.2,	202.7,	0.0);
(-689.4,	-578.5,	207.3,	0.0);	(-766.0,	-642.8,	207.3,	0.0);
(-957.6,	-803.5,	207.3,	0.0);	(-1149.1,	-964.2,	207.3,	0.0);
(-1340.6,	-1124.9,	207.3,	0.0);	(-1532.1,	-1285.6,	213.4,	0.0);
(-1723.6,	-1446.3,	213.4,	0.0);	(-1915.1,	-1607.0,	256.0,	0.0);
(-2298.1,	-1928.4,	323.1,	0.0);	(-3064.2,	-2571.2,	359.7,	0.0);
(-3830.2,	-3213.9,	384.0,	0.0);	(-5745.3,	-4820.9,	378.0,	0.0);
(-7660.4,	-6427.9,	378.0,	0.0);	(-11490.7,	-9641.8,	360.0,	0.0);
(-15320.9,	-12855.8,	380.0,	0.0);	(-22981.3,	-19283.6,	400.0,	0.0);
(-30641.8,	-25711.5,	400.0,	0.0);	(-38302.2,	-32139.4,	380.0,	0.0);
(-86.6,	-50.0,	213.4,	0.0);	(-173.2,	-100.0,	213.4,	0.0);
(-259.8,	-150.0,	213.4,	0.0);	(-346.4,	-200.0,	207.3,	0.0);
(-433.0,	-250.0,	213.4,	0.0);	(-519.6,	-300.0,	213.4,	0.0);
(-606.2,	-350.0,	213.4,	0.0);	(-692.8,	-400.0,	213.4,	0.0);
(-779.4,	-450.0,	213.4,	0.0);	(-866.0,	-500.0,	213.4,	0.0);
(-1082.5,	-625.0,	225.6,	0.0);	(-1299.0,	-750.0,	274.3,	0.0);
(-1515.5,	-875.0,	329.2,	0.0);	(-1732.1,	-1000.0,	310.9,	0.0);
(-1948.6,	-1125.0,	286.5,	0.0);	(-2165.1,	-1250.0,	256.0,	0.0);
(-2598.1,	-1500.0,	243.8,	0.0);	(-3464.1,	-2000.0,	365.8,	0.0);
(-4330.1,	-2500.0,	372.5,	0.0);	(-6495.2,	-3750.0,	378.0,	0.0);
(-8660.3,	-5000.0,	402.3,	0.0);	(-12990.4,	-7500.0,	360.0,	0.0);
(-17320.5,	-10000.0,	380.0,	0.0);	(-25980.8,	-15000.0,	380.0,	0.0);
(-34641.0,	-20000.0,	400.0,	0.0);	(-43301.3,	-25000.0,	360.0,	0.0);
(-94.0,	-34.2,	213.4,	0.0);	(-187.9,	-68.4,	213.4,	0.0);
(-281.9,	-102.6,	213.4,	0.0);	(-375.9,	-136.8,	213.4,	0.0);
(-469.8,	-171.0,	213.4,	0.0);	(-563.8,	-205.2,	213.4,	0.0);

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/29/94
*** One source; 936 receptors up to 50KM away; Vapor. *** 10:56:41
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(-657.8,	-239.4,	213.4,	0.0);	(-751.8,	-273.6,	219.5,	0.0);
(-845.7,	-307.8,	219.5,	0.0);	(-939.7,	-342.0,	213.4,	0.0);
(-1174.6,	-427.5,	353.6,	0.0);	(-1409.5,	-513.0,	353.6,	0.0);
(-1644.5,	-598.5,	341.4,	0.0);	(-1879.4,	-684.0,	335.3,	0.0);
(-2114.3,	-769.5,	353.6,	0.0);	(-2349.2,	-855.1,	304.8,	0.0);
(-2819.1,	-1026.1,	243.8,	0.0);	(-3758.8,	-1368.1,	298.7,	0.0);
(-4698.5,	-1710.1,	359.7,	0.0);	(-7047.7,	-2565.2,	365.8,	0.0);
(-9396.9,	-3420.2,	402.3,	0.0);	(-14095.4,	-5130.3,	380.0,	0.0);
(-18793.9,	-6840.4,	400.0,	0.0);	(-28190.8,	-10260.6,	380.0,	0.0);
(-37587.7,	-13680.8,	400.0,	0.0);	(-46984.6,	-17101.0,	360.0,	0.0);
(-98.5,	-17.4,	213.4,	0.0);	(-197.0,	-34.7,	213.4,	0.0);
(-295.4,	-52.1,	213.4,	0.0);	(-393.9,	-69.5,	213.4,	0.0);
(-492.4,	-86.8,	213.4,	0.0);	(-590.9,	-104.2,	213.4,	0.0);
(-689.4,	-121.6,	213.4,	0.0);	(-787.8,	-138.9,	219.5,	0.0);
(-886.3,	-156.3,	225.6,	0.0);	(-984.8,	-173.6,	310.9,	0.0);
(-1231.0,	-217.1,	359.7,	0.0);	(-1477.2,	-260.5,	359.7,	0.0);
(-1723.4,	-303.9,	365.8,	0.0);	(-1969.6,	-347.3,	371.9,	0.0);
(-2215.8,	-390.7,	353.6,	0.0);	(-2462.0,	-434.1,	371.9,	0.0);
(-2954.4,	-520.9,	353.6,	0.0);	(-3939.2,	-694.6,	365.8,	0.0);
(-4924.0,	-868.2,	365.8,	0.0);	(-7386.1,	-1302.4,	390.1,	0.0);
(-9848.1,	-1736.5,	339.9,	0.0);	(-14772.1,	-2604.7,	360.0,	0.0);
(-19696.2,	-3473.0,	380.0,	0.0);	(-29544.2,	-5209.4,	420.0,	0.0);
(-39392.3,	-6945.9,	400.0,	0.0);	(-49240.4,	-8682.4,	400.0,	0.0);
(-100.0,	0.0,	213.4,	0.0);	(-200.0,	0.0,	213.4,	0.0);
(-300.0,	0.0,	213.4,	0.0);	(-400.0,	0.0,	213.4,	0.0);
(-500.0,	0.0,	213.4,	0.0);	(-600.0,	0.0,	213.4,	0.0);
(-700.0,	0.0,	213.4,	0.0);	(-800.0,	0.0,	213.4,	0.0);
(-900.0,	0.0,	243.8,	0.0);	(-1000.0,	0.0,	298.7,	0.0);
(-1250.0,	0.0,	304.8,	0.0);	(-1500.0,	0.0,	304.8,	0.0);
(-1750.0,	0.0,	335.3,	0.0);	(-2000.0,	0.0,	341.4,	0.0);
(-2250.0,	0.0,	371.9,	0.0);	(-2500.0,	0.0,	371.9,	0.0);
(-3000.0,	0.0,	371.9,	0.0);	(-4000.0,	0.0,	378.0,	0.0);
(-5000.0,	0.0,	371.9,	0.0);	(-7500.0,	0.0,	371.9,	0.0);
(-10000.0,	0.0,	360.0,	0.0);	(-15000.0,	0.0,	340.0,	0.0);
(-20000.0,	0.0,	360.0,	0.0);	(-30000.0,	0.0,	380.0,	0.0);
(-40000.0,	0.0,	380.0,	0.0);	(-50000.0,	0.0,	400.0,	0.0);
(-98.5,	17.4,	213.4,	0.0);	(-197.0,	34.7,	213.4,	0.0);
(-295.4,	52.1,	213.4,	0.0);	(-393.9,	69.5,	213.4,	0.0);
(-492.4,	86.8,	213.4,	0.0);	(-590.9,	104.2,	225.6,	0.0);
(-689.4,	121.6,	225.6,	0.0);	(-787.8,	138.9,	237.7,	0.0);
(-886.3,	156.3,	243.8,	0.0);	(-984.8,	173.6,	280.4,	0.0);
(-1231.0,	217.1,	317.0,	0.0);	(-1477.2,	260.5,	304.8,	0.0);
(-1723.4,	303.9,	298.7,	0.0);	(-1969.6,	347.3,	341.4,	0.0);
(-2215.8,	390.7,	371.9,	0.0);	(-2462.0,	434.1,	353.6,	0.0);
(-2954.4,	520.9,	365.8,	0.0);	(-3939.2,	694.6,	353.6,	0.0);

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/29/94
*** One source; 936 receptors up to 50KM away; Vapor. *** 10:56:41
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*** MODELING OPTIONS USED: COMC RURAL ELEV DFAULT

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(-4924.0,	868.2,	378.0,	0.0);	(-7386.1,	1302.4,	384.0,	0.0);
(-9848.1,	1736.5,	389.2,	0.0);	(-14772.1,	2604.7,	400.0,	0.0);
(-19696.2,	3473.0,	420.0,	0.0);	(-29544.2,	5209.4,	380.0,	0.0);
(-39392.3,	6945.9,	380.0,	0.0);	(-49240.4,	8682.4,	400.0,	0.0);
(-94.0,	34.2,	213.4,	0.0);	(-187.9,	68.4,	213.4,	0.0);
(-281.9,	102.6,	213.4,	0.0);	(-375.9,	136.8,	219.5,	0.0);
(-469.8,	171.0,	225.6,	0.0);	(-563.8,	205.2,	225.6,	0.0);
(-657.8,	239.4,	243.8,	0.0);	(-751.8,	273.6,	274.3,	0.0);
(-845.7,	307.8,	286.5,	0.0);	(-939.7,	342.0,	298.7,	0.0);
(-1174.6,	427.5,	317.0,	0.0);	(-1409.5,	513.0,	298.7,	0.0);
(-1644.5,	598.5,	298.7,	0.0);	(-1879.4,	684.0,	359.7,	0.0);
(-2114.3,	769.5,	384.0,	0.0);	(-2349.2,	855.1,	378.0,	0.0);
(-2819.1,	1026.1,	378.0,	0.0);	(-3758.8,	1368.1,	378.0,	0.0);
(-4698.5,	1710.1,	378.0,	0.0);	(-7047.7,	2565.2,	371.9,	0.0);
(-9396.9,	3420.2,	424.9,	0.0);	(-14095.4,	5130.3,	420.0,	0.0);
(-18793.9,	6840.4,	360.0,	0.0);	(-28190.8,	10260.6,	400.0,	0.0);
(-37587.7,	13680.8,	380.0,	0.0);	(-46984.6,	17101.0,	400.0,	0.0);
(-86.6,	50.0,	213.4,	0.0);	(-173.2,	100.0,	213.4,	0.0);
(-259.8,	150.0,	219.5,	0.0);	(-346.4,	200.0,	231.6,	0.0);
(-433.0,	250.0,	225.6,	0.0);	(-519.6,	300.0,	231.6,	0.0);
(-606.2,	350.0,	268.2,	0.0);	(-692.8,	400.0,	304.8,	0.0);
(-779.4,	450.0,	310.9,	0.0);	(-866.0,	500.0,	304.8,	0.0);
(-1082.5,	625.0,	292.6,	0.0);	(-1299.0,	750.0,	323.1,	0.0);
(-1515.5,	875.0,	359.7,	0.0);	(-1732.1,	1000.0,	371.9,	0.0);
(-1948.6,	1125.0,	371.9,	0.0);	(-2165.1,	1250.0,	378.0,	0.0);
(-2598.1,	1500.0,	378.0,	0.0);	(-3464.1,	2000.0,	378.0,	0.0);
(-4330.1,	2500.0,	384.0,	0.0);	(-6495.2,	3750.0,	384.0,	0.0);
(-8660.3,	5000.0,	426.7,	0.0);	(-12990.4,	7500.0,	400.0,	0.0);
(-17320.5,	10000.0,	400.0,	0.0);	(-25980.8,	15000.0,	420.0,	0.0);
(-34641.0,	20000.0,	400.0,	0.0);	(-43301.3,	25000.0,	350.0,	0.0);
(-76.6,	64.3,	213.4,	0.0);	(-153.2,	128.6,	213.4,	0.0);
(-229.8,	192.8,	225.6,	0.0);	(-306.4,	257.1,	231.6,	0.0);
(-383.0,	321.4,	225.6,	0.0);	(-459.6,	385.7,	231.6,	0.0);
(-536.2,	450.0,	268.2,	0.0);	(-612.8,	514.2,	304.8,	0.0);
(-689.4,	578.5,	316.4,	0.0);	(-766.0,	642.8,	317.0,	0.0);
(-957.6,	803.5,	304.8,	0.0);	(-1149.1,	964.2,	341.4,	0.0);
(-1340.6,	1124.9,	353.6,	0.0);	(-1532.1,	1285.6,	365.8,	0.0);
(-1723.6,	1446.3,	371.9,	0.0);	(-1915.1,	1607.0,	378.0,	0.0);
(-2298.1,	1928.4,	384.0,	0.0);	(-3064.2,	2571.2,	359.7,	0.0);
(-3830.2,	3213.9,	384.0,	0.0);	(-5745.3,	4820.9,	378.0,	0.0);
(-7660.4,	6427.9,	379.2,	0.0);	(-11490.7,	9641.8,	360.0,	0.0);
(-15320.9,	12855.8,	400.0,	0.0);	(-22981.3,	19283.6,	400.0,	0.0);
(-30641.8,	25711.5,	400.0,	0.0);	(-38302.2,	32139.4,	370.0,	0.0);
(-64.3,	76.6,	213.4,	0.0);	(-128.6,	153.2,	225.6,	0.0);
(-192.8,	229.8,	231.6,	0.0);	(-257.1,	306.4,	231.6,	0.0);

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/29/94
*** One source; 936 receptors up to 50KM away; Vapor. *** 10:56:41
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(-321.4,	383.0,	225.6,	0.0);	(-385.7,	459.6,	231.6,	0.0);
(-450.0,	536.2,	274.3,	0.0);	(-514.2,	612.8,	304.8,	0.0);
(-578.5,	689.4,	310.9,	0.0);	(-642.8,	766.0,	310.9,	0.0);
(-803.5,	957.6,	317.0,	0.0);	(-964.2,	1149.1,	347.5,	0.0);
(-1124.9,	1340.6,	353.6,	0.0);	(-1285.6,	1532.1,	353.6,	0.0);
(-1446.3,	1723.6,	359.7,	0.0);	(-1607.0,	1915.1,	365.8,	0.0);
(-1928.4,	2298.1,	384.0,	0.0);	(-2571.2,	3064.2,	384.0,	0.0);
(-3213.9,	3830.2,	378.0,	0.0);	(-4820.9,	5745.3,	378.0,	0.0);
(-6427.9,	7660.4,	378.0,	0.0);	(-9641.8,	11490.7,	380.0,	0.0);
(-12855.8,	15320.9,	400.0,	0.0);	(-19283.6,	22981.3,	400.0,	0.0);
(-25711.5,	30641.8,	360.0,	0.0);	(-32139.4,	38302.2,	360.0,	0.0);
(-50.0,	86.6,	213.4,	0.0);	(-100.0,	173.2,	225.6,	0.0);
(-150.0,	259.8,	231.6,	0.0);	(-200.0,	346.4,	231.6,	0.0);
(-250.0,	433.0,	225.6,	0.0);	(-300.0,	519.6,	243.8,	0.0);
(-350.0,	606.2,	249.9,	0.0);	(-400.0,	692.8,	243.8,	0.0);
(-450.0,	779.4,	304.8,	0.0);	(-500.0,	866.0,	304.8,	0.0);
(-625.0,	1082.5,	286.5,	0.0);	(-750.0,	1299.0,	329.2,	0.0);
(-875.0,	1515.5,	347.5,	0.0);	(-1000.0,	1732.1,	353.6,	0.0);
(-1125.0,	1948.6,	353.6,	0.0);	(-1250.0,	2165.1,	384.0,	0.0);
(-1500.0,	2598.1,	384.0,	0.0);	(-2000.0,	3464.1,	384.0,	0.0);
(-2500.0,	4330.1,	378.0,	0.0);	(-3750.0,	6495.2,	365.8,	0.0);
(-5000.0,	8660.3,	371.9,	0.0);	(-7500.0,	12990.4,	360.0,	0.0);
(-10000.0,	17320.5,	360.0,	0.0);	(-15000.0,	25980.8,	340.0,	0.0);
(-20000.0,	34641.0,	380.0,	0.0);	(-25000.0,	43301.3,	350.0,	0.0);
(-34.2,	94.0,	213.4,	0.0);	(-68.4,	187.9,	225.6,	0.0);
(-102.6,	281.9,	225.6,	0.0);	(-136.8,	375.9,	225.6,	0.0);
(-171.0,	469.8,	225.6,	0.0);	(-205.2,	563.8,	243.8,	0.0);
(-239.4,	657.8,	262.1,	0.0);	(-273.6,	751.8,	286.5,	0.0);
(-307.8,	845.7,	280.4,	0.0);	(-342.0,	939.7,	292.6,	0.0);
(-427.5,	1174.6,	323.1,	0.0);	(-513.0,	1409.5,	353.6,	0.0);
(-598.5,	1644.5,	359.7,	0.0);	(-684.0,	1879.4,	359.7,	0.0);
(-769.5,	2114.3,	329.2,	0.0);	(-855.1,	2349.2,	347.5,	0.0);
(-1026.1,	2819.1,	378.0,	0.0);	(-1368.1,	3758.8,	385.0,	0.0);
(-1710.1,	4698.5,	371.9,	0.0);	(-2565.2,	7047.7,	329.2,	0.0);
(-3420.2,	9396.9,	349.0,	0.0);	(-5130.3,	14095.4,	360.0,	0.0);
(-6840.4,	18793.9,	360.0,	0.0);	(-10260.6,	28190.8,	340.0,	0.0);
(-13680.8,	37587.7,	370.0,	0.0);	(-17101.0,	46984.6,	350.0,	0.0);
(-17.4,	98.5,	213.4,	0.0);	(-34.7,	197.0,	225.6,	0.0);
(-52.1,	295.4,	225.6,	0.0);	(-69.5,	393.9,	225.6,	0.0);
(-86.8,	492.4,	225.6,	0.0);	(-104.2,	590.9,	243.8,	0.0);
(-121.6,	689.4,	262.1,	0.0);	(-138.9,	787.8,	292.6,	0.0);
(-156.3,	886.3,	298.7,	0.0);	(-173.6,	984.8,	298.7,	0.0);
(-217.1,	1231.0,	335.3,	0.0);	(-260.5,	1477.2,	365.8,	0.0);
(-303.9,	1723.4,	359.7,	0.0);	(-347.3,	1969.6,	359.7,	0.0);
(-390.7,	2215.8,	341.4,	0.0);	(-434.1,	2462.0,	378.0,	0.0);

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/29/94
*** One source; 936 receptors up to 50KM away; Vapor. *** 10:56:41
PAGE 16

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(-520.9,	2954.4,	384.0,	0.0);	(-694.6,	3939.2,	378.0,	0.0);
(-868.2,	4924.0,	365.8,	0.0);	(-1302.4,	7386.1,	341.4,	0.0);
(-1736.5,	9848.1,	339.9,	0.0);	(-2604.7,	14772.1,	340.0,	0.0);
(-3473.0,	19696.2,	360.0,	0.0);	(-5209.5,	29544.2,	340.0,	0.0);
(-6945.9,	39392.3,	330.0,	0.0);	(-8682.4,	49240.4,	320.0,	0.0);
(0.0,	100.0,	213.4,	0.0);	(0.0,	200.0,	225.6,	0.0);
(0.0,	300.0,	225.6,	0.0);	(0.0,	400.0,	225.6,	0.0);
(0.0,	500.0,	225.6,	0.0);	(0.0,	600.0,	237.7,	0.0);
(0.0,	700.0,	256.0,	0.0);	(0.0,	800.0,	280.4,	0.0);
(0.0,	900.0,	298.7,	0.0);	(0.0,	1000.0,	292.6,	0.0);
(0.0,	1250.0,	353.6,	0.0);	(0.0,	1500.0,	323.1,	0.0);
(0.0,	1750.0,	341.4,	0.0);	(0.0,	2000.0,	317.0,	0.0);
(0.0,	2250.0,	359.7,	0.0);	(0.0,	2500.0,	359.7,	0.0);
(0.0,	3000.0,	378.0,	0.0);	(0.0,	4000.0,	383.4,	0.0);
(0.0,	5000.0,	359.7,	0.0);	(0.0,	7500.0,	371.9,	0.0);
(0.0,	10000.0,	380.1,	0.0);	(0.0,	15000.0,	360.0,	0.0);
(0.0,	20000.0,	340.0,	0.0);	(0.0,	30000.0,	380.0,	0.0);
(0.0,	40000.0,	350.0,	0.0);	(0.0,	50000.0,	350.0,	0.0);

*** MODELING OPTIONS USED: COMC RURAL ELEV DFAULT

*** METEOROLOGICAL DAYS SELECTED FOR PROCESSING ***
(1=YES; 0=NO)

1 1 1

*** ISCOMDEP VERSION 94227 *** *** WTI stack modeling, EPA Region V, Project 1363, Base Case *** 08/29/94
*** One source; 936 receptors up to 50KM away; Vapor. *** 10:56:41
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** THE FIRST 24 HOURS OF METEOROLOGICAL DATA ***

FILE: depbin.met FORMAT: (4I2,2F9.4,F6.1,I2,2F7.1,f9.4,f10.1,f8.4,f5.1,i4,f7.2)
SURFACE STATION NO.: 94823 UPPER AIR STATION NO.: 94823
NAME: WTI NAME: WTI
YEAR: 1993 YEAR: 1993

YEAR	MONTH	DAY	HOUR	FLOW VECTOR	SPEED (M/S)	TEMP (K)	STAB CLASS	MIXING HEIGHT (M) RURAL	MIXING HEIGHT (M) URBAN	USTAR (M/S)	M-O LENGTH (M)	Z-0 (M)	Zd (M)	IPCODE	PRATE (mm/HR)
93	1	1	1	104.0	4.47	275.4	4	601.6	601.6	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	2	112.0	5.36	274.8	4	617.6	617.6	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	3	106.0	4.47	274.0	4	633.5	633.5	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	4	115.0	4.47	273.9	4	649.5	649.5	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	5	120.0	4.02	273.8	4	665.4	665.4	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	6	123.0	5.36	273.3	4	681.4	681.4	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	7	130.0	4.92	272.5	4	697.3	697.3	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	8	124.0	4.92	271.9	4	713.3	713.3	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	9	115.0	4.47	271.0	4	729.2	729.2	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	10	107.0	4.02	270.9	4	745.2	745.2	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	11	113.0	4.02	270.6	4	761.1	761.1	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	12	108.0	4.47	270.9	4	777.1	777.1	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	13	114.0	5.36	271.1	4	793.0	793.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	14	107.0	4.92	271.0	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	15	120.0	4.92	270.8	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	16	119.0	4.47	270.5	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	17	118.0	3.58	270.4	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	18	124.0	2.68	270.4	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	19	124.0	2.68	270.1	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	20	113.0	2.23	270.3	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	21	97.0	2.68	270.3	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	22	113.0	3.13	270.3	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	23	117.0	3.13	270.4	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	24	152.0	2.68	269.9	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00

*** NOTES: STABILITY CLASS 1=A, 2=B, 3=C, 4=D, 5=E AND 6=F.
FLOW VECTOR IS DIRECTION TOWARD WHICH WIND IS BLOWING.

```
 *** ISCOMDEP VERSION 94227 ***     ***  WTI Fugitive source modeling - TRUCK WASH                    ***        12/23/94
                                   ***  One Volume source; 936 receptors up to 50KM away; Vapor.    ***        18:28:17
                                                                                                              PAGE    1
 *** MODELING OPTIONS USED:  CONC   RURAL  ELEV          DFAULT

                                        ***     MODEL SETUP OPTIONS SUMMARY      ***
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

**Intermediate Terrain Processing is Selected

**Model Is Setup For Calculation of Average CONCentration Values.

  --  SCAVENGING/DEPOSITION LOGIC --
**Model Uses NO DRY DEPLETION.  DDPLETE =  F
**Model Uses NO WET DEPLETION.  WDPLETE =  F
**NO WET SCAVENGING Data Provided.
**Model Uses GRIDDED TERRAIN Data for Depletion Calculations

**Model Uses RURAL Dispersion.

**Model Uses Regulatory DEFAULT Options:
          1. Final Plume Rise.
          2. Stack-tip Downwash.
          3. Buoyancy-induced Dispersion.
          4. Use Calms Processing Routine.
          5. Not Use Missing Data Processing Routine.
          6. Default Wind Profile Exponents.
          7. Default Vertical Potential Temperature Gradients.
          8. 'Upper Bound' Values for Supersquat Buildings.
          9. No Exponential Decay for RURAL Mode

**Model Accepts Receptors on ELEV Terrain.

**Model Assumes No FLAGPOLE Receptor Heights.

**Model Accepting Temperature Profile Data.
  Number of Levels :            3
    (m AGL)          30.0000
    (m AGL)          45.7000
    (m AGL)          152.400

**Model Accepting Wind Profile Data.
  Number of Levels :            5
    (m AGL)          30.0000
    (m AGL)          45.7000
    (m AGL)          80.8000
    (m AGL)          111.300
    (m AGL)          152.400

**Model Calculates  1 Short Term Average(s) of:   1-HR
    and Calculates PERIOD Averages

**This Run Includes:     1 Source(s);      1 Source Group(s); and    936 Receptor(s)

**The Model Assumes A Pollutant Type of:  FUGITIVE

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
         Model Outputs Tables of PERIOD Averages by Receptor
         Model Outputs Tables of Highest Short Term Values by Receptor (RECTABLE Keyword)
         Model Outputs Tables of Overall Maximum Short Term Values (MAXTABLE Keyword)
         Model Outputs External File(s) of High Values for Plotting (PLOTFILE Keyword)

**NOTE:  The Following Flags May Appear Following CONC Values:  c for Calm Hours
                                                                m for Missing Hours
                                                                b for Both Calm and Missing Hours

**Misc. Inputs:  Anem. Hgt. (m) =    30.00 ;    Decay Coef. =   0.0000     ;   Rot. Angle =     0.0
                 Emission Units = GRAMS/SEC                                 ;  Emission Rate Unit Factor =   0.10000E+07
                 Output Units   = MICROGRAMS/M**3

**Input Runstream File: truckwsh.inc                          ;  **Output Print File: truckwsh.out
**Detailed Error/Message File:   TRUCKWSH.ERR
```

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - TRUCK WASH *** 12/23/94
*** One Volume source; 936 receptors up to 50KM away; Vapor. *** 18:28:17
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** VOLUME SOURCE DATA ***

SOURCE ID	NUMBER PART. CATS.	EMISSION RATE (GRAMS/SEC)	X (METERS)	Y (METERS)	BASE ELEV. (METERS)	RELEASE HEIGHT (METERS)	INIT. SY (METERS)	INIT. SZ (METERS)	EMISSION RATE SCALAR VARY BY
TRUCK	0	0.10000E+01	100.2	170.9	212.1	3.05	1.77	2.84	

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*** ISCOMDEP VERSION 94227 ***     ***  WTI Fugitive source modeling - TRUCK WASH                    ***     12/23/94
                                   ***  One Volume source; 936 receptors up to 50KM away; Vapor.    ***     18:28:17
                                                                                                            PAGE   3
*** MODELING OPTIONS USED:  CONC   RURAL  ELEV          DFAULT


                                        *** SOURCE IDs DEFINING SOURCE GROUPS ***

GROUP ID                                              SOURCE IDs

ALL       TRUCK    ,
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```
*** ISCOMDEP VERSION 94227 ***     ***  WTI Fugitive source modeling - TRUCK WASH                    ***     12/23/94
                                   ***  One Volume source; 936 receptors up to 50KM away; Vapor.    ***     18:28:17
                                                                                                            PAGE   4
*** MODELING OPTIONS USED:  CONC   RURAL  ELEV          DFAULT

                                          *** SOURCE PARTICULATE/GAS DATA ***


      *** SOURCE ID = TRUCK    ; SOURCE TYPE =   VOLUME ***

      SCAV COEF [LIQ] 1/(S-MM/HR)=
      0.00E+00,

      SCAV COEF [ICE] 1/(S-MM/HR)=
      0.00E+00,
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*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - TRUCK WASH *** 12/23/94
*** One Volume source; 936 receptors up to 50KM away; Vapor. *** 18:28:17
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

* SOURCE-RECEPTOR COMBINATIONS LESS THAN 1.0 METER OR 3*ZLB *
IN DISTANCE. CALCULATIONS MAY NOT BE PERFORMED.

SOURCE ID	- - RECEPTOR LOCATION - - XR (METERS)	YR (METERS)	DISTANCE (METERS)
TRUCK	100.0	173.2	-1.50

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** METEOROLOGICAL DAYS SELECTED FOR PROCESSING ***
(1=YES; 0=NO)

1 1 1

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - TRUCK WASH *** 12/23/94
*** One Volume source; 936 receptors up to 50KM away; Vapor. *** 18:28:17
PAGE 18

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** THE FIRST 24 HOURS OF METEOROLOGICAL DATA ***

FILE: depbin.met FORMAT: (4I2,2F9.4,F6.1,I2,2F7.1,f9.4,f10.1,f8.4,f5.1,i4,f7.2)
SURFACE STATION NO.: 94823 UPPER AIR STATION NO.: 94823
NAME: WTI NAME: WTI
YEAR: 1993 YEAR: 1993

YEAR	MONTH	DAY	HOUR	FLOW VECTOR	SPEED (M/S)	TEMP (K)	STAB CLASS	MIXING HEIGHT (M) RURAL	MIXING HEIGHT (M) URBAN	USTAR (M/S)	M-O LENGTH (M)	Z-0 (M)	Zd (M)	IPCODE	PRATE (mm/HR)
93	1	1	1	104.0	4.47	275.4	4	601.6	601.6	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	2	112.0	5.36	274.8	4	617.6	617.6	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	3	106.0	4.47	274.0	4	633.5	633.5	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	4	115.0	4.47	273.9	4	649.5	649.5	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	5	120.0	4.02	273.8	4	665.4	665.4	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	6	123.0	5.36	273.3	4	681.4	681.4	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	7	130.0	4.92	272.5	4	697.3	697.3	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	8	124.0	4.92	271.9	4	713.3	713.3	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	9	115.0	4.47	271.0	4	729.2	729.2	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	10	107.0	4.02	270.9	4	745.2	745.2	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	11	113.0	4.02	270.6	4	761.1	761.1	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	12	108.0	4.47	270.9	4	777.1	777.1	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	13	114.0	5.36	271.1	4	793.0	793.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	14	107.0	4.92	271.0	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	15	120.0	4.92	270.8	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	16	119.0	4.47	270.5	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	17	118.0	3.58	270.4	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	18	124.0	2.68	270.4	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	19	124.0	2.68	270.1	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	20	113.0	2.23	270.3	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	21	97.0	2.68	270.3	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	22	113.0	3.13	270.3	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	23	117.0	3.13	270.4	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	24	152.0	2.68	269.9	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00

*** NOTES: STABILITY CLASS 1=A, 2=B, 3=C, 4=D, 5=E AND 6=F.
FLOW VECTOR IS DIRECTION TOWARD WHICH WIND IS BLOWING.

```
*** ISCOMDEP VERSION 94227 ***     *** WTI Fugitive source modeling - ORGANIC WASTE TANK FARM          ***     12/27/94
                                   *** Four Point source; 936 receptors up to 50KM away; Vapor.       ***     16:48:17
                                                                                                              PAGE   1
*** MODELING OPTIONS USED:  CONC   RURAL  ELEV          DFAULT

                                          ***     MODEL SETUP OPTIONS SUMMARY       ***
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

**Intermediate Terrain Processing is Selected

**Model Is Setup For Calculation of Average CONCentration Values.

  --  SCAVENGING/DEPOSITION LOGIC --
**Model Uses NO DRY DEPLETION.  DDPLETE =  F
**Model Uses NO WET DEPLETION.  WDPLETE =  F
**NO WET SCAVENGING Data Provided.
**Model Uses GRIDDED TERRAIN Data for Depletion Calculations

**Model Uses RURAL Dispersion.

**Model Uses Regulatory DEFAULT Options:
          1. Final Plume Rise.
          2. Stack-tip Downwash.
          3. Buoyancy-induced Dispersion.
          4. Use Calms Processing Routine.
          5. Not Use Missing Data Processing Routine.
          6. Default Wind Profile Exponents.
          7. Default Vertical Potential Temperature Gradients.
          8. 'Upper Bound' Values for Supersquat Buildings.
          9. No Exponential Decay for RURAL Mode

**Model Accepts Receptors on ELEV Terrain.

**Model Assumes No FLAGPOLE Receptor Heights.

**Model Accepting Temperature Profile Data.
  Number of Levels :           3
    (m AGL)          30.0000
    (m AGL)          45.7000
    (m AGL)          152.400

**Model Accepting Wind Profile Data.
  Number of Levels :           5
    (m AGL)          30.0000
    (m AGL)          45.7000
    (m AGL)          80.8000
    (m AGL)          111.300
    (m AGL)          152.400

**Model Calculates  1 Short Term Average(s) of:   1-HR
    and Calculates PERIOD Averages

**This Run Includes:     4 Source(s);      1 Source Group(s); and    936 Receptor(s)

**The Model Assumes A Pollutant Type of:  FUGITIVE

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
         Model Outputs Tables of PERIOD Averages by Receptor
         Model Outputs Tables of Highest Short Term Values by Receptor (RECTABLE Keyword)
         Model Outputs Tables of Overall Maximum Short Term Values (MAXTABLE Keyword)
         Model Outputs External File(s) of High Values for Plotting (PLOTFILE Keyword)

**NOTE:  The Following Flags May Appear Following CONC Values:  c for Calm Hours
                                                                m for Missing Hours
                                                                b for Both Calm and Missing Hours

**Misc. Inputs:  Anem. Hgt. (m) =    30.00 ;    Decay Coef. =   0.0000     ;    Rot. Angle =     0.0
                 Emission Units = GRAMS/SEC                                ;  Emission Rate Unit Factor =   0.10000E+07
                 Output Units   = MICROGRAMS/M**3

**Input Runstream File: WASTE.INC                          ;  **Output Print File: WASTE.OUT
**Detailed Error/Message File:   WASTE.ERR
```

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ORGANIC WASTE TANK FARM *** 12/27/94
*** Four Point source; 936 receptors up to 50KM away; Vapor. *** 16:48:17
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** POINT SOURCE DATA ***

SOURCE ID	NUMBER PART. CATS.	EMISSION RATE (GRAMS/SEC)	X (METERS)	Y (METERS)	BASE ELEV. (METERS)	STACK HEIGHT (METERS)	STACK TEMP. (DEG.K)	STACK EXIT VEL. (M/SEC)	STACK DIAMETER (METERS)	BUILDING EXISTS	EMISSION RATE SCALAR VARY BY
WASTE1	0	0.10000E+01	173.5	108.6	212.1	18.90	310.00	0.10	0.10	YES	
WASTE2	0	0.10000E+01	193.1	116.9	212.1	18.90	310.00	0.10	0.10	YES	
WASTE3	0	0.10000E+01	199.3	102.3	212.1	18.90	310.00	0.10	0.10	YES	
WASTE4	0	0.10000E+01	179.7	94.0	212.1	18.90	310.00	0.10	0.10	YES	

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ORGANIC WASTE TANK FARM *** 12/27/94
*** Four Point source; 936 receptors up to 50KM away; Vapor. *** 16:48:17
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** SOURCE IDs DEFINING SOURCE GROUPS ***

GROUP ID	SOURCE IDs
ALL	WASTE1 , WASTE2 , WASTE3 , WASTE4 ,

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ORGANIC WASTE TANK FARM *** 12/27/94
*** Four Point source; 936 receptors up to 50KM away; Vapor. *** 16:48:17
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** SOURCE PARTICULATE/GAS DATA ***

*** SOURCE ID = WASTE1 ; SOURCE TYPE = POINT ***

SCAV COEF [LIQ] 1/(S-MM/HR)=
0.00E+00,

SCAV COEF [ICE] 1/(S-MM/HR)=
0.00E+00,

*** SOURCE ID = WASTE2 ; SOURCE TYPE = POINT ***

SCAV COEF [LIQ] 1/(S-MM/HR)=
0.00E+00,

SCAV COEF [ICE] 1/(S-MM/HR)=
0.00E+00,

*** SOURCE ID = WASTE3 ; SOURCE TYPE = POINT ***

SCAV COEF [LIQ] 1/(S-MM/HR)=
0.00E+00,

SCAV COEF [ICE] 1/(S-MM/HR)=
0.00E+00,

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ORGANIC WASTE TANK FARM *** 12/27/94
*** Four Point source; 936 receptors up to 50KM away; Vapor. *** 16:48:17
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** SOURCE PARTICULATE/GAS DATA ***

*** SOURCE ID = WASTE4 ; SOURCE TYPE = POINT ***

SCAV COEF [LIQ] 1/(S-MM/HR)=
0.00E+00,

SCAV COEF [ICE] 1/(S-MM/HR)=
0.00E+00,

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ORGANIC WASTE TANK FARM *** 12/27/94
*** Four Point source; 936 receptors up to 50KM away; Vapor. *** 16:48:17
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** DIRECTION SPECIFIC BUILDING DIMENSIONS ***

SOURCE ID: WASTE1

IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK
1	15.2,	50.1,	0	2	15.2,	47.0,	0	3	15.2,	42.5,	0	4	15.2,	36.7,	0	5	15.2,	29.8,	0	6	15.2,	21.9,	0
7	15.2,	18.2,	0	8	15.2,	26.4,	0	9	15.2,	33.7,	0	10	15.2,	40.1,	0	11	15.2,	45.2,	0	12	15.2,	48.9,	0
13	15.2,	51.2,	0	14	15.2,	51.9,	0	15	15.2,	51.0,	0	16	15.2,	50.1,	0	17	15.2,	51.7,	0	18	15.2,	51.7,	0
19	15.2,	50.1,	0	20	15.2,	47.0,	0	21	15.2,	42.5,	0	22	15.2,	36.7,	0	23	15.2,	29.8,	0	24	15.2,	21.9,	0
25	15.2,	18.2,	0	26	15.2,	26.4,	0	27	15.2,	33.7,	0	28	15.2,	40.1,	0	29	15.2,	45.2,	0	30	15.2,	48.9,	0
31	15.2,	51.2,	0	32	15.2,	51.9,	0	33	15.2,	51.0,	0	34	15.2,	50.1,	0	35	15.2,	51.7,	0	36	15.2,	51.7,	0

SOURCE ID: WASTE2

IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK
1	15.2,	50.1,	0	2	15.2,	47.0,	0	3	15.2,	42.5,	0	4	15.2,	36.7,	0	5	15.2,	29.8,	0	6	15.2,	21.9,	0
7	15.2,	18.2,	0	8	15.2,	26.4,	0	9	15.2,	33.7,	0	10	15.2,	40.1,	0	11	15.2,	45.2,	0	12	15.2,	48.9,	0
13	15.2,	51.2,	0	14	15.2,	51.9,	0	15	15.2,	51.0,	0	16	15.2,	50.1,	0	17	15.2,	51.7,	0	18	15.2,	51.7,	0
19	15.2,	50.1,	0	20	15.2,	47.0,	0	21	15.2,	42.5,	0	22	15.2,	36.7,	0	23	15.2,	29.8,	0	24	15.2,	21.9,	0
25	15.2,	18.2,	0	26	15.2,	26.4,	0	27	15.2,	33.7,	0	28	15.2,	40.1,	0	29	15.2,	45.2,	0	30	15.2,	48.9,	0
31	15.2,	51.2,	0	32	15.2,	51.9,	0	33	15.2,	51.0,	0	34	15.2,	50.1,	0	35	15.2,	51.7,	0	36	15.2,	51.7,	0

SOURCE ID: WASTE3

IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK
1	15.2,	50.1,	0	2	15.2,	47.0,	0	3	15.2,	42.5,	0	4	15.2,	36.7,	0	5	15.2,	29.8,	0	6	15.2,	21.9,	0
7	15.2,	18.2,	0	8	15.2,	26.4,	0	9	15.2,	33.7,	0	10	15.2,	40.1,	0	11	15.2,	45.2,	0	12	15.2,	48.9,	0
13	15.2,	51.2,	0	14	15.2,	51.9,	0	15	15.2,	51.0,	0	16	15.2,	50.1,	0	17	15.2,	51.7,	0	18	15.2,	51.7,	0
19	15.2,	50.1,	0	20	15.2,	47.0,	0	21	15.2,	42.5,	0	22	15.2,	36.7,	0	23	15.2,	29.8,	0	24	15.2,	21.9,	0
25	15.2,	18.2,	0	26	15.2,	26.4,	0	27	15.2,	33.7,	0	28	15.2,	40.1,	0	29	15.2,	45.2,	0	30	15.2,	48.9,	0
31	15.2,	51.2,	0	32	15.2,	51.9,	0	33	15.2,	51.0,	0	34	15.2,	50.1,	0	35	15.2,	51.7,	0	36	15.2,	51.7,	0

SOURCE ID: WASTE4

IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK
1	15.2,	50.1,	0	2	15.2,	47.0,	0	3	15.2,	42.5,	0	4	15.2,	36.7,	0	5	15.2,	29.8,	0	6	15.2,	21.9,	0
7	15.2,	18.2,	0	8	15.2,	26.4,	0	9	15.2,	33.7,	0	10	15.2,	40.1,	0	11	15.2,	45.2,	0	12	15.2,	48.9,	0
13	15.2,	51.2,	0	14	15.2,	51.9,	0	15	15.2,	51.0,	0	16	15.2,	50.1,	0	17	15.2,	51.7,	0	18	15.2,	51.7,	0
19	15.2,	50.1,	0	20	15.2,	47.0,	0	21	15.2,	42.5,	0	22	15.2,	36.7,	0	23	15.2,	29.8,	0	24	15.2,	21.9,	0
25	15.2,	18.2,	0	26	15.2,	26.4,	0	27	15.2,	33.7,	0	28	15.2,	40.1,	0	29	15.2,	45.2,	0	30	15.2,	48.9,	0
31	15.2,	51.2,	0	32	15.2,	51.9,	0	33	15.2,	51.0,	0	34	15.2,	50.1,	0	35	15.2,	51.7,	0	36	15.2,	51.7,	0

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

* SOURCE-RECEPTOR COMBINATIONS LESS THAN 1.0 METER OR 3*ZLB * IN DISTANCE. CALCULATIONS MAY NOT BE PERFORMED.

SOURCE ID	- - RECEPTOR LOCATION - - XR (METERS)	YR (METERS)	DISTANCE (METERS)
WASTE1	153.2	128.6	28.45
WASTE1	173.2	100.0	8.58
WASTE1	187.9	68.4	42.70
WASTE2	153.2	128.6	41.58
WASTE2	173.2	100.0	26.12
WASTE3	173.2	100.0	26.20
WASTE3	187.9	68.4	35.76
WASTE4	153.2	128.6	43.52
WASTE4	173.2	100.0	8.81
WASTE4	187.9	68.4	26.89

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** METEOROLOGICAL DAYS SELECTED FOR PROCESSING ***
(1=YES; 0=NO)

1 1 1

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ORGANIC WASTE TANK FARM *** 12/27/94
*** Four Point source; 936 receptors up to 50KM away; Vapor. *** 16:48:17
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*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** THE FIRST 24 HOURS OF METEOROLOGICAL DATA ***

FILE: depbin.met FORMAT: (4I2,2F9.4,F6.1,I2,2F7.1,f9.4,f10.1,f8.4,f5.1,i4,f7.2)
SURFACE STATION NO.: 94823 UPPER AIR STATION NO.: 94823
NAME: WTI NAME: WTI
YEAR: 1993 YEAR: 1993

YEAR	MONTH	DAY	HOUR	FLOW VECTOR	SPEED (M/S)	TEMP (K)	STAB CLASS	MIXING HEIGHT (M) RURAL	MIXING HEIGHT (M) URBAN	USTAR (M/S)	M-O LENGTH (M)	Z-0 (M)	Zd (M)	IPCODE	PRATE (mm/HR)
93	1	1	1	104.0	4.47	275.4	4	601.6	601.6	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	2	112.0	5.36	274.8	4	617.6	617.6	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	3	106.0	4.47	274.0	4	633.5	633.5	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	4	115.0	4.47	273.9	4	649.5	649.5	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	5	120.0	4.02	273.8	4	665.4	665.4	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	6	123.0	5.36	273.3	4	681.4	681.4	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	7	130.0	4.92	272.5	4	697.3	697.3	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	8	124.0	4.92	271.9	4	713.3	713.3	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	9	115.0	4.47	271.0	4	729.2	729.2	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	10	107.0	4.02	270.9	4	745.2	745.2	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	11	113.0	4.02	270.6	4	761.1	761.1	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	12	108.0	4.47	270.9	4	777.1	777.1	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	13	114.0	5.36	271.1	4	793.0	793.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	14	107.0	4.92	271.0	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	15	120.0	4.92	270.8	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	16	119.0	4.47	270.5	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	17	118.0	3.58	270.4	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	18	124.0	2.68	270.4	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	19	124.0	2.68	270.1	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	20	113.0	2.23	270.3	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	21	97.0	2.68	270.3	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	22	113.0	3.13	270.3	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	23	117.0	3.13	270.4	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	24	152.0	2.68	269.9	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00

*** NOTES: STABILITY CLASS 1=A, 2=B, 3=C, 4=D, 5=E AND 6=F.
FLOW VECTOR IS DIRECTION TOWARD WHICH WIND IS BLOWING.

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 *** ISCOMDEP VERSION 94227 ***     ***  WTI Fugitive source modeling - OPEN WASTEWATER TANK                ***        12/23/94
                                   ***  One Volume source; 936 receptors up to 50KM away; Vapor.           ***        17:14:24
                                                                                                                     PAGE   1

 *** MODELING OPTIONS USED:  CONC   RURAL  ELEV          DFAULT

                                          ***     MODEL SETUP OPTIONS SUMMARY       ***
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

**Intermediate Terrain Processing is Selected

**Model Is Setup For Calculation of Average CONCentration Values.

  --  SCAVENGING/DEPOSITION LOGIC --
**Model Uses NO DRY DEPLETION.  DDPLETE =  F
**Model Uses NO WET DEPLETION.  WDPLETE =  F
**NO WET SCAVENGING Data Provided.
**Model Uses GRIDDED TERRAIN Data for Depletion Calculations

**Model Uses RURAL Dispersion.

**Model Uses Regulatory DEFAULT Options:
          1. Final Plume Rise.
          2. Stack-tip Downwash.
          3. Buoyancy-induced Dispersion.
          4. Use Calms Processing Routine.
          5. Not Use Missing Data Processing Routine.
          6. Default Wind Profile Exponents.
          7. Default Vertical Potential Temperature Gradients.
          8. "Upper Bound" Values for Supersquat Buildings.
          9. No Exponential Decay for RURAL Mode

**Model Accepts Receptors on ELEV Terrain.

**Model Assumes No FLAGPOLE Receptor Heights.

**Model Accepting Temperature Profile Data.
  Number of Levels :              3
    (m AGL)          30.0000
    (m AGL)          45.7000
    (m AGL)          152.400

**Model Accepting Wind Profile Data.
  Number of Levels :              5
    (m AGL)          30.0000
    (m AGL)          45.7000
    (m AGL)          80.8000
    (m AGL)          111.300
    (m AGL)          152.400

**Model Calculates  1 Short Term Average(s) of:   1-HR
   and Calculates PERIOD Averages

**This Run Includes:     1 Source(s);      1 Source Group(s); and    936 Receptor(s)

**The Model Assumes A Pollutant Type of:  FUGITIVE

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
        Model Outputs Tables of PERIOD Averages by Receptor
        Model Outputs Tables of Highest Short Term Values by Receptor (RECTABLE Keyword)
        Model Outputs Tables of Overall Maximum Short Term Values (MAXTABLE Keyword)
        Model Outputs External File(s) of High Values for Plotting (PLOTFILE Keyword)

**NOTE:  The Following Flags May Appear Following CONC Values:  c for Calm Hours
                                                                m for Missing Hours
                                                                b for Both Calm and Missing Hours

**Misc. Inputs:  Anem. Hgt. (m) =    30.00 ;    Decay Coef. =   0.0000     ;    Rot. Angle =     0.0
                 Emission Units = GRAMS/SEC                                ;  Emission Rate Unit Factor =   0.10000E+07
                 Output Units   = MICROGRAMS/M**3

**Input Runstream File: tank.inc                                  ;  **Output Print File: tank.out
**Detailed Error/Message File:   TANK.ERR
```

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - OPEN WASTEWATER TANK *** 12/23/94
*** One Volume source; 936 receptors up to 50KM away; Vapor. *** 17:14:24
PAGE 2

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** VOLUME SOURCE DATA ***

SOURCE ID	NUMBER PART. CATS.	EMISSION RATE (GRAMS/SEC)	X (METERS)	Y (METERS)	BASE ELEV. (METERS)	RELEASE HEIGHT (METERS)	INIT. SY (METERS)	INIT. SZ (METERS)	EMISSION RATE SCALAR VARY BY
TANK	0	0.10000E+01	177.1	204.8	212.1	5.30	2.35	4.96	

```
*** ISCOMDEP VERSION 94227 ***     ***  WTI Fugitive source modeling - OPEN WASTEWATER TANK          ***     12/23/94
                                   ***  One Volume source; 936 receptors up to 50KM away; Vapor.     ***     17:14:24
                                                                                                            PAGE   3
*** MODELING OPTIONS USED:  CONC   RURAL  ELEV          DFAULT


                                        *** SOURCE IDs DEFINING SOURCE GROUPS ***

GROUP ID                                              SOURCE IDs


ALL         TANK     ,
```

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - OPEN WASTEWATER TANK *** 12/23/94
*** One Volume source; 936 receptors up to 50KM away; Vapor. *** 17:14:24
PAGE 4

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** SOURCE PARTICULATE/GAS DATA ***

*** SOURCE ID = TANK ; SOURCE TYPE = VOLUME ***

SCAV COEF [LIQ] 1/(S-MM/HR)=
0.00E+00,

SCAV COEF [ICE] 1/(S-MM/HR)=
0.00E+00,

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - OPEN WASTEWATER TANK *** 12/23/94
*** One Volume source; 936 receptors up to 50KM away; Vapor. *** 17:14:24
PAGE 16

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** METEOROLOGICAL DAYS SELECTED FOR PROCESSING ***
(1=YES; 0=NO)

1 1 1

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - OPEN WASTEWATER TANK *** 12/23/94
*** One Volume source; 936 receptors up to 50KM away; Vapor. *** 17:14:24
PAGE 17

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** THE FIRST 24 HOURS OF METEOROLOGICAL DATA ***

FILE: depbin.met FORMAT: (4I2,2F9.4,F6.1,I2,2F7.1,f9.4,f10.1,f8.4,f5.1,i4,f7.2)
SURFACE STATION NO.: 94823 UPPER AIR STATION NO.: 94823
NAME: WTI NAME: WTI
YEAR: 1993 YEAR: 1993

YEAR	MONTH	DAY	HOUR	FLOW VECTOR	SPEED (M/S)	TEMP (K)	STAB CLASS	MIXING HEIGHT (M) RURAL	MIXING HEIGHT (M) URBAN	USTAR (M/S)	M-O LENGTH (M)	Z-0 (M)	Zd (M)	IPCODE	PRATE (gm/HR)
93	1	1	1	104.0	4.47	275.4	4	601.6	601.6	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	2	112.0	5.36	274.8	4	617.6	617.6	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	3	106.0	4.47	274.0	4	633.5	633.5	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	4	115.0	4.47	273.9	4	649.5	649.5	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	5	120.0	4.02	273.8	4	665.4	665.4	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	6	123.0	5.36	273.3	4	681.4	681.4	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	7	130.0	4.92	272.5	4	697.3	697.3	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	8	124.0	4.92	271.9	4	713.3	713.3	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	9	115.0	4.47	271.0	4	729.2	729.2	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	10	107.0	4.02	270.9	4	745.2	745.2	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	11	113.0	4.02	270.6	4	761.1	761.1	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	12	108.0	4.47	270.9	4	777.1	777.1	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	13	114.0	5.36	271.1	4	793.0	793.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	14	107.0	4.92	271.0	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	15	120.0	4.92	270.8	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	16	119.0	4.47	270.5	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	17	118.0	3.58	270.4	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	18	124.0	2.68	270.4	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	19	124.0	2.68	270.1	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	20	113.0	2.23	270.3	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	21	97.0	2.68	270.3	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	22	113.0	3.13	270.3	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	23	117.0	3.13	270.4	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	24	152.0	2.68	269.9	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00

*** NOTES: STABILITY CLASS 1=A, 2=B, 3=C, 4=D, 5=E AND 6=F.
FLOW VECTOR IS DIRECTION TOWARD WHICH WIND IS BLOWING.

```
 *** ISCOMDEP VERSION 94227 ***     *** WTI Fugitive source modeling - CARBON VENT STACK                    ***        02/16/95
                                   *** One Point source; 936 receptors up to 50KM away; Vapor.            ***        17:13:30
                                                                                                                     PAGE   1
 *** MODELING OPTIONS USED:  CONC   RURAL  ELEV          DFAULT

                                          ***     MODEL SETUP OPTIONS SUMMARY       ***
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

**Intermediate Terrain Processing is Selected

**Model Is Setup For Calculation of Average CONCentration Values.

  --  SCAVENGING/DEPOSITION LOGIC --
**Model Uses NO DRY DEPLETION.  DDPLETE =  F
**Model Uses NO WET DEPLETION.  WDPLETE =  F
**NO WET SCAVENGING Data Provided.
**Model Uses GRIDDED TERRAIN Data for Depletion Calculations

**Model Uses RURAL Dispersion.

**Model Uses Regulatory DEFAULT Options:
          1. Final Plume Rise.
          2. Stack-tip Downwash.
          3. Buoyancy-induced Dispersion.
          4. Use Calms Processing Routine.
          5. Not Use Missing Data Processing Routine.
          6. Default Wind Profile Exponents.
          7. Default Vertical Potential Temperature Gradients.
          8. "Upper Bound" Values for Supersquat Buildings.
          9. No Exponential Decay for RURAL Mode

**Model Accepts Receptors on ELEV Terrain.

**Model Assumes No FLAGPOLE Receptor Heights.

**Model Accepting Temperature Profile Data.
  Number of Levels :          3
    (m AGL)          30.0000
    (m AGL)          45.7000
    (m AGL)          152.400

**Model Accepting Wind Profile Data.
  Number of Levels :          5
    (m AGL)          30.0000
    (m AGL)          45.7000
    (m AGL)          80.8000
    (m AGL)          111.300
    (m AGL)          152.400

**Model Calculates  1 Short Term Average(s) of:   1-HR
    and Calculates PERIOD Averages

**This Run Includes:    1 Source(s);      1 Source Group(s); and    936 Receptor(s)

**The Model Assumes A Pollutant Type of:  FUGITIVE

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
         Model Outputs Tables of PERIOD Averages by Receptor
         Model Outputs Tables of Highest Short Term Values by Receptor (RECTABLE Keyword)
         Model Outputs Tables of Overall Maximum Short Term Values (MAXTABLE Keyword)
         Model Outputs External File(s) of High Values for Plotting (PLOTFILE Keyword)

**NOTE:  The Following Flags May Appear Following CONC Values:  c for Calm Hours
                                                                m for Missing Hours
                                                                b for Both Calm and Missing Hours

**Misc. Inputs:  Anem. Hgt. (m) =    30.00 ;    Decay Coef. =   0.0000     ;    Rot. Angle =     0.0
                 Emission Units = GRAMS/SEC                                ;  Emission Rate Unit Factor =   0.10000E+07
                 Output Units   = MICROGRAMS/M**3

**Input Runstream File: cadstack.inc                                ;  **Output Print File: cadstack.out
**Detailed Error/Message File:  CADSTACK.ERR
```

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - CARBON VENT STACK *** 02/16/95
*** One Point source; 936 receptors up to 50KM away; Vapor. *** 17:13:30
PAGE 2

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** POINT SOURCE DATA ***

SOURCE ID	NUMBER PART. CATS.	EMISSION RATE (GRAMS/SEC)	X (METERS)	Y (METERS)	BASE ELEV. (METERS)	STACK HEIGHT (METERS)	STACK TEMP. (DEG.K)	STACK EXIT VEL. (M/SEC)	STACK DIAMETER (METERS)	BUILDING EXISTS	EMISSION RATE SCALAR VARY BY
CADSTACK	0	0.10000E+01	61.0	42.8	212.1	28.04	250.00	31.05	0.76	YES	

```
*** ISCOMDEP VERSION 94227 ***    ***  WTI Fugitive source modeling - CARBON VENT STACK                    ***        02/16/95
                                  ***  One Point source; 936 receptors up to 50KM away; Vapor.            ***        17:13:30
                                                                                                                    PAGE    3
*** MODELING OPTIONS USED:  CONC   RURAL  ELEV          DFAULT


                                          *** SOURCE IDs DEFINING SOURCE GROUPS ***

GROUP ID                                              SOURCE IDs


ALL       CADSTACK,
```

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - CARBON VENT STACK *** 02/16/95
*** One Point source; 936 receptors up to 50KM away; Vapor. *** 17:13:30
PAGE 4

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** SOURCE PARTICULATE/GAS DATA ***

*** SOURCE ID = CADSTACK; SOURCE TYPE = POINT ***

SCAV COEF [LIQ] 1/(S-MM/HR)=
0.00E+00,

SCAV COEF [ICE] 1/(S-MM/HR)=
0.00E+00,

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - CARBON VENT STACK *** 02/16/95
*** One Point source; 936 receptors up to 50KM away; Vapor. *** 17:13:30
PAGE 5

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** DIRECTION SPECIFIC BUILDING DIMENSIONS ***

SOURCE ID: CADSTACK

IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK
1	25.8,	27.1,	0	2	25.8,	28.1,	0	3	25.8,	28.3,	0	4	25.8,	27.6,	0	5	25.8,	26.1,	0	6	25.8,	23.8,	0
7	24.4,	26.0,	0	8	25.8,	24.8,	0	9	25.8,	26.4,	0	10	25.8,	27.3,	0	11	25.8,	27.3,	0	12	25.8,	26.4,	0
13	25.8,	24.8,	0	14	25.8,	22.4,	0	15	25.8,	20.1,	0	16	25.8,	19.3,	0	17	25.8,	22.6,	0	18	25.8,	25.2,	0
19	25.8,	27.1,	0	20	25.8,	28.1,	0	21	25.8,	28.3,	0	22	25.8,	27.6,	0	23	25.8,	26.1,	0	24	25.8,	23.8,	0
25	24.4,	26.0,	0	26	25.8,	24.8,	0	27	25.8,	26.4,	0	28	25.8,	27.3,	0	29	25.8,	27.3,	0	30	25.8,	26.4,	0
31	25.8,	24.8,	0	32	25.8,	22.4,	0	33	25.8,	20.1,	0	34	25.8,	19.3,	0	35	25.8,	22.6,	0	36	25.8,	25.2,	0

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

* SOURCE-RECEPTOR COMBINATIONS LESS THAN 1.0 METER OR 3*ZLB *
IN DISTANCE. CALCULATIONS MAY NOT BE PERFORMED.

SOURCE ID	- - RECEPTOR LOCATION - - XR (METERS)	YR (METERS)	DISTANCE (METERS)
CADSTACK	34.2	94.0	57.74
CADSTACK	50.0	86.6	45.14
CADSTACK	64.3	76.6	33.93
CADSTACK	76.6	64.3	26.51
CADSTACK	86.6	50.0	26.57
CADSTACK	94.0	34.2	34.06
CADSTACK	98.5	17.4	45.30
CADSTACK	100.0	0.0	57.91

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** METEOROLOGICAL DAYS SELECTED FOR PROCESSING ***
(1=YES; 0=NO)

1 1 1

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - CARBON VENT STACK *** 02/16/95
*** One Point source; 936 receptors up to 50KM away; Vapor. *** 17:13:30
PAGE 19

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** THE FIRST 24 HOURS OF METEOROLOGICAL DATA ***

FILE: depbin.met FORMAT: (4I2,2F9.4,F6.1,I2,2F7.1,f9.4,f10.1,f8.4,f5.1,i4,f7.2)
SURFACE STATION NO.: 94823 UPPER AIR STATION NO.: 94823
NAME: WTI NAME: WTI
YEAR: 1993 YEAR: 1993

YEAR	MONTH	DAY	HOUR	FLOW VECTOR	SPEED (M/S)	TEMP (K)	STAB CLASS	MIXING HEIGHT (M) RURAL	MIXING HEIGHT (M) URBAN	USTAR (M/S)	M-O LENGTH (M)	Z-0 (M)	Zd (M)	IPCODE	PRATE (mm/HR)
93	1	1	1	104.0	4.47	275.4	4	601.6	601.6	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	2	112.0	5.36	274.8	4	617.6	617.6	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	3	106.0	4.47	274.0	4	633.5	633.5	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	4	115.0	4.47	273.9	4	649.5	649.5	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	5	120.0	4.02	273.8	4	665.4	665.4	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	6	123.0	5.36	273.3	4	681.4	681.4	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	7	130.0	4.92	272.5	4	697.3	697.3	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	8	124.0	4.92	271.9	4	713.3	713.3	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	9	115.0	4.47	271.0	4	729.2	729.2	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	10	107.0	4.02	270.9	4	745.2	745.2	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	11	113.0	4.02	270.6	4	761.1	761.1	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	12	108.0	4.47	270.9	4	777.1	777.1	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	13	114.0	5.36	271.1	4	793.0	793.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	14	107.0	4.92	271.0	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	15	120.0	4.92	270.8	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	16	119.0	4.47	270.5	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	17	118.0	3.58	270.4	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	18	124.0	2.68	270.4	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	19	124.0	2.68	270.1	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	20	113.0	2.23	270.3	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	21	97.0	2.68	270.3	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	22	113.0	3.13	270.3	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	23	117.0	3.13	270.4	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	24	152.0	2.68	269.9	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00

*** NOTES: STABILITY CLASS 1=A, 2=B, 3=C, 4=D, 5=E AND 6=F.
FLOW VECTOR IS DIRECTION TOWARD WHICH WIND IS BLOWING.

```
 *** ISCOMDEP VERSION 94227 ***     ***  WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG          ***        01/25/95
                                   ***  One Point source; 936 receptors up to 50KM away; Mass Wt.       ***        18:00:36
                                                                                                                  PAGE   1
 *** MODELING OPTIONS USED:  CONC   RURAL  ELEV          DFAULT                                          DRYDPL WETDPL

                                          ***     MODEL SETUP OPTIONS SUMMARY       ***
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

**Intermediate Terrain Processing is Selected

**Model Is Setup For Calculation of Average CONCentration Values.

  --  SCAVENGING/DEPOSITION LOGIC --
**Model Uses DRY DEPLETION.  DDPLETE =  T
**Model Uses WET DEPLETION.  WDPLETE =  T
**SCAVENGING Data Provided.  LMGAS,LWPART =  F T
**Model Uses GRIDDED TERRAIN Data for Depletion Calculations

**Model Uses RURAL Dispersion.

**Model Uses Regulatory DEFAULT Options:
          1. Final Plume Rise.
          2. Stack-tip Downwash.
          3. Buoyancy-induced Dispersion.
          4. Use Calms Processing Routine.
          5. Not Use Missing Data Processing Routine.
          6. Default Wind Profile Exponents.
          7. Default Vertical Potential Temperature Gradients.
          8. 'Upper Bound' Values for Supersquat Buildings.
          9. No Exponential Decay for RURAL Mode

**Model Accepts Receptors on ELEV Terrain.

**Model Assumes No FLAGPOLE Receptor Heights.

**Model Accepting Temperature Profile Data.
  Number of Levels :          3
    (m AGL)          30.0000
    (m AGL)          45.7000
    (m AGL)          152.400

**Model Accepting Wind Profile Data.
  Number of Levels :          5
    (m AGL)          30.0000
    (m AGL)          45.7000
    (m AGL)          80.8000
    (m AGL)          111.300
    (m AGL)          152.400

**Model Calculates  1 Short Term Average(s) of:   1-HR
    and Calculates PERIOD Averages

**This Run Includes:    1 Source(s);      1 Source Group(s); and    936 Receptor(s)

**The Model Assumes A Pollutant Type of:  FUGITIVE

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
        Model Outputs Tables of PERIOD Averages by Receptor
        Model Outputs Tables of Highest Short Term Values by Receptor (RECTABLE Keyword)
        Model Outputs Tables of Overall Maximum Short Term Values (MAXTABLE Keyword)
        Model Outputs External File(s) of High Values for Plotting (PLOTFILE Keyword)

**NOTE:  The Following Flags May Appear Following CONC Values:  c for Calm Hours
                                                                m for Missing Hours
                                                                b for Both Calm and Missing Hours

**Misc. Inputs:  Anem. Hgt. (m) =    30.00 ;    Decay Coef. =   0.0000     ;    Rot. Angle =     0.0
                 Emission Units = GRAMS/SEC                                ;  Emission Rate Unit Factor =   0.10000E+07
                 Output Units   = MICROGRAMS/M**3

**Input Runstream File: steama_c.inc                              ;  **Output Print File: steama_c.out
**Detailed Error/Message File:   STEAM_C.ERR
```

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** 01/25/95
*** One Point source; 936 receptors up to 50KM away; Mass Wt. *** 18:00:36
PAGE 2

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** POINT SOURCE DATA ***

SOURCE ID	NUMBER PART. CATS.	EMISSION RATE (GRAMS/SEC)	X (METERS)	Y (METERS)	BASE ELEV. (METERS)	STACK HEIGHT (METERS)	STACK TEMP. (DEG.K)	STACK EXIT VEL. (M/SEC)	STACK DIAMETER (METERS)	BUILDING EXISTS	EMISSION RATE SCALAR VARY BY
STEAM	10	0.10000E+01	23.9	49.0	212.1	6.71	310.00	0.10	0.10	YES	

```
*** ISCOMDEP VERSION 94227 ***     ***  WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG          ***        01/25/95
                                   ***  One Point source; 936 receptors up to 50KM away; Mass Wt.       ***        18:00:36
                                                                                                                  PAGE    3
*** MODELING OPTIONS USED:  CONC   RURAL  ELEV          DFAULT                                    DRYDFL WETDFL
```

*** SOURCE IDs DEFINING SOURCE GROUPS ***

GROUP ID	SOURCE IDs
ALL	STEAM ,

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** 01/25/95
*** One Point source; 936 receptors up to 50KM away; Mass Wt. *** 18:00:36
PAGE 4

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** SOURCE PARTICULATE/GAS DATA ***

*** SOURCE ID = STEAM ; SOURCE TYPE = POINT ***

MASS FRACTION =
0.04260, 0.08510, 0.17020, 0.19150, 0.19150, 0.11910, 0.10000, 0.05000, 0.04000, 0.01000,

PARTICLE DIAMETER (MICRONS) =
2.97000, 1.89000, 0.93000, 0.55000, 0.40000, 0.27000, 0.18000, 0.12000, 0.06200, 0.03000,

PARTICLE DENSITY (G/CM**3) =
1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000,

SCAV COEF [LIQ] 1/(S-MM/HR)=
0.21E-03,0.14E-03,0.50E-04,0.50E-04,0.60E-04,0.90E-04,0.13E-03,0.15E-03,0.20E-03,0.22E-03,

SCAV COEF [ICE] 1/(S-MM/HR)=
0.70E-04,0.47E-04,0.17E-04,0.17E-04,0.20E-04,0.30E-04,0.43E-04,0.50E-04,0.67E-04,0.73E-04,

*** ISCONDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** 01/25/95
*** One Point source; 936 receptors up to 50KM away; Mass Wt. *** 18:00:36
PAGE 5

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDFL WETDFL

*** DIRECTION SPECIFIC BUILDING DIMENSIONS ***

SOURCE ID: STEAM

IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK
1	29.1,	25.9,	0	2	29.1,	24.7,	0	3	29.1,	21.8,	0	4	24.4,	28.9,	0	5	24.4,	27.0,	0	6	24.4,	24.6,	0
7	6.7,	16.4,	0	8	25.8,	24.8,	0	9	25.8,	26.4,	0	10	25.8,	27.3,	0	11	25.8,	27.3,	0	12	25.8,	26.4,	0
13	25.8,	24.8,	0	14	25.8,	22.4,	0	15	25.8,	20.1,	0	16	29.1,	25.9,	0	17	29.1,	25.9,	0	18	29.1,	25.9,	0
19	29.1,	25.9,	0	20	29.1,	24.7,	0	21	29.1,	21.8,	0	22	24.4,	28.9,	0	23	24.4,	27.0,	0	24	24.4,	24.6,	0
25	14.9,	65.3,	0	26	25.8,	24.8,	0	27	25.8,	26.4,	0	28	25.8,	27.3,	0	29	25.8,	27.3,	0	30	25.8,	26.4,	0
31	25.8,	24.8,	0	32	25.8,	22.4,	0	33	25.8,	20.1,	0	34	29.1,	25.9,	0	35	29.1,	25.9,	0	36	29.1,	25.9,	0

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** 01/25/95
*** One Point source; 936 receptors up to 50KM away; Mass Wt. *** 18:00:36
PAGE 17

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

* SOURCE-RECEPTOR COMBINATIONS LESS THAN 1.0 METER OR 3*ZLB *
IN DISTANCE. CALCULATIONS MAY NOT BE PERFORMED.

SOURCE ID	- - RECEPTOR LOCATION - - XR (METERS)	YR (METERS)	DISTANCE (METERS)
STEAM	17.4	98.5	49.93
STEAM	34.2	94.0	46.16
STEAM	50.0	86.6	45.80
STEAM	64.3	76.6	48.93
STEAM	86.6	50.0	62.72
STEAM	94.0	34.2	71.62
STEAM	-34.2	94.0	73.48
STEAM	-17.4	98.5	64.44
STEAM	0.0	100.0	56.34

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** METEOROLOGICAL DAYS SELECTED FOR PROCESSING ***
(1=YES; 0=NO)

1 1 1

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** 01/25/95
*** One Point source; 936 receptors up to 50KM away; Mass Wt. *** 18:00:36
PAGE 19

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** THE FIRST 24 HOURS OF METEOROLOGICAL DATA ***

FILE: depbin.met FORMAT: (4I2,2F9.4,F6.1,I2,2F7.1,f9.4,f10.1,f8.4,f5.1,i4,f7.2)
SURFACE STATION NO.: 94823 UPPER AIR STATION NO.: 94823
NAME: WTI NAME: WTI
YEAR: 1993 YEAR: 1993

YEAR	MONTH	DAY	HOUR	FLOW VECTOR	SPEED (M/S)	TEMP (K)	STAB CLASS	MIXING HEIGHT (M) RURAL	MIXING HEIGHT (M) URBAN	USTAR (M/S)	M-O LENGTH (M)	Z-0 (M)	Zd (M)	IPCODE	PRATE (mm/HR)
93	1	1	1	104.0	4.47	275.4	4	601.6	601.6	0.3366	176.8	0.3000	1.5	13	0.00
93	1	1	2	112.0	5.36	274.8	4	617.6	617.6	0.4269	283.7	0.3000	1.5	0	0.25
93	1	1	3	106.0	4.47	274.0	4	633.5	633.5	0.3363	175.6	0.3000	1.5	0	0.00
93	1	1	4	115.0	4.47	273.9	4	649.5	649.5	0.3363	175.4	0.3000	1.5	28	0.00
93	1	1	5	120.0	4.02	273.8	4	665.4	665.4	0.2874	128.1	0.3000	1.5	28	0.00
93	1	1	6	123.0	5.36	273.3	4	681.4	681.4	0.4266	281.8	0.3000	1.5	28	0.00
93	1	1	7	130.0	4.92	272.5	4	697.3	697.3	0.3820	225.3	0.3000	1.5	28	0.00
93	1	1	8	124.0	4.92	271.9	4	713.3	713.3	0.3819	224.6	0.3000	1.5	28	0.00
93	1	1	9	115.0	4.47	271.0	4	729.2	729.2	0.3355	172.9	0.3000	1.5	28	0.00
93	1	1	10	107.0	4.02	270.9	4	745.2	745.2	0.3534	-999.0	0.3000	1.5	28	0.00
93	1	1	11	113.0	4.02	270.6	4	761.1	761.1	0.3534	-999.0	0.3000	1.5	28	0.00
93	1	1	12	108.0	4.47	270.9	4	777.1	777.1	0.3926	-999.0	0.3000	1.5	28	0.00
93	1	1	13	114.0	5.36	271.1	4	793.0	793.0	0.4712	-999.0	0.3000	1.5	28	0.00
93	1	1	14	107.0	4.92	271.0	4	809.0	809.0	0.4319	-999.0	0.3000	1.5	28	0.00
93	1	1	15	120.0	4.92	270.8	4	809.0	809.0	0.3817	223.4	0.3000	1.5	28	0.00
93	1	1	16	119.0	4.47	270.5	4	809.0	809.0	0.3354	172.4	0.3000	1.5	28	0.00
93	1	1	17	118.0	3.58	270.4	4	809.0	809.0	0.2310	81.7	0.3000	1.5	28	0.00
93	1	1	18	124.0	2.68	270.4	4	809.0	809.0	0.1178	29.4	0.3000	1.5	28	0.00
93	1	1	19	124.0	2.68	270.1	4	809.0	809.0	0.1178	29.4	0.3000	1.5	28	0.00
93	1	1	20	113.0	2.23	270.3	4	809.0	809.0	0.0982	29.4	0.3000	1.5	28	0.00
93	1	1	21	97.0	2.68	270.3	4	809.0	809.0	0.1178	29.4	0.3000	1.5	0	0.00
93	1	1	22	113.0	3.13	270.3	4	809.0	809.0	0.1374	29.4	0.3000	1.5	28	0.00
93	1	1	23	117.0	3.13	270.4	4	809.0	809.0	0.1374	29.4	0.3000	1.5	0	0.00
93	1	1	24	152.0	2.68	269.9	4	809.0	809.0	0.1178	29.4	0.3000	1.5	28	0.00

*** NOTES: STABILITY CLASS 1=A, 2=B, 3=C, 4=D, 5=E AND 6=F.
FLOW VECTOR IS DIRECTION TOWARD WHICH WIND IS BLOWING.

```
*** ISCOMDEP VERSION 94227 ***     *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG          ***
                                   *** One Point source; 936 receptors up to 50KM away; Mass Wt.      ***        23:53:23
                                                                                                                 PAGE   1
 *** MODELING OPTIONS USED:  WDEP   RURAL  ELEV          DFAULT                                          DRYDPL WETDPL

                                          ***     MODEL SETUP OPTIONS SUMMARY       ***
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

**Intermediate Terrain Processing is Selected

**Model Is Setup For Calculation of Wet DEPosition Values.

  --  SCAVENGING/DEPOSITION LOGIC --
**Model Uses DRY DEPLETION.  DDPLETE =  T
**Model Uses WET DEPLETION.  WDPLETE =  T .
**SCAVENGING Data Provided.  LMGAS,LMPART =  F T
**Model Uses GRIDDED TERRAIN Data for Depletion Calculations

**Model Uses RURAL Dispersion.

**Model Uses Regulatory DEFAULT Options:
          1. Final Plume Rise.
          2. Stack-tip Downwash.
          3. Buoyancy-induced Dispersion.
          4. Use Calms Processing Routine.
          5. Not Use Missing Data Processing Routine.
          6. Default Wind Profile Exponents.
          7. Default Vertical Potential Temperature Gradients.
          8. "Upper Bound" Values for Supersquat Buildings.
          9. No Exponential Decay for RURAL Mode

**Model Accepts Receptors on ELEV Terrain.

**Model Assumes No FLAGPOLE Receptor Heights.

**Model Accepting Temperature Profile Data.
  Number of Levels :  3
    (m AGL)       30.0
    (m AGL)       45.7
    (m AGL)       152.3999

**Model Accepting Wind Profile Data.
  Number of Levels :  5
    (m AGL)       30.0
    (m AGL)       45.7
    (m AGL)       80.8
    (m AGL)       111.3
    (m AGL)       152.3999

**Model Calculates  1 Short Term Average(s) of:   1-HR
    and Calculates PERIOD Averages

**This Run Includes:    1 Source(s);      1 Source Group(s); and    936 Receptor(s)

**The Model Assumes A Pollutant Type of:  FUGITIVE

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
         Model Outputs Tables of PERIOD Averages by Receptor
         Model Outputs Tables of Highest Short Term Values by Receptor (RECTABLE Keyword)
         Model Outputs Tables of Overall Maximum Short Term Values (MAXTABLE Keyword)
         Model Outputs External File(s) of High Values for Plotting (PLOTFILE Keyword)

**NOTE:  The Following Flags May Appear Following DEPO Values:  c for Calm Hours
                                                                m for Missing Hours
                                                                b for Both Calm and Missing Hours

**Misc. Inputs:  Anem. Hgt. (m) =    30.00 ;    Decay Coef. =    .0000E+00 ;    Rot. Angle =      .0
                 Emission Units = GRAMS/SEC                                  ;  Emission Rate Unit Factor =    3600.0
                 Output Units   = GRAMS/M**2

**Input Runstream File: steama_w.ind                    ;  **Output Print File: steama_w.out
**Detailed Error/Message File:
STEAMA_W.ERR
```

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** *** 23:53:23
*** One Point source; 936 receptors up to 50KM away; Mass Wt. *** PAGE 2

*** MODELING OPTIONS USED: WDEP RURAL ELEV DFAULT DRYDPL WETDPL

*** POINT SOURCE DATA ***

SOURCE ID	NUMBER PART. CATS.	EMISSION RATE (GRAMS/SEC)	X (METERS)	Y (METERS)	BASE ELEV. (METERS)	STACK HEIGHT (METERS)	STACK TEMP. (DEG.K)	STACK EXIT VEL. (M/SEC)	STACK DIAMETER (METERS)	BUILDING EXISTS	EMISSION RATE SCALAR VARY BY
STEAM	10	.10000E+01	23.9	49.0	212.1	6.71	310.00	.10	.10	YES	

```
*** ISCOMDEP VERSION 94227 ***     *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG          ***
                                   *** One Point source; 936 receptors up to 50KM away; Mass Wt.      ***  23:53:23
                                                                                                           PAGE   3
 *** MODELING OPTIONS USED:  WDEP   RURAL  ELEV          DFAULT                                    DRYDPL WETDPL

                                        *** SOURCE IDs DEFINING SOURCE GROUPS ***

GROUP ID                                SOURCE IDs

 ALL        STEAM    ,
```

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** *** 23:53:23
*** One Point source; 936 receptors up to 50KM away; Mass Wt. *** PAGE 4

*** MODELING OPTIONS USED: WDEP RURAL ELEV DFAULT DRYDPL WETDPL

*** SOURCE PARTICULATE/GAS DATA ***

*** SOURCE ID = STEAM ; SOURCE TYPE = POINT ***

MASS FRACTION =
.04260, .08510, .17020, .19150, .19150, .11910, .10000, .05000, .04000, .01000,

PARTICLE DIAMETER (MICRONS) =
2.97000, 1.89000, .93000, .55000, .40000, .27000, .18000, .12000, .06200, .03000,

PARTICLE DENSITY (G/CM**3) =
1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000,

SCAV COEF [LIQ] 1/(S-MM/HR)=
.21E-03, .14E-03, .50E-04, .50E-04, .60E-04, .90E-04, .13E-03, .15E-03, .20E-03, .22E-03,

SCAV COEF [ICE] 1/(S-MM/HR)=
.70E-04, .47E-04, .17E-04, .17E-04, .20E-04, .30E-04, .43E-04, .50E-04, .67E-04, .73E-04,

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** *** 23:53:23
*** One Point source; 936 receptors up to 50KM away; Mass Wt. *** PAGE 5

*** MODELING OPTIONS USED: WDEP RURAL ELEV DFAULT DRYDPL WETDPL

*** DIRECTION SPECIFIC BUILDING DIMENSIONS ***

SOURCE ID: STEAM

IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK
1	29.1,	25.9,	0	2	29.1,	24.7,	0	3	29.1,	21.8,	0	4	24.4,	28.9,	0	5	24.4,	27.0,	0	6	24.4,	24.6,	0
7	6.7,	16.4,	0	8	25.8,	24.8,	0	9	25.8,	26.4,	0	10	25.8,	27.3,	0	11	25.8,	27.3,	0	12	25.8,	26.4,	0
13	25.8,	24.8,	0	14	25.8,	22.4,	0	15	25.8,	20.1,	0	16	29.1,	25.9,	0	17	29.1,	25.9,	0	18	29.1,	25.9,	0
19	29.1,	25.9,	0	20	29.1,	24.7,	0	21	29.1,	21.8,	0	22	24.4,	28.9,	0	23	24.4,	27.0,	0	24	24.4,	24.6,	0
25	14.9,	65.3,	0	26	25.8,	24.8,	0	27	25.8,	26.4,	0	28	25.8,	27.3,	0	29	25.8,	27.3,	0	30	25.8,	26.4,	0
31	25.8,	24.8,	0	32	25.8,	22.4,	0	33	25.8,	20.1,	0	34	29.1,	25.9,	0	35	29.1,	25.9,	0	36	29.1,	25.9,	0

* SOURCE-RECEPTOR COMBINATIONS LESS THAN 1.0 METER OR 3*ZLB *
IN DISTANCE. CALCULATIONS MAY NOT BE PERFORMED.

SOURCE ID	- - RECEPTOR LOCATION - - XR (METERS)	YR (METERS)	DISTANCE (METERS)
STEAM	17.4	98.5	49.93
STEAM	34.2	94.0	46.16
STEAM	50.0	86.6	45.80
STEAM	64.3	76.6	48.93
STEAM	86.6	50.0	62.72
STEAM	94.0	34.2	71.62
STEAM	-34.2	94.0	73.48
STEAM	-17.4	98.5	64.44
STEAM	.0	100.0	56.34

*** MODELING OPTIONS USED: WDEP RURAL ELEV DFAULT DRYDPL WETDPL

*** METEOROLOGICAL DAYS SELECTED FOR PROCESSING ***
(1=YES; 0=NO)

1 1 1

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** 23:53:23
*** One Point source; 936 receptors up to 50KM away; Mass Wt. *** PAGE 19

*** MODELING OPTIONS USED: MDEP RURAL ELEV DFAULT DRYDPL WETDPL

*** THE FIRST 24 HOURS OF METEOROLOGICAL DATA ***

FILE: depbin.met FORMAT: (4I2,2F9.4,F6.1,I2,2F7.1,f9.4,f10.1,f8.4,f5.1,i4,f7.2)
SURFACE STATION NO.: 94823 UPPER AIR STATION NO.: 94823
NAME: WTI NAME: WTI
YEAR: 1993 YEAR: 1993

YEAR	MONTH	DAY	HOUR	FLOW VECTOR	SPEED (M/S)	TEMP (K)	STAB CLASS	MIXING HEIGHT (M) RURAL	MIXING HEIGHT (M) URBAN	USTAR (M/S)	M-O LENGTH (M)	Z-0 (M)	Zd (M)	IPCODE	PRATE (mm/HR)
93	1	1	1	104.0	4.47	275.4	4	601.6	601.6	.3366	176.8	.3000	1.5	13	.00
93	1	1	2	112.0	5.36	274.8	4	617.6	617.6	.4269	283.7	.3000	1.5	0	.25
93	1	1	3	106.0	4.47	274.0	4	633.5	633.5	.3363	175.6	.3000	1.5	0	.00
93	1	1	4	115.0	4.47	273.9	4	649.5	649.5	.3363	175.4	.3000	1.5	28	.00
93	1	1	5	120.0	4.02	273.8	4	665.4	665.4	.2874	128.1	.3000	1.5	28	.00
93	1	1	6	123.0	5.36	273.3	4	681.4	681.4	.4266	281.8	.3000	1.5	28	.00
93	1	1	7	130.0	4.92	272.5	4	697.3	697.3	.3820	225.3	.3000	1.5	28	.00
93	1	1	8	124.0	4.92	271.9	4	713.3	713.3	.3819	224.6	.3000	1.5	28	.00
93	1	1	9	115.0	4.47	271.0	4	729.2	729.2	.3355	172.9	.3000	1.5	28	.00
93	1	1	10	107.0	4.02	270.9	4	745.2	745.2	.3534	-999.0	.3000	1.5	28	.00
93	1	1	11	113.0	4.02	270.6	4	761.1	761.1	.3534	-999.0	.3000	1.5	28	.00
93	1	1	12	108.0	4.47	270.9	4	777.1	777.1	.3926	-999.0	.3000	1.5	28	.00
93	1	1	13	114.0	5.36	271.1	4	793.0	793.0	.4712	-999.0	.3000	1.5	28	.00
93	1	1	14	107.0	4.92	271.0	4	809.0	809.0	.4319	-999.0	.3000	1.5	28	.00
93	1	1	15	120.0	4.92	270.8	4	809.0	809.0	.3817	223.4	.3000	1.5	28	.00
93	1	1	16	119.0	4.47	270.5	4	809.0	809.0	.3354	172.4	.3000	1.5	28	.00
93	1	1	17	118.0	3.58	270.4	4	809.0	809.0	.2310	81.7	.3000	1.5	28	.00
93	1	1	18	124.0	2.68	270.4	4	809.0	809.0	.1178	29.4	.3000	1.5	28	.00
93	1	1	19	124.0	2.68	270.1	4	809.0	809.0	.1178	29.4	.3000	1.5	28	.00
93	1	1	20	113.0	2.23	270.3	4	809.0	809.0	.0982	29.4	.3000	1.5	28	.00
93	1	1	21	97.0	2.68	270.3	4	809.0	809.0	.1178	29.4	.3000	1.5	0	.00
93	1	1	22	113.0	3.13	270.3	4	809.0	809.0	.1374	29.4	.3000	1.5	28	.00
93	1	1	23	117.0	3.13	270.4	4	809.0	809.0	.1374	29.4	.3000	1.5	0	.00
93	1	1	24	152.0	2.68	269.9	4	809.0	809.0	.1178	29.4	.3000	1.5	28	.00

*** NOTES: STABILITY CLASS 1=A, 2=B, 3=C, 4=D, 5=E AND 6=F.
FLOW VECTOR IS DIRECTION TOWARD WHICH WIND IS BLOWING.

```
 *** ISCOMDEP VERSION 94227 ***     ***  WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG          ***        01/26/95
                                   ***  One Point source; 936 receptors up to 50KM away; Mass Wt.       ***        00:18:55
                                                                                                                  PAGE    1
 *** MODELING OPTIONS USED:  DDEP   RURAL  ELEV          DFAULT                                          DRYDPL WETDPL

                                          ***     MODEL SETUP OPTIONS SUMMARY       ***
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

**Intermediate Terrain Processing is Selected

**Model Is Setup For Calculation of Dry DEPosition Values.

  --  SCAVENGING/DEPOSITION LOGIC --
**Model Uses DRY DEPLETION.  DDPLETE =  T
**Model Uses WET DEPLETION.  WDPLETE =  T
**SCAVENGING Data Provided.  LWGAS,LWPART =  F T
**Model Uses GRIDDED TERRAIN Data for Depletion Calculations

**Model Uses RURAL Dispersion.

**Model Uses Regulatory DEFAULT Options:
          1. Final Plume Rise.
          2. Stack-tip Downwash.
          3. Buoyancy-induced Dispersion.
          4. Use Calms Processing Routine.
          5. Not Use Missing Data Processing Routine.
          6. Default Wind Profile Exponents.
          7. Default Vertical Potential Temperature Gradients.
          8. 'Upper Bound' Values for Supersquat Buildings.
          9. No Exponential Decay for RURAL Mode

**Model Accepts Receptors on ELEV Terrain.

**Model Assumes No FLAGPOLE Receptor Heights.

**Model Accepting Temperature Profile Data.
  Number of Levels :          3
    (m AGL)          30.0000
    (m AGL)          45.7000
    (m AGL)          152.400

**Model Accepting Wind Profile Data.
  Number of Levels :          5
    (m AGL)          30.0000
    (m AGL)          45.7000
    (m AGL)          80.8000
    (m AGL)          111.300
    (m AGL)          152.400

**Model Calculates  1 Short Term Average(s) of:   1-HR
    and Calculates PERIOD Averages

**This Run Includes:     1 Source(s);      1 Source Group(s); and    936 Receptor(s)

**The Model Assumes A Pollutant Type of:  FUGITIVE

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
        Model Outputs Tables of PERIOD Averages by Receptor
        Model Outputs Tables of Highest Short Term Values by Receptor (RECTABLE Keyword)
        Model Outputs Tables of Overall Maximum Short Term Values (MAXTABLE Keyword)
        Model Outputs External File(s) of High Values for Plotting (PLOTFILE Keyword)

**NOTE:  The Following Flags May Appear Following DEPO Values:  c for Calm Hours
                                                                m for Missing Hours
                                                                b for Both Calm and Missing Hours

**Misc. Inputs:  Anem. Hgt. (m) =    30.00 ;    Decay Coef. =   0.0000     ;    Rot. Angle =     0.0
                 Emission Units = GRAMS/SEC                                ;  Emission Rate Unit Factor =    3600.0
                 Output Units   = GRAMS/M**2

**Input Runstream File: steama_d.ind                          ;  **Output Print File: steama_d.out
**Detailed Error/Message File:   STEAMA_D.ERR
```

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** 01/26/95
*** One Point source; 936 receptors up to 50KM away; Mass Wt. *** 00:18:55
PAGE 2

*** MODELING OPTIONS USED: DDEP RURAL ELEV DFAULT DRYDPL WETDPL

*** POINT SOURCE DATA ***

SOURCE ID	NUMBER PART. CATS.	EMISSION RATE (GRAMS/SEC)	X (METERS)	Y (METERS)	BASE ELEV. (METERS)	STACK HEIGHT (METERS)	STACK TEMP. (DEG.K)	STACK EXIT VEL. (M/SEC)	STACK DIAMETER (METERS)	BUILDING EXISTS	EMISSION RATE SCALAR VARY BY
STEAM	10	0.10000E+01	23.9	49.0	212.1	6.71	310.00	0.10	0.10	YES	

```
*** ISCOMDEP VERSION 94227 ***     ***  WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG          ***        01/26/95
                                   ***  One Point source; 936 receptors up to 50KM away; Mass Wt.       ***        00:18:55
                                                                                                                   PAGE   3
*** MODELING OPTIONS USED:  DDEP   RURAL  ELEV          DFAULT                                          DRYDPL WETDPL


                                          *** SOURCE IDs DEFINING SOURCE GROUPS ***

GROUP ID                                                SOURCE IDs

ALL       STEAM    .
```

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** 01/26/95
*** One Point source; 936 receptors up to 50KM away; Mass Wt. *** 00:18:55
PAGE 4

*** MODELING OPTIONS USED: DDEP RURAL ELEV DFAULT DRYDPL WETDPL

*** SOURCE PARTICULATE/GAS DATA ***

*** SOURCE ID = STEAM ; SOURCE TYPE = POINT ***

MASS FRACTION =
0.04260, 0.08510, 0.17020, 0.19150, 0.19150, 0.11910, 0.10000, 0.05000, 0.04000, 0.01000,

PARTICLE DIAMETER (MICRONS) =
2.97000, 1.89000, 0.93000, 0.55000, 0.40000, 0.27000, 0.18000, 0.12000, 0.06200, 0.03000,

PARTICLE DENSITY (G/CM**3) =
1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000,

SCAV COEF [LIQ] 1/(S-MM/HR)=
0.21E-03,0.14E-03,0.50E-04,0.50E-04,0.60E-04,0.90E-04,0.13E-03,0.15E-03,0.20E-03,0.22E-03,

SCAV COEF [ICE] 1/(S-MM/HR)=
0.70E-04,0.47E-04,0.17E-04,0.17E-04,0.20E-04,0.30E-04,0.43E-04,0.50E-04,0.67E-04,0.73E-04,

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** 01/26/95
*** One Point source; 936 receptors up to 50KM away; Mass Wt. *** 00:18:55
PAGE 5

*** MODELING OPTIONS USED: DDEP RURAL ELEV DFAULT DRYDPL WETDPL

*** DIRECTION SPECIFIC BUILDING DIMENSIONS ***

SOURCE ID: STEAM

IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK
1	29.1,	25.9,	0	2	29.1,	24.7,	0	3	29.1,	21.8,	0	4	24.4,	28.9,	0	5	24.4,	27.0,	0	6	24.4,	24.6,	0
7	6.7,	16.4,	0	8	25.8,	24.8,	0	9	25.8,	26.4,	0	10	25.8,	27.3,	0	11	25.8,	27.3,	0	12	25.8,	26.4,	0
13	25.8,	24.8,	0	14	25.8,	22.4,	0	15	25.8,	20.1,	0	16	29.1,	25.9,	0	17	29.1,	25.9,	0	18	29.1,	25.9,	0
19	29.1,	25.9,	0	20	29.1,	24.7,	0	21	29.1,	21.8,	0	22	24.4,	28.9,	0	23	24.4,	27.0,	0	24	24.4,	24.6,	0
25	14.9,	65.3,	0	26	25.8,	24.8,	0	27	25.8,	26.4,	0	28	25.8,	27.3,	0	29	25.8,	27.3,	0	30	25.8,	26.4,	0
31	25.8,	24.8,	0	32	25.8,	22.4,	0	33	25.8,	20.1,	0	34	29.1,	25.9,	0	35	29.1,	25.9,	0	36	29.1,	25.9,	0

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** 01/26/95
*** One Point source; 936 receptors up to 50KM away; Mass Wt. *** 00:18:55
PAGE 17

*** MODELING OPTIONS USED: DDEP RURAL ELEV DFAULT DRYDPL WETDPL

* SOURCE-RECEPTOR COMBINATIONS LESS THAN 1.0 METER OR 3*ELB *
IN DISTANCE. CALCULATIONS MAY NOT BE PERFORMED.

SOURCE ID	- - RECEPTOR LOCATION - - XR (METERS)	YR (METERS)	DISTANCE (METERS)
STEAM	17.4	98.5	49.93
STEAM	34.2	94.0	46.16
STEAM	50.0	86.6	45.80
STEAM	64.3	76.6	48.93
STEAM	86.6	50.0	62.72
STEAM	94.0	34.2	71.62
STEAM	-34.2	94.0	73.48
STEAM	-17.4	98.5	64.44
STEAM	0.0	100.0	56.34

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** 01/26/95
*** One Point source; 936 receptors up to 50KM away; Mass Wt. *** 00:18:55
PAGE 18

*** MODELING OPTIONS USED: DDEP RURAL ELEV DFAULT DRYDPL WETDPL

*** METEOROLOGICAL DAYS SELECTED FOR PROCESSING ***
(1=YES; 0=NO)

1 1 1

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** 01/26/95
*** One Point source; 936 receptors up to 50KM away; Mass Wt. *** 00:18:55
PAGE 19

*** MODELING OPTIONS USED: DDEP RURAL ELEV DFAULT DRYDPL WETDPL

*** THE FIRST 24 HOURS OF METEOROLOGICAL DATA ***

FILE: depbin.met FORMAT: (4I2,2F9.4,F6.1,I2,2F7.1,f9.4,f10.1,f8.4,f5.1,i4,f7.2)
SURFACE STATION NO.: 94823 UPPER AIR STATION NO.: 94823
NAME: WTI NAME: WTI
YEAR: 1993 YEAR: 1993

YEAR	MONTH	DAY	HOUR	FLOW VECTOR	SPEED (M/S)	TEMP (K)	STAB CLASS	MIXING HEIGHT (M) RURAL	MIXING HEIGHT (M) URBAN	USTAR (M/S)	M-O LENGTH (M)	Z-0 (M)	Zd (M)	IPCODE	PRATE (mm/HR)
93	1	1	1	104.0	4.47	275.4	4	601.6	601.6	0.3366	176.8	0.3000	1.5	13	0.00
93	1	1	2	112.0	5.36	274.8	4	617.6	617.6	0.4269	283.7	0.3000	1.5	0	0.25
93	1	1	3	106.0	4.47	274.0	4	633.5	633.5	0.3363	175.6	0.3000	1.5	0	0.00
93	1	1	4	115.0	4.47	273.9	4	649.5	649.5	0.3363	175.4	0.3000	1.5	28	0.00
93	1	1	5	120.0	4.02	273.8	4	665.4	665.4	0.2874	128.1	0.3000	1.5	28	0.00
93	1	1	6	123.0	5.36	273.3	4	681.4	681.4	0.4266	281.8	0.3000	1.5	28	0.00
93	1	1	7	130.0	4.92	272.5	4	697.3	697.3	0.3820	225.3	0.3000	1.5	28	0.00
93	1	1	8	124.0	4.92	271.9	4	713.3	713.3	0.3819	224.6	0.3000	1.5	28	0.00
93	1	1	9	115.0	4.47	271.0	4	729.2	729.2	0.3355	172.9	0.3000	1.5	28	0.00
93	1	1	10	107.0	4.02	270.9	4	745.2	745.2	0.3534	-999.0	0.3000	1.5	28	0.00
93	1	1	11	113.0	4.02	270.6	4	761.1	761.1	0.3534	-999.0	0.3000	1.5	28	0.00
93	1	1	12	108.0	4.47	270.9	4	777.1	777.1	0.3926	-999.0	0.3000	1.5	28	0.00
93	1	1	13	114.0	5.36	271.1	4	793.0	793.0	0.4712	-999.0	0.3000	1.5	28	0.00
93	1	1	14	107.0	4.92	271.0	4	809.0	809.0	0.4319	-999.0	0.3000	1.5	28	0.00
93	1	1	15	120.0	4.92	270.8	4	809.0	809.0	0.3817	223.4	0.3000	1.5	28	0.00
93	1	1	16	119.0	4.47	270.5	4	809.0	809.0	0.3354	172.4	0.3000	1.5	28	0.00
93	1	1	17	118.0	3.58	270.4	4	809.0	809.0	0.2310	81.7	0.3000	1.5	28	0.00
93	1	1	18	124.0	2.68	270.4	4	809.0	809.0	0.1178	29.4	0.3000	1.5	28	0.00
93	1	1	19	124.0	2.68	270.1	4	809.0	809.0	0.1178	29.4	0.3000	1.5	28	0.00
93	1	1	20	113.0	2.23	270.3	4	809.0	809.0	0.0982	29.4	0.3000	1.5	28	0.00
93	1	1	21	97.0	2.68	270.3	4	809.0	809.0	0.1178	29.4	0.3000	1.5	0	0.00
93	1	1	22	113.0	3.13	270.3	4	809.0	809.0	0.1374	29.4	0.3000	1.5	28	0.00
93	1	1	23	117.0	3.13	270.4	4	809.0	809.0	0.1374	29.4	0.3000	1.5	0	0.00
93	1	1	24	152.0	2.68	269.9	4	809.0	809.0	0.1178	29.4	0.3000	1.5	28	0.00

*** NOTES: STABILITY CLASS 1=A, 2=B, 3=C, 4=D, 5=E AND 6=F.
FLOW VECTOR IS DIRECTION TOWARD WHICH WIND IS BLOWING.

```
*** ISCOMDEP VERSION 94227 ***     *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG              ***
                                   *** One Point source; 936 receptors up to 50KM away; Mass Wt.          ***        10:57:13
                                                                                                                    PAGE   1
 *** MODELING OPTIONS USED:  DEPOS  RURAL  ELEV          DFAULT                                          DRYDPL WETDPL

                                          ***     MODEL SETUP OPTIONS SUMMARY       ***
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

**Intermediate Terrain Processing is Selected

**Model Is Setup For Calculation of Total DEPOSition Values.

  --  SCAVENGING/DEPOSITION LOGIC --
**Model Uses DRY DEPLETION.  DDPLETE =  T
**Model Uses WET DEPLETION.  WDPLETE =  T
**SCAVENGING Data Provided.  LMGAS,LWPART =  F T
**Model Uses GRIDDED TERRAIN Data for Depletion Calculations

**Model Uses RURAL Dispersion.

**Model Uses Regulatory DEFAULT Options:
          1. Final Plume Rise.
          2. Stack-tip Downwash.
          3. Buoyancy-induced Dispersion.
          4. Use Calms Processing Routine.
          5. Not Use Missing Data Processing Routine.
          6. Default Wind Profile Exponents.
          7. Default Vertical Potential Temperature Gradients.
          8. "Upper Bound" Values for Supersquat Buildings.
          9. No Exponential Decay for RURAL Mode

**Model Accepts Receptors on ELEV Terrain.

**Model Assumes No FLAGPOLE Receptor Heights.

**Model Accepting Temperature Profile Data.
  Number of Levels :  3
    (m AGL)       30.0
    (m AGL)       45.7
    (m AGL)       152.3999

**Model Accepting Wind Profile Data.
  Number of Levels :  5
    (m AGL)       30.0
    (m AGL)       45.7
    (m AGL)       80.8
    (m AGL)       111.3
    (m AGL)       152.3999

**Model Calculates  1 Short Term Average(s) of:   1-HR
    and Calculates PERIOD Averages

**This Run Includes:    1 Source(s);      1 Source Group(s); and    936 Receptor(s)

**The Model Assumes A Pollutant Type of:  FUGITIVE

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
        Model Outputs Tables of PERIOD Averages by Receptor
        Model Outputs Tables of Highest Short Term Values by Receptor (RECTABLE Keyword)
        Model Outputs Tables of Overall Maximum Short Term Values (MAXTABLE Keyword)
        Model Outputs External File(s) of High Values for Plotting (PLOTFILE Keyword)

**NOTE:  The Following Flags May Appear Following DEPO Values:  c for Calm Hours
                                                                m for Missing Hours
                                                                b for Both Calm and Missing Hours

**Misc. Inputs:  Anem. Hgt. (m) =    30.00 ;    Decay Coef. =    .0000E+00 ;    Rot. Angle =      .0
                 Emission Units = GRAMS/SEC                                  ;  Emission Rate Unit Factor =    3600.0
                 Output Units   = GRAMS/M**2

**Input Runstream File: steama_dw.ind                    ;  **Output Print File: steama_dw.out
**Detailed Error/Message File:
STEAMA_DW.ERR
```

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** *** One Point source; 936 receptors up to 50KM away; Mass Wt. *** 10:57:13
PAGE 2

*** MODELING OPTIONS USED: DEPOS RURAL ELEV DFAULT DRYDPL WETDPL

*** POINT SOURCE DATA ***

SOURCE ID	NUMBER PART. CATS.	EMISSION RATE (GRAMS/SEC)	X (METERS)	Y (METERS)	BASE ELEV. (METERS)	STACK HEIGHT (METERS)	STACK TEMP. (DEG.K)	STACK EXIT VEL. (M/SEC)	STACK DIAMETER (METERS)	BUILDING EXISTS	EMISSION RATE SCALAR VARY BY
STEAM	10	.10000E+01	23.9	49.0	212.1	6.71	310.00	.10	.10	YES	

```
*** ISCOMDEP VERSION 94227 ***     *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG          ***
                                   *** One Point source; 936 receptors up to 50KM away; Mass Wt.      ***  10:57:13
                                                                                                           PAGE    3
 *** MODELING OPTIONS USED:  DEPOS  RURAL  ELEV          DFAULT                                  DRYDPL WETDPL


                                        *** SOURCE IDs DEFINING SOURCE GROUPS ***

GROUP ID                                SOURCE IDs

 ALL       STEAM    ,
```

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** 10:57:13
*** One Point source; 936 receptors up to 50KM away; Mass Wt. *** PAGE 4

*** MODELING OPTIONS USED: DEPOS RURAL ELEV DFAULT DRYDPL WETDPL

*** SOURCE PARTICULATE/GAS DATA ***

*** SOURCE ID = STEAM ; SOURCE TYPE = POINT ***

MASS FRACTION =
.04260, .08510, .17020, .19150, .19150, .11910, .10000, .05000, .04000, .01000,

PARTICLE DIAMETER (MICRONS) =
2.97000, 1.89000, .93000, .55000, .40000, .27000, .18000, .12000, .06200, .03000,

PARTICLE DENSITY (G/CM**3) =
1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000,

SCAV COEF [LIQ] 1/(S-MM/HR)=
.21E-03, .14E-03, .50E-04, .50E-04, .60E-04, .90E-04, .13E-03, .15E-03, .20E-03, .22E-03,

SCAV COEF [ICE] 1/(S-MM/HR)=
.70E-04, .47E-04, .17E-04, .17E-04, .20E-04, .30E-04, .43E-04, .50E-04, .67E-04, .73E-04,

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** *** 10:57:13
*** One Point source; 936 receptors up to 50KM away; Mass Wt. *** PAGE 5

*** MODELING OPTIONS USED: DEPOS RURAL ELEV DFAULT DRYDPL WETDPL

*** DIRECTION SPECIFIC BUILDING DIMENSIONS ***

SOURCE ID: STEAM

IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK
1	29.1,	25.9,	0	2	29.1,	24.7,	0	3	29.1,	21.8,	0	4	24.4,	28.9,	0	5	24.4,	27.0,	0	6	24.4,	24.6,	0
7	6.7,	16.4,	0	8	25.8,	24.8,	0	9	25.8,	26.4,	0	10	25.8,	27.3,	0	11	25.8,	27.3,	0	12	25.8,	26.4,	0
13	25.8,	24.8,	0	14	25.8,	22.4,	0	15	25.8,	20.1,	0	16	29.1,	25.9,	0	17	29.1,	25.9,	0	18	29.1,	25.9,	0
19	29.1,	25.9,	0	20	29.1,	24.7,	0	21	29.1,	21.8,	0	22	24.4,	28.9,	0	23	24.4,	27.0,	0	24	24.4,	24.6,	0
25	14.9,	65.3,	0	26	25.8,	24.8,	0	27	25.8,	26.4,	0	28	25.8,	27.3,	0	29	25.8,	27.3,	0	30	25.8,	26.4,	0
31	25.8,	24.8,	0	32	25.8,	22.4,	0	33	25.8,	20.1,	0	34	29.1,	25.9,	0	35	29.1,	25.9,	0	36	29.1,	25.9,	0

* SOURCE-RECEPTOR COMBINATIONS LESS THAN 1.0 METER OR 3*ZLB *
IN DISTANCE. CALCULATIONS MAY NOT BE PERFORMED.

SOURCE ID	- - RECEPTOR LOCATION - - XR (METERS)	YR (METERS)	DISTANCE (METERS)
STEAM	17.4	98.5	49.93
STEAM	-34.2	94.0	46.16
STEAM	50.0	86.6	45.80
STEAM	64.3	76.6	48.93
STEAM	86.6	50.0	62.72
STEAM	94.0	34.2	71.62
STEAM	-34.2	94.0	73.48
STEAM	-17.4	98.5	64.44
STEAM	.0	100.0	56.34

*** MODELING OPTIONS USED: DEPOS RURAL ELEV DFAULT DRYDPL WETDPL

*** METEOROLOGICAL DAYS SELECTED FOR PROCESSING ***
(1=YES; 0=NO)

1 1 1

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** 10:57:13
*** One Point source; 936 receptors up to 50KM away; Mass Wt. *** PAGE 19

*** MODELING OPTIONS USED: DEPOS RURAL ELEV DFAULT DRYDPL WETDPL

*** THE FIRST 24 HOURS OF METEOROLOGICAL DATA ***

FILE: depbin.met FORMAT: (4I2,2F9.4,F6.1,I2,2F7.1,f9.4,f10.1,f8.4,f5.1,i4,f7.2)
SURFACE STATION NO.: 94823 UPPER AIR STATION NO.: 94823
NAME: WTI NAME: WTI
YEAR: 1993 YEAR: 1993

YEAR	MONTH	DAY	HOUR	FLOW VECTOR	SPEED (M/S)	TEMP (K)	STAB CLASS	MIXING HEIGHT (M) RURAL	MIXING HEIGHT (M) URBAN	USTAR (M/S)	M-O LENGTH (M)	Z-0 (M)	Zd (M)	IPCODE	PRATE (mm/HR)
93	1	1	1	104.0	4.47	275.4	4	601.6	601.6	.3366	176.8	.3000	1.5	13	.00
93	1	1	2	112.0	5.36	274.8	4	617.6	617.6	.4269	283.7	.3000	1.5	0	.25
93	1	1	3	106.0	4.47	274.0	4	633.5	633.5	.3363	175.6	.3000	1.5	0	.00
93	1	1	4	115.0	4.47	273.9	4	649.5	649.5	.3363	175.4	.3000	1.5	28	.00
93	1	1	5	120.0	4.02	273.8	4	665.4	665.4	.2874	128.1	.3000	1.5	28	.00
93	1	1	6	123.0	5.36	273.3	4	681.4	681.4	.4266	281.8	.3000	1.5	28	.00
93	1	1	7	130.0	4.92	272.5	4	697.3	697.3	.3820	225.3	.3000	1.5	28	.00
93	1	1	8	124.0	4.92	271.9	4	713.3	713.3	.3819	224.6	.3000	1.5	28	.00
93	1	1	9	115.0	4.47	271.0	4	729.2	729.2	.3355	172.9	.3000	1.5	28	.00
93	1	1	10	107.0	4.02	270.9	4	745.2	745.2	.3534	-999.0	.3000	1.5	28	.00
93	1	1	11	113.0	4.02	270.6	4	761.1	761.1	.3534	-999.0	.3000	1.5	28	.00
93	1	1	12	108.0	4.47	270.9	4	777.1	777.1	.3926	-999.0	.3000	1.5	28	.00
93	1	1	13	114.0	5.36	271.1	4	793.0	793.0	.4712	-999.0	.3000	1.5	28	.00
93	1	1	14	107.0	4.92	271.0	4	809.0	809.0	.4319	-999.0	.3000	1.5	28	.00
93	1	1	15	120.0	4.92	270.8	4	809.0	809.0	.3817	223.4	.3000	1.5	28	.00
93	1	1	16	119.0	4.47	270.5	4	809.0	809.0	.3354	172.4	.3000	1.5	28	.00
93	1	1	17	118.0	3.58	270.4	4	809.0	809.0	.2310	81.7	.3000	1.5	28	.00
93	1	1	18	124.0	2.68	270.4	4	809.0	809.0	.1178	29.4	.3000	1.5	28	.00
93	1	1	19	124.0	2.68	270.1	4	809.0	809.0	.1178	29.4	.3000	1.5	28	.00
93	1	1	20	113.0	2.23	270.3	4	809.0	809.0	.0982	29.4	.3000	1.5	28	.00
93	1	1	21	97.0	2.68	270.3	4	809.0	809.0	.1178	29.4	.3000	1.5	0	.00
93	1	1	22	113.0	3.13	270.3	4	809.0	809.0	.1374	29.4	.3000	1.5	28	.00
93	1	1	23	117.0	3.13	270.4	4	809.0	809.0	.1374	29.4	.3000	1.5	0	.00
93	1	1	24	152.0	2.68	269.9	4	809.0	809.0	.1178	29.4	.3000	1.5	28	.00

*** NOTES: STABILITY CLASS 1=A, 2=B, 3=C, 4=D, 5=E AND 6=F.
FLOW VECTOR IS DIRECTION TOWARD WHICH WIND IS BLOWING.

```
*** ISCOMDEP VERSION 94227 ***     *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG              ***
                                   *** One Point source; 936 receptors up to 50KM away; Surface Wt.       ***          02:23:06
                                                                                                                       PAGE    1
 *** MODELING OPTIONS USED:  CONC   RURAL  ELEV          DFAULT                                                 DRYDPL WETDPL

                                          ***     MODEL SETUP OPTIONS SUMMARY       ***
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

**Intermediate Terrain Processing is Selected

**Model Is Setup For Calculation of Average CONCentration Values.

  --  SCAVENGING/DEPOSITION LOGIC --
**Model Uses DRY DEPLETION.  DDPLETE =  T
**Model Uses WET DEPLETION.  WDPLETE =  T
**SCAVENGING Data Provided.  LMGAS,LMPART =  F T
**Model Uses GRIDDED TERRAIN Data for Depletion Calculations

**Model Uses RURAL Dispersion.

**Model Uses Regulatory DEFAULT Options:
          1. Final Plume Rise.
          2. Stack-tip Downwash.
          3. Buoyancy-induced Dispersion.
          4. Use Calms Processing Routine.
          5. Not Use Missing Data Processing Routine.
          6. Default Wind Profile Exponents.
          7. Default Vertical Potential Temperature Gradients.
          8. 'Upper Bound' Values for Supersquat Buildings.
          9. No Exponential Decay for RURAL Mode

**Model Accepts Receptors on ELEV Terrain.

**Model Assumes No FLAGPOLE Receptor Heights.

**Model Accepting Temperature Profile Data.
  Number of Levels :  3
    (m AGL)       30.0
    (m AGL)       45.7
    (m AGL)       152.3999

**Model Accepting Wind Profile Data.
  Number of Levels :  5
    (m AGL)       30.0
    (m AGL)       45.7
    (m AGL)       80.8
    (m AGL)       111.3
    (m AGL)       152.3999

**Model Calculates  1 Short Term Average(s) of:   1-HR
    and Calculates PERIOD Averages

**This Run Includes:     1 Source(s);      1 Source Group(s); and    936 Receptor(s)

**The Model Assumes A Pollutant Type of:  FUGITIVE

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
         Model Outputs Tables of PERIOD Averages by Receptor
         Model Outputs Tables of Highest Short Term Values by Receptor (RECTABLE Keyword)
         Model Outputs Tables of Overall Maximum Short Term Values (MAXTABLE Keyword)
         Model Outputs External File(s) of High Values for Plotting (PLOTFILE Keyword)

**NOTE:  The Following Flags May Appear Following CONC Values:  c for Calm Hours
                                                                m for Missing Hours
                                                                b for Both Calm and Missing Hours

**Misc. Inputs:  Anem. Hgt. (m) =    30.00 ;    Decay Coef. =     .0000E+00 ;    Rot. Angle =      .0
                 Emission Units = GRAMS/SEC                                ;  Emission Rate Unit Factor =    .10000E+07
                 Output Units   = MICROGRAMS/M**3

**Input Runstream File: steamb_c.inc                    ;  **Output Print File: steamb_c.out
**Detailed Error/Message File:
STEAMB_C.ERR
```

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** 02:23:06
*** One Point source; 936 receptors up to 50KM away; Surface Wt. *** PAGE 2

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** POINT SOURCE DATA ***

SOURCE ID	NUMBER PART. CATS.	EMISSION RATE (GRAMS/SEC)	X (METERS)	Y (METERS)	BASE ELEV. (METERS)	STACK HEIGHT (METERS)	STACK TEMP. (DEG.K)	STACK EXIT VEL. (M/SEC)	STACK DIAMETER (METERS)	BUILDING EXISTS	EMISSION RATE SCALAR VARY BY
STEAM	10	.10000E+01	23.9	49.0	212.1	6.71	310.00	.10	.10	YES	

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG ***
*** One Point source; 936 receptors up to 50KM away; Surface Wt. *** 02:23:06
PAGE 3

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** SOURCE IDs DEFINING SOURCE GROUPS ***

GROUP ID	SOURCE IDs
ALL	STEAM ,

*** SOURCE PARTICULATE/GAS DATA ***

*** SOURCE ID = STEAM ; SOURCE TYPE = POINT ***

MASS FRACTION =
.00414, .01301, .05288, .10060, .13832, .12745, .16051, .12038, .18640, .09631,

PARTICLE DIAMETER (MICRONS) =
2.97000, 1.89000, .93000, .55000, .40000, .27000, .18000, .12000, .06200, .03000,

PARTICLE DENSITY (G/CM**3) =
1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000,

SCAV COEF [LIQ] 1/(S-MM/HR)=
.21E-03, .14E-03, .50E-04, .50E-04, .60E-04, .90E-04, .13E-03, .15E-03, .20E-03, .22E-03,

SCAV COEF [ICE] 1/(S-MM/HR)=
.70E-04, .47E-04, .17E-04, .17E-04, .20E-04, .30E-04, .43E-04, .50E-04, .67E-04, .73E-04,

*** DIRECTION SPECIFIC BUILDING DIMENSIONS ***

SOURCE ID: STEAM

IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK
1	29.1,	25.9,	0	2	29.1,	24.7,	0	3	29.1,	21.8,	0	4	24.4,	28.9,	0	5	24.4,	27.0,	0	6	24.4,	24.6,	0
7	6.7,	16.4,	0	8	25.8,	24.8,	0	9	25.8,	26.4,	0	10	25.8,	27.3,	0	11	25.8,	27.3,	0	12	25.8,	26.4,	0
13	25.8,	24.8,	0	14	25.8,	22.4,	0	15	25.8,	20.1,	0	16	29.1,	25.9,	0	17	29.1,	25.9,	0	18	29.1,	25.9,	0
19	29.1,	25.9,	0	20	29.1,	24.7,	0	21	29.1,	21.8,	0	22	24.4,	28.9,	0	23	24.4,	27.0,	0	24	24.4,	24.6,	0
25	14.9,	65.3,	0	26	25.8,	24.8,	0	27	25.8,	26.4,	0	28	25.8,	27.3,	0	29	25.8,	27.3,	0	30	25.8,	26.4,	0
31	25.8,	24.8,	0	32	25.8,	22.4,	0	33	25.8,	20.1,	0	34	29.1,	25.9,	0	35	29.1,	25.9,	0	36	29.1,	25.9,	0

* SOURCE-RECEPTOR COMBINATIONS LESS THAN 1.0 METER OR 3*ZLB *
IN DISTANCE. CALCULATIONS MAY NOT BE PERFORMED.

SOURCE ID	- - RECEPTOR LOCATION - - XR (METERS)	YR (METERS)	DISTANCE (METERS)
STEAM	17.4	98.5	49.93
STEAM	34.2	94.0	46.16
STEAM	50.0	86.6	45.80
STEAM	64.3	76.6	48.93
STEAM	86.6	50.0	62.72
STEAM	94.0	34.2	71.62
STEAM	-34.2	94.0	73.48
STEAM	-17.4	98.5	64.44
STEAM	.0	100.0	56.34

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** *** 02:23:06
*** One Point source; 936 receptors up to 50KM away; Surface Wt. *** PAGE 18

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** METEOROLOGICAL DAYS SELECTED FOR PROCESSING ***
(1=YES; 0=NO)

1 1 1

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG ***
*** One Point source; 936 receptors up to 50KM away; Surface Wt. *** 02:23:06
PAGE 19

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT DRYDPL WETDPL

*** THE FIRST 24 HOURS OF METEOROLOGICAL DATA ***

FILE: depbin.met FORMAT: (4I2,2F9.4,F6.1,I2,2F7.1,f9.4,f10.1,f8.4,f5.1,i4,f7.2)
SURFACE STATION NO.: 94823 UPPER AIR STATION NO.: 94823
NAME: WTI NAME: WTI
YEAR: 1993 YEAR: 1993

YEAR	MONTH	DAY	HOUR	FLOW VECTOR	SPEED (M/S)	TEMP (K)	STAB CLASS	MIXING HEIGHT (M) RURAL	MIXING HEIGHT (M) URBAN	USTAR (M/S)	M-O LENGTH (M)	Z-0 (M)	Zd (M)	IPCODE	PRATE (mm/HR)
93	1	1	1	104.0	4.47	275.4	4	601.6	601.6	.3366	176.8	.3000	1.5	13	.00
93	1	1	2	112.0	5.36	274.8	4	617.6	617.6	.4269	283.7	.3000	1.5	0	.25
93	1	1	3	106.0	4.47	274.0	4	633.5	633.5	.3363	175.6	.3000	1.5	0	.00
93	1	1	4	115.0	4.47	273.9	4	649.5	649.5	.3363	175.4	.3000	1.5	28	.00
93	1	1	5	120.0	4.02	273.8	4	665.4	665.4	.2874	128.1	.3000	1.5	28	.00
93	1	1	6	123.0	5.36	273.3	4	681.4	681.4	.4266	281.8	.3000	1.5	28	.00
93	1	1	7	130.0	4.92	272.5	4	697.3	697.3	.3820	225.3	.3000	1.5	28	.00
93	1	1	8	124.0	4.92	271.9	4	713.3	713.3	.3819	224.6	.3000	1.5	28	.00
93	1	1	9	115.0	4.47	271.0	4	729.2	729.2	.3355	172.9	.3000	1.5	28	.00
93	1	1	10	107.0	4.02	270.9	4	745.2	745.2	.3534	-999.0	.3000	1.5	28	.00
93	1	1	11	113.0	4.02	270.6	4	761.1	761.1	.3534	-999.0	.3000	1.5	28	.00
93	1	1	12	108.0	4.47	270.9	4	777.1	777.1	.3926	-999.0	.3000	1.5	28	.00
93	1	1	13	114.0	5.36	271.1	4	793.0	793.0	.4712	-999.0	.3000	1.5	28	.00
93	1	1	14	107.0	4.92	271.0	4	809.0	809.0	.4319	-999.0	.3000	1.5	28	.00
93	1	1	15	120.0	4.92	270.8	4	809.0	809.0	.3817	223.4	.3000	1.5	28	.00
93	1	1	16	119.0	4.47	270.5	4	809.0	809.0	.3354	172.4	.3000	1.5	28	.00
93	1	1	17	118.0	3.58	270.4	4	809.0	809.0	.2310	81.7	.3000	1.5	28	.00
93	1	1	18	124.0	2.68	270.4	4	809.0	809.0	.1178	29.4	.3000	1.5	28	.00
93	1	1	19	124.0	2.68	270.1	4	809.0	809.0	.1178	29.4	.3000	1.5	28	.00
93	1	1	20	113.0	2.23	270.3	4	809.0	809.0	.0982	29.4	.3000	1.5	28	.00
93	1	1	21	97.0	2.68	270.3	4	809.0	809.0	.1178	29.4	.3000	1.5	0	.00
93	1	1	22	113.0	3.13	270.3	4	809.0	809.0	.1374	29.4	.3000	1.5	28	.00
93	1	1	23	117.0	3.13	270.4	4	809.0	809.0	.1374	29.4	.3000	1.5	0	.00
93	1	1	24	152.0	2.68	269.9	4	809.0	809.0	.1178	29.4	.3000	1.5	28	.00

*** NOTES: STABILITY CLASS 1=A, 2=B, 3=C, 4=D, 5=E AND 6=F.
FLOW VECTOR IS DIRECTION TOWARD WHICH WIND IS BLOWING.

```
*** ISCOMDEP VERSION 94227 ***     *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG              ***
                                   *** One Point source; 936 receptors up to 50KM away; Surface Wt.       ***          20:43:21
                                                                                                                      PAGE    1
 *** MODELING OPTIONS USED:  WDEP    RURAL  ELEV          DFAULT                                          DRYDPL WETDPL

                                          ***     MODEL SETUP OPTIONS SUMMARY       ***
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

**Intermediate Terrain Processing is Selected

**Model Is Setup For Calculation of Wet DEPosition Values.

  --  SCAVENGING/DEPOSITION LOGIC --
**Model Uses DRY DEPLETION.  DDPLETE =  T
**Model Uses WET DEPLETION.  WDPLETE =  T
**SCAVENGING Data Provided.  LNGAS,LNPART =  F T
**Model Uses GRIDDED TERRAIN Data for Depletion Calculations

**Model Uses RURAL Dispersion.

**Model Uses Regulatory DEFAULT Options:
          1. Final Plume Rise.
          2. Stack-tip Downwash.
          3. Buoyancy-induced Dispersion.
          4. Use Calms Processing Routine.
          5. Not Use Missing Data Processing Routine.
          6. Default Wind Profile Exponents.
          7. Default Vertical Potential Temperature Gradients.
          8. "Upper Bound" Values for Supersquat Buildings.
          9. No Exponential Decay for RURAL Mode

**Model Accepts Receptors on ELEV Terrain.

**Model Assumes No FLAGPOLE Receptor Heights.

**Model Accepting Temperature Profile Data.
  Number of Levels :  3
    (m AGL)       30.0
    (m AGL)       45.7
    (m AGL)       152.3999

**Model Accepting Wind Profile Data.
  Number of Levels :  5
    (m AGL)       30.0
    (m AGL)       45.7
    (m AGL)       80.8
    (m AGL)       111.3
    (m AGL)       152.3999

**Model Calculates  1 Short Term Average(s) of:   1-HR
    and Calculates PERIOD Averages

**This Run Includes:    1 Source(s);      1 Source Group(s); and    936 Receptor(s)

**The Model Assumes A Pollutant Type of:  FUGITIVE

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
         Model Outputs Tables of PERIOD Averages by Receptor
         Model Outputs Tables of Highest Short Term Values by Receptor (RECTABLE Keyword)
         Model Outputs Tables of Overall Maximum Short Term Values (MAXTABLE Keyword)
         Model Outputs External File(s) of High Values for Plotting (PLOTFILE Keyword)

**NOTE:  The Following Flags May Appear Following DEPO Values:. c for Calm Hours
                                                                m for Missing Hours
                                                                b for Both Calm and Missing Hours

**Misc. Inputs:  Anem. Hgt. (m) =    30.00 ;    Decay Coef. =    .0000E+00 ;    Rot. Angle =      .0
                 Emission Units = GRAMS/SEC                                  ;  Emission Rate Unit Factor =    3600.0
                 Output Units   = GRAMS/M**2

**Input Runstream File: steamb_w.ind                          ;  **Output Print File: steamb_w.out
**Detailed Error/Message File:
STEAMB_W.ERR
```

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** 20:43:21
*** One Point source; 936 receptors up to 50KM away; Surface Wt. *** PAGE 2

*** MODELING OPTIONS USED: WDEP RURAL ELEV DFAULT DRYDPL WETDPL

*** POINT SOURCE DATA ***

SOURCE ID	NUMBER PART. CATS.	EMISSION RATE (GRAMS/SEC)	X (METERS)	Y (METERS)	BASE ELEV. (METERS)	STACK HEIGHT (METERS)	STACK TEMP. (DEG.K)	STACK EXIT VEL. (M/SEC)	STACK DIAMETER (METERS)	BUILDING EXISTS	EMISSION RATE SCALAR VARY BY
STEAM	10	.10000E+01	23.9	49.0	212.1	6.71	310.00	.10	.10	YES	

```
*** ISCOMDEP VERSION 94227 ***     *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG          ***
                                   *** One Point source; 936 receptors up to 50KM away; Surface Wt.   ***        20:43:21
                                                                                                               PAGE   3
 *** MODELING OPTIONS USED:  WDEP   RURAL  ELEV          DFAULT                                    DRYDPL WETDPL


                                        *** SOURCE IDs DEFINING SOURCE GROUPS ***

GROUP ID                                            SOURCE IDs

 ALL       STEAM
```

*** SOURCE PARTICULATE/GAS DATA ***

*** SOURCE ID = STEAM ; SOURCE TYPE = POINT ***

MASS FRACTION =
.00414, .01301, .05288, .10060, .13832, .12745, .16051, .12038, .18640, .09631,

PARTICLE DIAMETER (MICRONS) =
2.97000, 1.89000, .93000, .55000, .40000, .27000, .18000, .12000, .06200, .03000,

PARTICLE DENSITY (G/CM**3) =
1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000,

SCAV COEF [LIQ] 1/(S-MM/HR)=
.21E-03, .14E-03, .50E-04, .50E-04, .60E-04, .90E-04, .13E-03, .15E-03, .20E-03, .22E-03,

SCAV COEF [ICE] 1/(S-MM/HR)=
.70E-04, .47E-04, .17E-04, .17E-04, .20E-04, .30E-04, .43E-04, .50E-04, .67E-04, .73E-04,

*** DIRECTION SPECIFIC BUILDING DIMENSIONS ***

SOURCE ID: STEAM

IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK
1	29.1,	25.9,	0	2	29.1,	24.7,	0	3	29.1,	21.8,	0	4	24.4,	28.9,	0	5	24.4,	27.0,	0	6	24.4,	24.6,	0
7	6.7,	16.4,	0	8	25.8,	24.8,	0	9	25.8,	26.4,	0	10	25.8,	27.3,	0	11	25.8,	27.3,	0	12	25.8,	26.4,	0
13	25.8,	24.8,	0	14	25.8,	22.4,	0	15	25.8,	20.1,	0	16	29.1,	25.9,	0	17	29.1,	25.9,	0	18	29.1,	25.9,	0
19	29.1,	25.9,	0	20	29.1,	24.7,	0	21	29.1,	21.8,	0	22	24.4,	28.9,	0	23	24.4,	27.0,	0	24	24.4,	24.6,	0
25	14.9,	65.3,	0	26	25.8,	24.8,	0	27	25.8,	26.4,	0	28	25.8,	27.3,	0	29	25.8,	27.3,	0	30	25.8,	26.4,	0
31	25.8,	24.8,	0	32	25.8,	22.4,	0	33	25.8,	20.1,	0	34	29.1,	25.9,	0	35	29.1,	25.9,	0	36	29.1,	25.9,	0

* SOURCE-RECEPTOR COMBINATIONS LESS THAN 1.0 METER OR 3*ZLB *
IN DISTANCE. CALCULATIONS MAY NOT BE PERFORMED.

SOURCE ID	- - RECEPTOR LOCATION - - XR (METERS)	YR (METERS)	DISTANCE (METERS)
STEAM	17.4	98.5	49.93
STEAM	34.2	94.0	46.16
STEAM	50.0	86.6	45.80
STEAM	64.3	76.6	48.93
STEAM	86.6	50.0	62.72
STEAM	94.0	34.2	71.62
STEAM	-34.2	94.0	73.48
STEAM	-17.4	98.5	64.44
STEAM	.0	100.0	56.34

*** METEOROLOGICAL DAYS SELECTED FOR PROCESSING ***
(1=YES; 0=NO)

1 1 1

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG ***
*** One Point source; 936 receptors up to 50KM away; Surface Wt. *** 20:43:21
PAGE 19

*** MODELING OPTIONS USED: WDEP RURAL ELEV DFAULT DRYDPL WETDPL

*** THE FIRST 24 HOURS OF METEOROLOGICAL DATA ***

FILE: depbin.met FORMAT: (4I2,2F9.4,F6.1,I2,2F7.1,f9.4,f10.1,f8.4,f5.1,i4,f7.2)
SURFACE STATION NO.: 94823 UPPER AIR STATION NO.: 94823
NAME: WTI NAME: WTI
YEAR: 1993 YEAR: 1993

YEAR	MONTH	DAY	HOUR	FLOW VECTOR	SPEED (M/S)	TEMP (K)	STAB CLASS	MIXING HEIGHT (M) RURAL	MIXING HEIGHT (M) URBAN	USTAR (M/S)	M-O LENGTH (M)	Z-0 (M)	Zd (M)	IPCODE	PRATE (mm/HR)
93	1	1	1	104.0	4.47	275.4	4	601.6	601.6	.3366	176.8	.3000	1.5	13	.00
93	1	1	2	112.0	5.36	274.8	4	617.6	617.6	.4269	283.7	.3000	1.5	0	.25
93	1	1	3	106.0	4.47	274.0	4	633.5	633.5	.3363	175.6	.3000	1.5	0	.00
93	1	1	4	115.0	4.47	273.9	4	649.5	649.5	.3363	175.4	.3000	1.5	28	.00
93	1	1	5	120.0	4.02	273.8	4	665.4	665.4	.2874	128.1	.3000	1.5	28	.00
93	1	1	6	123.0	5.36	273.3	4	681.4	681.4	.4266	281.8	.3000	1.5	28	.00
93	1	1	7	130.0	4.92	272.5	4	697.3	697.3	.3820	225.3	.3000	1.5	28	.00
93	1	1	8	124.0	4.92	271.9	4	713.3	713.3	.3819	224.6	.3000	1.5	28	.00
93	1	1	9	115.0	4.47	271.0	4	729.2	729.2	.3355	172.9	.3000	1.5	28	.00
93	1	1	10	107.0	4.02	270.9	4	745.2	745.2	.3534	-999.0	.3000	1.5	28	.00
93	1	1	11	113.0	4.02	270.6	4	761.1	761.1	.3534	-999.0	.3000	1.5	28	.00
93	1	1	12	108.0	4.47	270.9	4	777.1	777.1	.3926	-999.0	.3000	1.5	28	.00
93	1	1	13	114.0	5.36	271.1	4	793.0	793.0	.4712	-999.0	.3000	1.5	28	.00
93	1	1	14	107.0	4.92	271.0	4	809.0	809.0	.4319	-999.0	.3000	1.5	28	.00
93	1	1	15	120.0	4.92	270.8	4	809.0	809.0	.3817	223.4	.3000	1.5	28	.00
93	1	1	16	119.0	4.47	270.5	4	809.0	809.0	.3354	172.4	.3000	1.5	28	.00
93	1	1	17	118.0	3.58	270.4	4	809.0	809.0	.2310	81.7	.3000	1.5	28	.00
93	1	1	18	124.0	2.68	270.4	4	809.0	809.0	.1178	29.4	.3000	1.5	28	.00
93	1	1	19	124.0	2.68	270.1	4	809.0	809.0	.1178	29.4	.3000	1.5	28	.00
93	1	1	20	113.0	2.23	270.3	4	809.0	809.0	.0982	29.4	.3000	1.5	28	.00
93	1	1	21	97.0	2.68	270.3	4	809.0	809.0	.1178	29.4	.3000	1.5	0	.00
93	1	1	22	113.0	3.13	270.3	4	809.0	809.0	.1374	29.4	.3000	1.5	28	.00
93	1	1	23	117.0	3.13	270.4	4	809.0	809.0	.1374	29.4	.3000	1.5	0	.00
93	1	1	24	152.0	2.68	269.9	4	809.0	809.0	.1178	29.4	.3000	1.5	28	.00

*** NOTES: STABILITY CLASS 1=A, 2=B, 3=C, 4=D, 5=E AND 6=F.
FLOW VECTOR IS DIRECTION TOWARD WHICH WIND IS BLOWING.

```
*** ISCOMDEP VERSION 94227 ***     *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG          ***        01/25/95
                                   *** One Point source; 936 receptors up to 50KM away; Surface Wt.   ***        18:55:36
                                                                                                               PAGE    1
*** MODELING OPTIONS USED:  DDEP   RURAL  ELEV          DFAULT                                          DRYDPL WETDPL

                                          ***     MODEL SETUP OPTIONS SUMMARY       ***
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

**Intermediate Terrain Processing is Selected

**Model Is Setup For Calculation of Dry DEPosition Values.

  --  SCAVENGING/DEPOSITION LOGIC --
**Model Uses DRY DEPLETION.  DDPLETE =  T
**Model Uses WET DEPLETION.  WDPLETE =  T
**SCAVENGING Data Provided.  LWGAS,LWPART =  F T
**Model Uses GRIDDED TERRAIN Data for Depletion Calculations

**Model Uses RURAL Dispersion.

**Model Uses Regulatory DEFAULT Options:
          1. Final Plume Rise.
          2. Stack-tip Downwash.
          3. Buoyancy-induced Dispersion.
          4. Use Calms Processing Routine.
          5. Not Use Missing Data Processing Routine.
          6. Default Wind Profile Exponents.
          7. Default Vertical Potential Temperature Gradients.
          8. "Upper Bound" Values for Supersquat Buildings.
          9. No Exponential Decay for RURAL Mode

**Model Accepts Receptors on ELEV Terrain.

**Model Assumes No FLAGPOLE Receptor Heights.

**Model Accepting Temperature Profile Data.
  Number of Levels :            3
    (m AGL)          30.0000
    (m AGL)          45.7000
    (m AGL)          152.400

**Model Accepting Wind Profile Data.
  Number of Levels :            5
    (m AGL)          30.0000
    (m AGL)          45.7000
    (m AGL)          80.8000
    (m AGL)          111.300
    (m AGL)          152.400

**Model Calculates  1 Short Term Average(s) of:   1-HR
   and Calculates PERIOD Averages

**This Run Includes:    1 Source(s);      1 Source Group(s); and    936 Receptor(s)

**The Model Assumes A Pollutant Type of:  FUGITIVE

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
        Model Outputs Tables of PERIOD Averages by Receptor
        Model Outputs Tables of Highest Short Term Values by Receptor (RECTABLE Keyword)
        Model Outputs Tables of Overall Maximum Short Term Values (MAXTABLE Keyword)
        Model Outputs External File(s) of High Values for Plotting (PLOTFILE Keyword)

**NOTE:  The Following Flags May Appear Following DEPO Values:  c for Calm Hours
                                                                m for Missing Hours
                                                                b for Both Calm and Missing Hours

**Misc. Inputs:  Anem. Hgt. (m) =    30.00 ;    Decay Coef. =   0.0000     ;    Rot. Angle =     0.0
                 Emission Units = GRAMS/SEC                                ;  Emission Rate Unit Factor =    3600.0
                 Output Units   = GRAMS/M**2

**Input Runstream File: steamb_d.ind                          ;  **Output Print File: steamb_d.out
**Detailed Error/Message File:   STEAMB_D.ERR
```

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** 01/25/95
*** One Point source; 936 receptors up to 50KM away; Surface Wt. *** 18:55:36
PAGE 2

*** MODELING OPTIONS USED: DDEP RURAL ELEV DFAULT DRYDPL WETDPL

*** POINT SOURCE DATA ***

SOURCE ID	NUMBER PART. CATS.	EMISSION RATE (GRAMS/SEC)	X (METERS)	Y (METERS)	BASE ELEV. (METERS)	STACK HEIGHT (METERS)	STACK TEMP. (DEG.K)	STACK EXIT VEL. (M/SEC)	STACK DIAMETER (METERS)	BUILDING EXISTS	EMISSION RATE SCALAR VARY BY
STEAM	10	0.10000E+01	23.9	49.0	212.1	6.71	310.00	0.10	0.10	YES	

```
*** ISCOMDEP VERSION 94227 ***     ***  WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG          ***        01/25/95
                                   ***  One Point source; 936 receptors up to 50KM away; Surface Wt.    ***        18:55:36
                                                                                                                  PAGE    3
*** MODELING OPTIONS USED:  DDEP   RURAL  ELEV          DFAULT                                          DRYDPL WETDPL

                                        *** SOURCE IDs DEFINING SOURCE GROUPS ***

GROUP ID                                              SOURCE IDs

 ALL        STEAM    ,
```

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** 01/25/95
*** One Point source; 936 receptors up to 50KM away; Surface Wt. *** 18:55:36
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*** MODELING OPTIONS USED: DDEP RURAL ELEV DFAULT DRYDPL WETDPL

*** SOURCE PARTICULATE/GAS DATA ***

*** SOURCE ID = STEAM ; SOURCE TYPE = POINT ***

MASS FRACTION =
0.00414, 0.01301, 0.05288, 0.10060, 0.13832, 0.12745, 0.16051, 0.12038, 0.18640, 0.09631,

PARTICLE DIAMETER (MICRONS) =
2.97000, 1.89000, 0.93000, 0.55000, 0.40000, 0.27000, 0.18000, 0.12000, 0.06200, 0.03000,

PARTICLE DENSITY (G/CM**3) =
1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000,

SCAV COEF [LIQ] 1/(S-MM/HR)=
0.21E-03,0.14E-03,0.50E-04,0.50E-04,0.60E-04,0.90E-04,0.13E-03,0.15E-03,0.20E-03,0.22E-03,

SCAV COEF [ICE] 1/(S-MM/HR)=
0.70E-04,0.47E-04,0.17E-04,0.17E-04,0.20E-04,0.30E-04,0.43E-04,0.50E-04,0.67E-04,0.73E-04,

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** 01/25/95
*** One Point source; 936 receptors up to 50KM away; Surface Wt. *** 18:55:36
PAGE 5

*** MODELING OPTIONS USED: DDEP RURAL ELEV DFAULT DRYDPL WETDPL

*** DIRECTION SPECIFIC BUILDING DIMENSIONS ***

SOURCE ID: STEAM

IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK
1	29.1,	25.9,	0	2	29.1,	24.7,	0	3	29.1,	21.8,	0	4	24.4,	28.9,	0	5	24.4,	27.0,	0	6	24.4,	24.6,	0
7	6.7,	16.4,	0	8	25.8,	24.8,	0	9	25.8,	26.4,	0	10	25.8,	27.3,	0	11	25.8,	27.3,	0	12	25.8,	26.4,	0
13	25.8,	24.8,	0	14	25.8,	22.4,	0	15	25.8,	20.1,	0	16	29.1,	25.9,	0	17	29.1,	25.9,	0	18	29.1,	25.9,	0
19	29.1,	25.9,	0	20	29.1,	24.7,	0	21	29.1,	21.8,	0	22	24.4,	28.9,	0	23	24.4,	27.0,	0	24	24.4,	24.6,	0
25	14.9,	65.3,	0	26	25.8,	24.8,	0	27	25.8,	26.4,	0	28	25.8,	27.3,	0	29	25.8,	27.3,	0	30	25.8,	26.4,	0
31	25.8,	24.8,	0	32	25.8,	22.4,	0	33	25.8,	20.1,	0	34	29.1,	25.9,	0	35	29.1,	25.9,	0	36	29.1,	25.9,	0

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** 01/25/95
*** One Point source; 936 receptors up to 50KM away; Surface Wt. *** 18:55:36
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*** MODELING OPTIONS USED: DDEP RURAL ELEV DFAULT DRYDPL WETDPL

* SOURCE-RECEPTOR COMBINATIONS LESS THAN 1.0 METER OR 3*ZLB *
IN DISTANCE. CALCULATIONS MAY NOT BE PERFORMED.

SOURCE ID	- - RECEPTOR LOCATION - - XR (METERS)	YR (METERS)	DISTANCE (METERS)
STEAM	17.4	98.5	49.93
STEAM	34.2	94.0	46.16
STEAM	50.0	86.6	45.80
STEAM	64.3	76.6	48.93
STEAM	86.6	50.0	62.72
STEAM	94.0	34.2	71.62
STEAM	-34.2	94.0	73.48
STEAM	-17.4	98.5	64.44
STEAM	0.0	100.0	56.34

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** 01/25/95
*** One Point source; 936 receptors up to 50KM away; Surface Wt. *** 18:55:36
PAGE 18

*** MODELING OPTIONS USED: DDEP RURAL ELEV DFAULT DRYDPL WETDPL

*** METEOROLOGICAL DAYS SELECTED FOR PROCESSING ***
(1=YES; 0=NO)

1 1 1

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** 01/25/95
*** One Point source; 936 receptors up to 50KM away; Surface Wt. *** 18:55:36
PAGE 19

*** MODELING OPTIONS USED: DDEP RURAL ELEV DFAULT DRYDFL WETDFL

*** THE FIRST 24 HOURS OF METEOROLOGICAL DATA ***

FILE: depbin.met FORMAT: (4I2,2F9.4,F6.1,I2,2F7.1,f9.4,f10.1,f8.4,f5.1,i4,f7.2)
SURFACE STATION NO.: 94823 UPPER AIR STATION NO.: 94823
NAME: WTI NAME: WTI
YEAR: 1993 YEAR: 1993

YEAR	MONTH	DAY	HOUR	FLOW VECTOR	SPEED (M/S)	TEMP (K)	STAB CLASS	MIXING HEIGHT (M) RURAL	MIXING HEIGHT (M) URBAN	USTAR (M/S)	M-O LENGTH (M)	Z-0 (M)	Zd (M)	IPCODE	PRATE (mm/HR)
93	1	1	1	104.0	4.47	275.4	4	601.6	601.6	0.3366	176.8	0.3000	1.5	13	0.00
93	1	1	2	112.0	5.36	274.8	4	617.6	617.6	0.4269	283.7	0.3000	1.5	0	0.25
93	1	1	3	106.0	4.47	274.0	4	633.5	633.5	0.3363	175.6	0.3000	1.5	0	0.00
93	1	1	4	115.0	4.47	273.9	4	649.5	649.5	0.3363	175.4	0.3000	1.5	28	0.00
93	1	1	5	120.0	4.02	273.8	4	665.4	665.4	0.2874	128.1	0.3000	1.5	28	0.00
93	1	1	6	123.0	5.36	273.3	4	681.4	681.4	0.4266	281.8	0.3000	1.5	28	0.00
93	1	1	7	130.0	4.92	272.5	4	697.3	697.3	0.3820	225.3	0.3000	1.5	28	0.00
93	1	1	8	124.0	4.92	271.9	4	713.3	713.3	0.3819	224.6	0.3000	1.5	28	0.00
93	1	1	9	115.0	4.47	271.0	4	729.2	729.2	0.3355	172.9	0.3000	1.5	28	0.00
93	1	1	10	107.0	4.02	270.9	4	745.2	745.2	0.3534	-999.0	0.3000	1.5	28	0.00
93	1	1	11	113.0	4.02	270.6	4	761.1	761.1	0.3534	-999.0	0.3000	1.5	28	0.00
93	1	1	12	108.0	4.47	270.9	4	777.1	777.1	0.3926	-999.0	0.3000	1.5	28	0.00
93	1	1	13	114.0	5.36	271.1	4	793.0	793.0	0.4712	-999.0	0.3000	1.5	28	0.00
93	1	1	14	107.0	4.92	271.0	4	809.0	809.0	0.4319	-999.0	0.3000	1.5	28	0.00
93	1	1	15	120.0	4.92	270.8	4	809.0	809.0	0.3817	223.4	0.3000	1.5	28	0.00
93	1	1	16	119.0	4.47	270.5	4	809.0	809.0	0.3354	172.4	0.3000	1.5	28	0.00
93	1	1	17	118.0	3.58	270.4	4	809.0	809.0	0.2310	81.7	0.3000	1.5	28	0.00
93	1	1	18	124.0	2.68	270.4	4	809.0	809.0	0.1178	29.4	0.3000	1.5	28	0.00
93	1	1	19	124.0	2.68	270.1	4	809.0	809.0	0.1178	29.4	0.3000	1.5	28	0.00
93	1	1	20	113.0	2.23	270.3	4	809.0	809.0	0.0982	29.4	0.3000	1.5	28	0.00
93	1	1	21	97.0	2.68	270.3	4	809.0	809.0	0.1178	29.4	0.3000	1.5	0	0.00
93	1	1	22	113.0	3.13	270.3	4	809.0	809.0	0.1374	29.4	0.3000	1.5	28	0.00
93	1	1	23	117.0	3.13	270.4	4	809.0	809.0	0.1374	29.4	0.3000	1.5	0	0.00
93	1	1	24	152.0	2.68	269.9	4	809.0	809.0	0.1178	29.4	0.3000	1.5	28	0.00

*** NOTES: STABILITY CLASS 1=A, 2=B, 3=C, 4=D, 5=E AND 6=F.
FLOW VECTOR IS DIRECTION TOWARD WHICH WIND IS BLOWING.

```
*** ISCOMDEP VERSION 94227 ***     *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG          ***
                                   *** One Point source; 936 receptors up to 50KM away; Surface Wt.    ***        16:37:51
                                                                                                                  PAGE    1
 *** MODELING OPTIONS USED:  DEPOS  RURAL  ELEV          DFAULT                                          DRYDPL WETDPL

                                          ***     MODEL SETUP OPTIONS SUMMARY       ***
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

**Intermediate Terrain Processing is Selected

**Model Is Setup For Calculation of Total DEPOSition Values.

  --  SCAVENGING/DEPOSITION LOGIC --
**Model Uses DRY DEPLETION.  DDPLETE =  T
**Model Uses WET DEPLETION.  WDPLETE =  T
**SCAVENGING Data Provided.  LMGAS,LWPART =  F T
**Model Uses GRIDDED TERRAIN Data for Depletion Calculations

**Model Uses RURAL Dispersion.

**Model Uses Regulatory DEFAULT Options:
          1. Final Plume Rise.
          2. Stack-tip Downwash.
          3. Buoyancy-induced Dispersion.
          4. Use Calms Processing Routine.
          5. Not Use Missing Data Processing Routine.
          6. Default Wind Profile Exponents.
          7. Default Vertical Potential Temperature Gradients.
          8. 'Upper Bound' Values for Supersquat Buildings.
          9. No Exponential Decay for RURAL Mode

**Model Accepts Receptors on ELEV Terrain.

**Model Assumes No FLAGPOLE Receptor Heights.

**Model Accepting Temperature Profile Data.
  Number of Levels :  3
    (m AGL)       30.0
    (m AGL)       45.7
    (m AGL)       152.3999

**Model Accepting Wind Profile Data.
  Number of Levels :  5
    (m AGL)       30.0
    (m AGL)       45.7
    (m AGL)       80.8
    (m AGL)       111.3
    (m AGL)       152.3999

**Model Calculates 1 Short Term Average(s) of:   1-HR
    and Calculates PERIOD Averages

**This Run Includes:     1 Source(s);      1 Source Group(s); and    936 Receptor(s)

**The Model Assumes A Pollutant Type of:  FUGITIVE

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
         Model Outputs Tables of PERIOD Averages by Receptor
         Model Outputs Tables of Highest Short Term Values by Receptor (RECTABLE Keyword)
         Model Outputs Tables of Overall Maximum Short Term Values (MAXTABLE Keyword)
         Model Outputs External File(s) of High Values for Plotting (PLOTFILE Keyword)

**NOTE:  The Following Flags May Appear Following DEPO Values:  c for Calm Hours
                                                                m for Missing Hours
                                                                b for Both Calm and Missing Hours

**Misc. Inputs:  Anem. Hgt. (m) =    30.00 ;    Decay Coef. =     .0000E+00 ;    Rot. Angle =      .0
                 Emission Units = GRAMS/SEC                                   ;  Emission Rate Unit Factor =    3600.0
                 Output Units   = GRAMS/M**2

**Input Runstream File: steamb_dw.ind                          ;  **Output Print File: steamb_dw.out
**Detailed Error/Message File:
STEAMB_DW.ERR
```

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** 16:37:51
*** One Point source; 936 receptors up to 50KM away; Surface Wt. *** PAGE 2

*** MODELING OPTIONS USED: DEPOS RURAL ELEV DFAULT DRYDPL WETDPL

*** POINT SOURCE DATA ***

SOURCE ID	NUMBER PART. CATS.	EMISSION RATE (GRAMS/SEC)	X (METERS)	Y (METERS)	BASE ELEV. (METERS)	STACK HEIGHT (METERS)	STACK TEMP. (DEG.K)	STACK EXIT VEL. (M/SEC)	STACK DIAMETER (METERS)	BUILDING EXISTS	EMISSION RATE SCALAR VARY BY
STEAM	10	.10000E+01	23.9	49.0	212.1	6.71	310.00	.10	.10	YES	

```
*** ISCOMBEP VERSION 94227 ***     *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG          ***
                                   *** One Point source; 936 receptors up to 50KM away; Surface Wt.   ***
                                                                                                        16:37:51
                                                                                                        PAGE   3
 *** MODELING OPTIONS USED:  DEPOS  RURAL  ELEV          DFAULT                                  DRYDPL WETDPL


                                        *** SOURCE IDs DEFINING SOURCE GROUPS ***

GROUP ID                                SOURCE IDs


 ALL      STEAM    ,
```

*** SOURCE PARTICULATE/GAS DATA ***

*** SOURCE ID = STEAM ; SOURCE TYPE = POINT ***

MASS FRACTION =
.00414, .01301, .05288, .10060, .13832, .12745, .16051, .12038, .18640, .09631,

PARTICLE DIAMETER (MICRONS) =
2.97000, 1.89000, .93000, .55000, .40000, .27000, .18000, .12000, .06200, .03000,

PARTICLE DENSITY (G/CM**3) =
1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000, 1.00000,

SCAV COEF [LIQ] 1/(S-MM/HR)=
.21E-03, .14E-03, .50E-04, .50E-04, .60E-04, .90E-04, .13E-03, .15E-03, .20E-03, .22E-03,

SCAV COEF [ICE] 1/(S-MM/HR)=
.70E-04, .47E-04, .17E-04, .17E-04, .20E-04, .30E-04, .43E-04, .50E-04, .67E-04, .73E-04,

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** 16:37:51
*** One Point source; 936 receptors up to 50KM away; Surface Wt. *** PAGE 5

*** MODELING OPTIONS USED: DEPOS RURAL ELEV DFAULT DRYDPL WETDPL

*** DIRECTION SPECIFIC BUILDING DIMENSIONS ***

SOURCE ID: STEAM

IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK
1	29.1,	25.9,	0	2	29.1,	24.7,	0	3	29.1,	21.8,	0	4	24.4,	28.9,	0	5	24.4,	27.0,	0	6	24.4,	24.6,	0
7	6.7,	16.4,	0	8	25.8,	24.8,	0	9	25.8,	26.4,	0	10	25.8,	27.3,	0	11	25.8,	27.3,	0	12	25.8,	26.4,	0
13	25.8,	24.8,	0	14	25.8,	22.4,	0	15	25.8,	20.1,	0	16	29.1,	25.9,	0	17	29.1,	25.9,	0	18	29.1,	25.9,	0
19	29.1,	25.9,	0	20	29.1,	24.7,	0	21	29.1,	21.8,	0	22	24.4,	28.9,	0	23	24.4,	27.0,	0	24	24.4,	24.6,	0
25	14.9,	65.3,	0	26	25.8,	24.8,	0	27	25.8,	26.4,	0	28	25.8,	27.3,	0	29	25.8,	27.3,	0	30	25.8,	26.4,	0
31	25.8,	24.8,	0	32	25.8,	22.4,	0	33	25.8,	20.1,	0	34	29.1,	25.9,	0	35	29.1,	25.9,	0	36	29.1,	25.9,	0

* SOURCE-RECEPTOR COMBINATIONS LESS THAN 1.0 METER OR 3*ZLB *
IN DISTANCE. CALCULATIONS MAY NOT BE PERFORMED.

SOURCE ID	- - RECEPTOR LOCATION - - XR (METERS)	YR (METERS)	DISTANCE (METERS)
STEAM	17.4	98.5	49.93
STEAM	34.2	94.0	46.16
STEAM	50.0	86.6	45.80
STEAM	64.3	76.6	48.93
STEAM	86.6	50.0	62.72
STEAM	94.0	34.2	71.62
STEAM	-34.2	94.0	73.48
STEAM	-17.4	98.5	64.44
STEAM	.0	100.0	56.34

*** ISCOMDEP VERSION 94227 *** *** MTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** *** 16:37:51
*** One Point source; 936 receptors up to 50KM away; Surface Wt. *** PAGE 18

*** MODELING OPTIONS USED: DEPOS RURAL ELEV DFAULT DRYDPL WETDPL

*** METEOROLOGICAL DAYS SELECTED FOR PROCESSING ***
(1=YES; 0=NO)

1 1 1

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG ***
*** One Point source; 936 receptors up to 50KM away; Surface Wt. *** 16:37:51
PAGE 19

*** MODELING OPTIONS USED: DEPOS RURAL ELEV DFAULT DRYDPL WETDPL

*** THE FIRST 24 HOURS OF METEOROLOGICAL DATA ***

FILE: depbin.met FORMAT: (4I2,2F9.4,F6.1,I2,2F7.1,f9.4,f10.1,f8.4,f5.1,i4,f7.2)
SURFACE STATION NO.: 94823 UPPER AIR STATION NO.: 94823
NAME: WTI NAME: WTI
YEAR: 1993 YEAR: 1993

YEAR	MONTH	DAY	HOUR	FLOW VECTOR	SPEED (M/S)	TEMP (K)	STAB CLASS	MIXING HEIGHT (M) RURAL	MIXING HEIGHT (M) URBAN	USTAR (M/S)	M-O LENGTH (M)	Z-0 (M)	Zd (M)	IPCODE	PRATE (mm/HR)
93	1	1	1	104.0	4.47	275.4	4	601.6	601.6	.3366	176.8	.3000	1.5	13	.00
93	1	1	2	112.0	5.36	274.8	4	617.6	617.6	.4269	283.7	.3000	1.5	0	.25
93	1	1	3	106.0	4.47	274.0	4	633.5	633.5	.3363	175.6	.3000	1.5	0	.00
93	1	1	4	115.0	4.47	273.9	4	649.5	649.5	.3363	175.4	.3000	1.5	28	.00
93	1	1	5	120.0	4.02	273.8	4	665.4	665.4	.2874	128.1	.3000	1.5	28	.00
93	1	1	6	123.0	5.36	273.3	4	681.4	681.4	.4266	281.8	.3000	1.5	28	.00
93	1	1	7	130.0	4.92	272.5	4	697.3	697.3	.3820	225.3	.3000	1.5	28	.00
93	1	1	8	124.0	4.92	271.9	4	713.3	713.3	.3819	224.6	.3000	1.5	28	.00
93	1	1	9	115.0	4.47	271.0	4	729.2	729.2	.3355	172.9	.3000	1.5	28	.00
93	1	1	10	107.0	4.02	270.9	4	745.2	745.2	.3534	-999.0	.3000	1.5	28	.00
93	1	1	11	113.0	4.02	270.6	4	761.1	761.1	.3534	-999.0	.3000	1.5	28	.00
93	1	1	12	108.0	4.47	270.9	4	777.1	777.1	.3926	-999.0	.3000	1.5	28	.00
93	1	1	13	114.0	5.36	271.1	4	793.0	793.0	.4712	-999.0	.3000	1.5	28	.00
93	1	1	14	107.0	4.92	271.0	4	809.0	809.0	.4319	-999.0	.3000	1.5	28	.00
93	1	1	15	120.0	4.92	270.8	4	809.0	809.0	.3817	223.4	.3000	1.5	28	.00
93	1	1	16	119.0	4.47	270.5	4	809.0	809.0	.3354	172.4	.3000	1.5	28	.00
93	1	1	17	118.0	3.58	270.4	4	809.0	809.0	.2310	81.7	.3000	1.5	28	.00
93	1	1	18	124.0	2.68	270.4	4	809.0	809.0	.1178	29.4	.3000	1.5	28	.00
93	1	1	19	124.0	2.68	270.1	4	809.0	809.0	.1178	29.4	.3000	1.5	28	.00
93	1	1	20	113.0	2.23	270.3	4	809.0	809.0	.0982	29.4	.3000	1.5	28	.00
93	1	1	21	97.0	2.68	270.3	4	809.0	809.0	.1178	29.4	.3000	1.5	0	.00
93	1	1	22	113.0	3.13	270.3	4	809.0	809.0	.1374	29.4	.3000	1.5	28	.00
93	1	1	23	117.0	3.13	270.4	4	809.0	809.0	.1374	29.4	.3000	1.5	0	.00
93	1	1	24	152.0	2.68	269.9	4	809.0	809.0	.1178	29.4	.3000	1.5	28	.00

*** NOTES: STABILITY CLASS 1=A, 2=B, 3=C, 4=D, 5=E AND 6=F.
FLOW VECTOR IS DIRECTION TOWARD WHICH WIND IS BLOWING.

```
 *** ISCOMDEP VERSION 94227 ***     ***  WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG          ***        12/27/94
                                   ***  One Point source; 936 receptors up to 50KM away; Vapor.         ***        17:14:25
                                                                                                                   PAGE   1
 *** MODELING OPTIONS USED:  CONC    RURAL  ELEV          DFAULT

                                          ***     MODEL SETUP OPTIONS SUMMARY       ***
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

**Intermediate Terrain Processing is Selected

**Model Is Setup For Calculation of Average CONCentration Values.

  --  SCAVENGING/DEPOSITION LOGIC --
**Model Uses NO DRY DEPLETION.  DDPLETE =  F
**Model Uses NO WET DEPLETION.  WDPLETE =  F
**NO WET SCAVENGING Data Provided.
**Model Uses GRIDDED TERRAIN Data for Depletion Calculations

**Model Uses RURAL Dispersion.

**Model Uses Regulatory DEFAULT Options:
          1. Final Plume Rise.
          2. Stack-tip Downwash.
          3. Buoyancy-induced Dispersion.
          4. Use Calms Processing Routine.
          5. Not Use Missing Data Processing Routine.
          6. Default Wind Profile Exponents.
          7. Default Vertical Potential Temperature Gradients.
          8. 'Upper Bound' Values for Supersquat Buildings.
          9. No Exponential Decay for RURAL Mode

**Model Accepts Receptors on ELEV Terrain.

**Model Assumes No FLAGPOLE Receptor Heights.

**Model Accepting Temperature Profile Data.
  Number of Levels :            3
    (m AGL)          30.0000
    (m AGL)          45.7000
    (m AGL)          152.400

**Model Accepting Wind Profile Data.
  Number of Levels :            5
    (m AGL)          30.0000
    (m AGL)          45.7000
    (m AGL)          80.8000
    (m AGL)          111.300
    (m AGL)          152.400

**Model Calculates  1 Short Term Average(s) of:   1-HR
    and Calculates PERIOD Averages

**This Run Includes:    1 Source(s);      1 Source Group(s); and    936 Receptor(s)

**The Model Assumes A Pollutant Type of:  FUGITIVE

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
        Model Outputs Tables of PERIOD Averages by Receptor
        Model Outputs Tables of Highest Short Term Values by Receptor (RECTABLE Keyword)
        Model Outputs Tables of Overall Maximum Short Term Values (MAXTABLE Keyword)
        Model Outputs External File(s) of High Values for Plotting (PLOTFILE Keyword)

**NOTE:  The Following Flags May Appear Following CONC Values:  c for Calm Hours
                                                                m for Missing Hours
                                                                b for Both Calm and Missing Hours

**Misc. Inputs:  Anem. Hgt. (m) =    30.00 ;    Decay Coef. =   0.0000     ;    Rot. Angle =     0.0
                 Emission Units = GRAMS/SEC                                ;  Emission Rate Unit Factor =   0.10000E+07
                 Output Units   = MICROGRAMS/M**3

**Input Runstream File: steam.inc                                ;  **Output Print File: steam.out
**Detailed Error/Message File:   STEAM.ERR
```

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** 12/27/94
*** One Point source; 936 receptors up to 50KM away; Vapor. *** 17:14:25
PAGE 2

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** POINT SOURCE DATA ***

SOURCE ID	NUMBER PART. CATS.	EMISSION RATE (GRAMS/SEC)	X (METERS)	Y (METERS)	BASE ELEV. (METERS)	STACK HEIGHT (METERS)	STACK TEMP. (DEG.K)	STACK EXIT VEL. (M/SEC)	STACK DIAMETER (METERS)	BUILDING EXISTS	EMISSION RATE SCALAR VARY BY
STEAM	0	0.10000E+01	23.9	49.0	212.1	6.71	310.00	0.10	0.10	YES	

```
*** ISCOMDEP VERSION 94227 ***     ***  WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG          ***     12/27/94
                                   ***  One Point source; 936 receptors up to 50KM away; Vapor.         ***     17:14:25
                                                                                                                PAGE   3
*** MODELING OPTIONS USED:  CONC   RURAL  ELEV          DFAULT


                                        *** SOURCE IDs DEFINING SOURCE GROUPS ***

GROUP ID                                              SOURCE IDs

ALL        STEAM    ,
```

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** 12/27/94
*** One Point source; 936 receptors up to 50KM away; Vapor. *** 17:14:25
PAGE 4

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** SOURCE PARTICULATE/GAS DATA ***

*** SOURCE ID = STEAM ; SOURCE TYPE = POINT ***

SCAV COEF [LIQ] 1/(S-MM/HR)=
0.00E+00,

SCAV COEF [ICE] 1/(S-MM/HR)=
0.00E+00,

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** 12/27/94
*** One Point source; 936 receptors up to 50KM away; Vapor. *** 17:14:25
PAGE 5

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** DIRECTION SPECIFIC BUILDING DIMENSIONS ***

SOURCE ID: STEAM

IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK
1	29.1,	25.9,	0	2	29.1,	24.7,	0	3	29.1,	21.8,	0	4	24.4,	28.9,	0	5	24.4,	27.0,	0	6	24.4,	24.6,	0
7	6.7,	16.4,	0	8	25.8,	24.8,	0	9	25.8,	26.4,	0	10	25.8,	27.3,	0	11	25.8,	27.3,	0	12	25.8,	26.4,	0
13	25.8,	24.8,	0	14	25.8,	22.4,	0	15	25.8,	20.1,	0	16	29.1,	25.9,	0	17	29.1,	25.9,	0	18	29.1,	25.9,	0
19	29.1,	25.9,	0	20	29.1,	24.7,	0	21	29.1,	21.8,	0	22	24.4,	28.9,	0	23	24.4,	27.0,	0	24	24.4,	24.6,	0
25	14.9,	65.3,	0	26	25.8,	24.8,	0	27	25.8,	26.4,	0	28	25.8,	27.3,	0	29	25.8,	27.3,	0	30	25.8,	26.4,	0
31	25.8,	24.8,	0	32	25.8,	22.4,	0	33	25.8,	20.1,	0	34	29.1,	25.9,	0	35	29.1,	25.9,	0	36	29.1,	25.9,	0

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** 12/27/94
*** One Point source; 936 receptors up to 50KM away; Vapor. *** 17:14:25
PAGE 17

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

* SOURCE-RECEPTOR COMBINATIONS LESS THAN 1.0 METER OR 3*ZLB *
IN DISTANCE. CALCULATIONS MAY NOT BE PERFORMED.

SOURCE ID	- - RECEPTOR LOCATION - - XR (METERS)	YR (METERS)	DISTANCE (METERS)
STEAM	17.4	98.5	49.93
STEAM	34.2	94.0	46.16
STEAM	50.0	86.6	45.80
STEAM	64.3	76.6	48.93
STEAM	86.6	50.0	62.72
STEAM	94.0	34.2	71.62
STEAM	-34.2	94.0	73.48
STEAM	-17.4	98.5	64.44
STEAM	0.0	100.0	56.34

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** 12/27/94
*** One Point source; 936 receptors up to 50KM away; Vapor. *** 17:14:25
PAGE 18

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** METEOROLOGICAL DAYS SELECTED FOR PROCESSING ***
(1=YES; 0=NO)

1 1 1

*** ISCOMDEP VERSION 94227 *** *** WTI Fugitive source modeling - ASH HANDLING/STEAM BLDG *** 12/27/94
*** One Point source; 936 receptors up to 50KM away; Vapor. *** 17:14:25
PAGE 19

*** MODELING OPTIONS USED: CONC RURAL ELEV DFAULT

*** THE FIRST 24 HOURS OF METEOROLOGICAL DATA ***

FILE: depbin.met FORMAT: (4I2,2F9.4,F6.1,I2,2F7.1,f9.4,f10.1,f8.4,f5.1,i4,f7.2)
SURFACE STATION NO.: 94823 UPPER AIR STATION NO.: 94823
NAME: WTI NAME: WTI
YEAR: 1993 YEAR: 1993

YEAR	MONTH	DAY	HOUR	FLOW VECTOR	SPEED (M/S)	TEMP (K)	STAB CLASS	MIXING HEIGHT (M) RURAL	MIXING HEIGHT (M) URBAN	USTAR (M/S)	M-O LENGTH (M)	Z-0 (M)	Zd (M)	IPCODE	PRATE (mm/HR)
93	1	1	1	104.0	4.47	275.4	4	601.6	601.6	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	2	112.0	5.36	274.8	4	617.6	617.6	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	3	106.0	4.47	274.0	4	633.5	633.5	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	4	115.0	4.47	273.9	4	649.5	649.5	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	5	120.0	4.02	273.8	4	665.4	665.4	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	6	123.0	5.36	273.3	4	681.4	681.4	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	7	130.0	4.92	272.5	4	697.3	697.3	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	8	124.0	4.92	271.9	4	713.3	713.3	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	9	115.0	4.47	271.0	4	729.2	729.2	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	10	107.0	4.02	270.9	4	745.2	745.2	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	11	113.0	4.02	270.6	4	761.1	761.1	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	12	108.0	4.47	270.9	4	777.1	777.1	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	13	114.0	5.36	271.1	4	793.0	793.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	14	107.0	4.92	271.0	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	15	120.0	4.92	270.8	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	16	119.0	4.47	270.5	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	17	118.0	3.58	270.4	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	18	124.0	2.68	270.4	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	19	124.0	2.68	270.1	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	20	113.0	2.23	270.3	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	21	97.0	2.68	270.3	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	22	113.0	3.13	270.3	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	23	117.0	3.13	270.4	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00
93	1	1	24	152.0	2.68	269.9	4	809.0	809.0	0.0000	0.0	0.0000	0.0	0	0.00

*** NOTES: STABILITY CLASS 1=A, 2=B, 3=C, 4=D, 5=E AND 6=F.
FLOW VECTOR IS DIRECTION TOWARD WHICH WIND IS BLOWING.

APPENDIX IV-4

ISC-COMPDEP Contour Plots

Main Incinerator Stack - Base Case Simulations

IV-4-1 to IV-4-8 - Mass-weighted pollutant distribution.

IV-4-9 to IV-4-16 - Surface area-weighted pollutant distribution.

IV-4-17 to IV-4-18 - Vapor pollutant.

Fugitive Emission Sources

IV-4-19 to IV-4-20 - Truck wash

IV-4-21 to IV-4-22 - Organic waste tank farm stacks

IV-4-23 to IV-4-24 - Open wastewater tank

IV-4-25 to IV-4-26 - Carbon adsorption bed stack

IV-4-27 to IV-4-44 - Ash handling stack

IV-4-27 to IV-4-34: mass-weighted pollutant distribution
IV-4-35 to IV-4-42: surface area-weighted distribution
IV-4-43 to IV-4-44: vapor distribution

Annual Concentrations ($\mu g/m^3$)
WTI Stack (Mass Distribution)

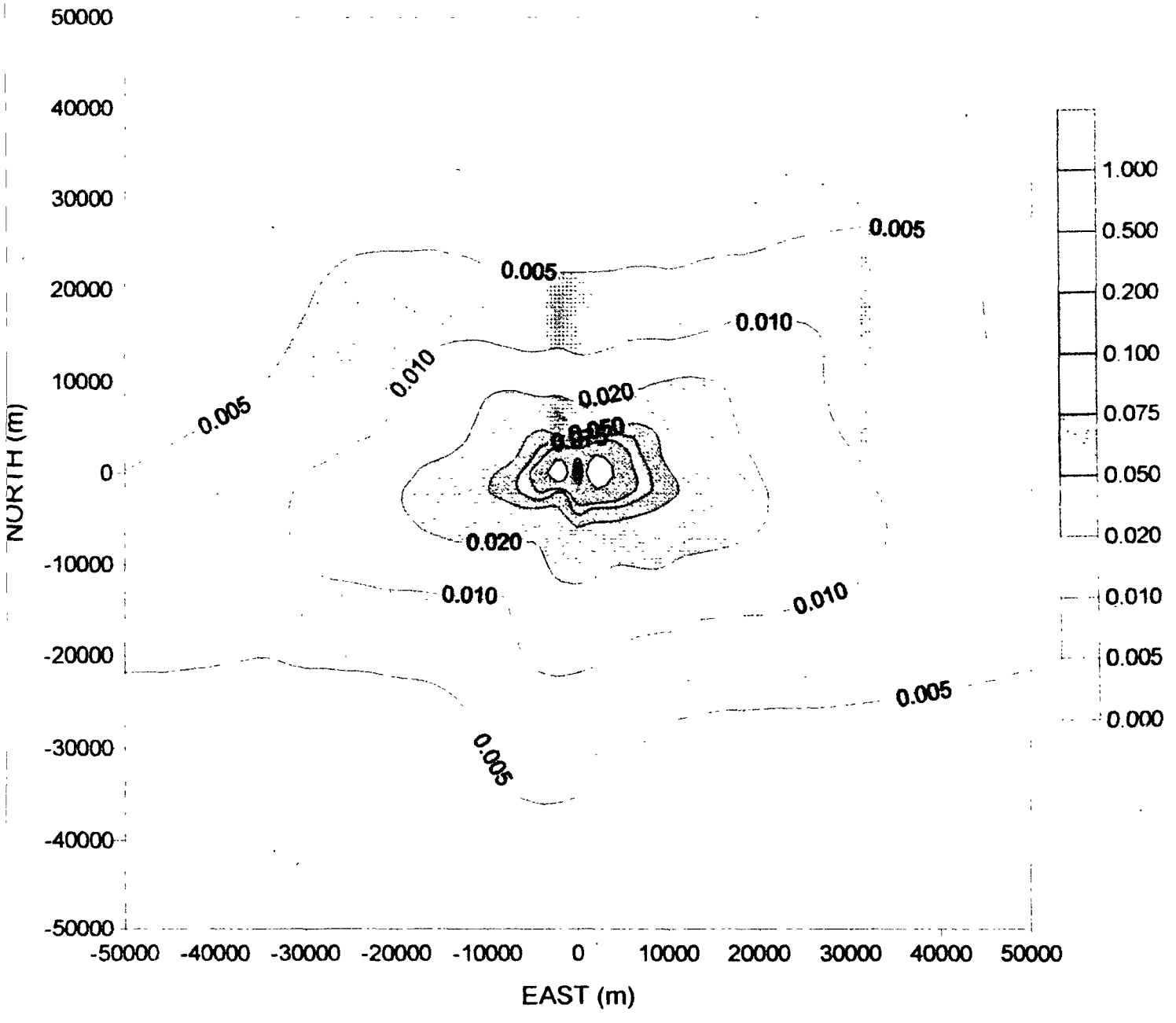

Figure IV-4-1. Annual average concentrations ($\mu g/m^3$) for the incinerator stack - Run 1a (ISC-COMPDEP, base case, mass-weighted pollutant distribution). Modeling domain out to 50 km is displayed.

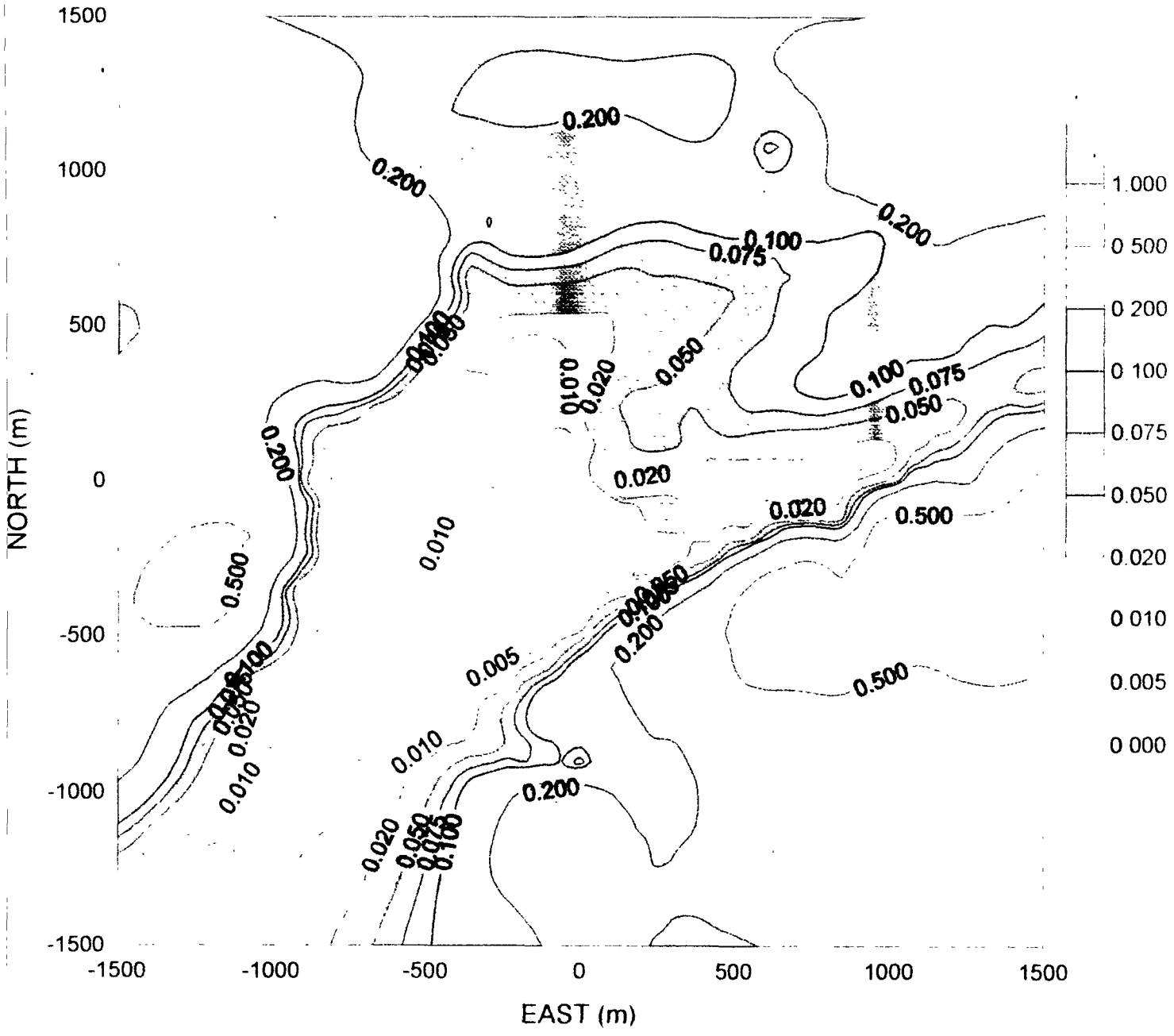

Figure IV-4-2. Annual average concentrations (µg/m^3) for the incinerator stack - Run 1a (ISC-COMPDEP, base case, mass-weighted pollutant distribution). Modeling domain out to 1.5 km is displayed.

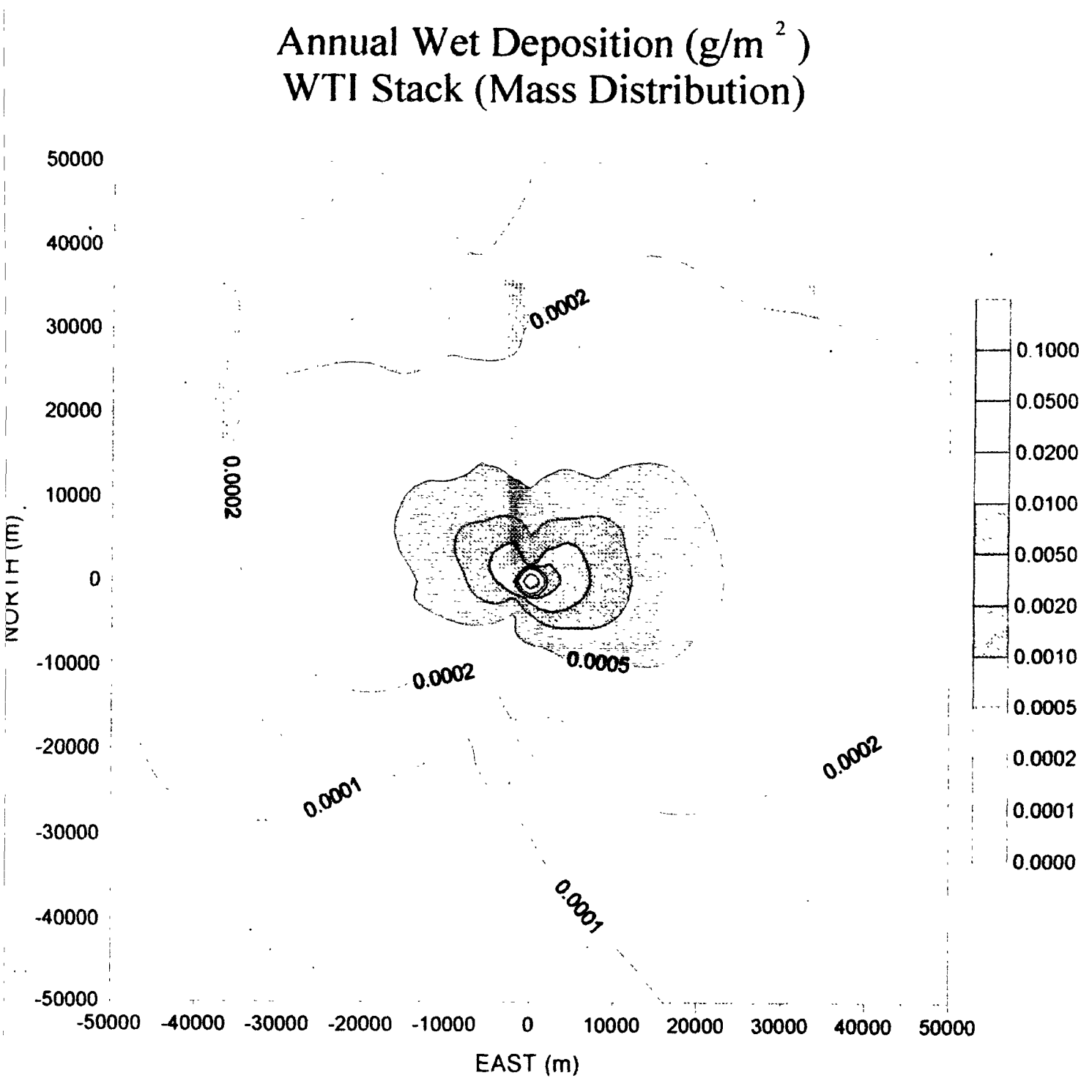

Figure IV-4-3. Annual wet deposition fluxes (g/m^2) for the incinerator stack - Run 1a (ISC-COMPDEP, base case, mass-weighted pollutant distribution). Modeling domain out to 50 km is displayed.

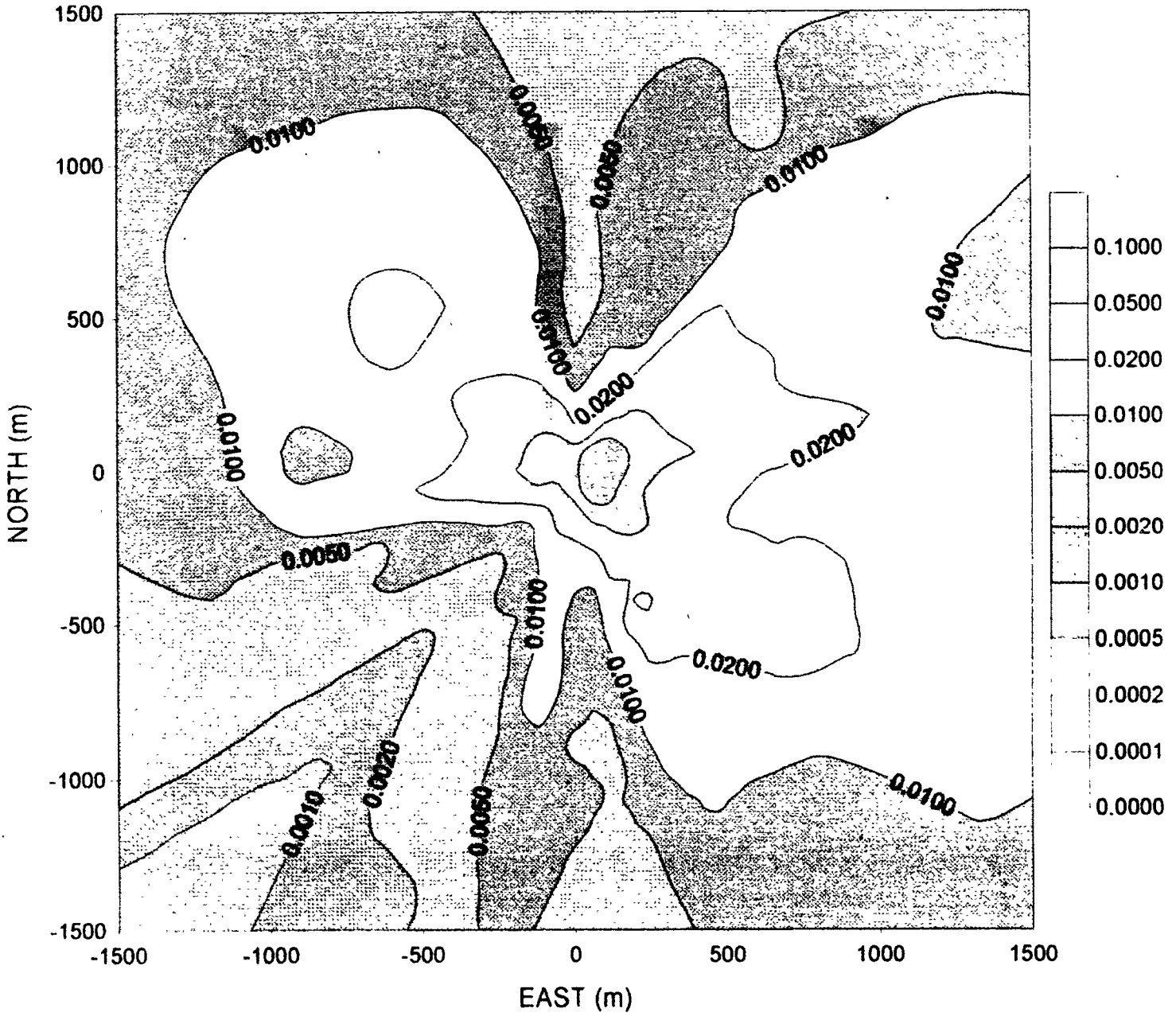

Figure IV-4-4. Annual wet deposition fluxes (g/m^2) for the incinerator stack - Run 1a (ISC-COMPDEP, base case, mass-weighted pollutant distribution). Modeling domain out to 1.5 km is displayed.

Annual Dry Deposition (g/m^2)
WTI Stack (Mass Distribution)

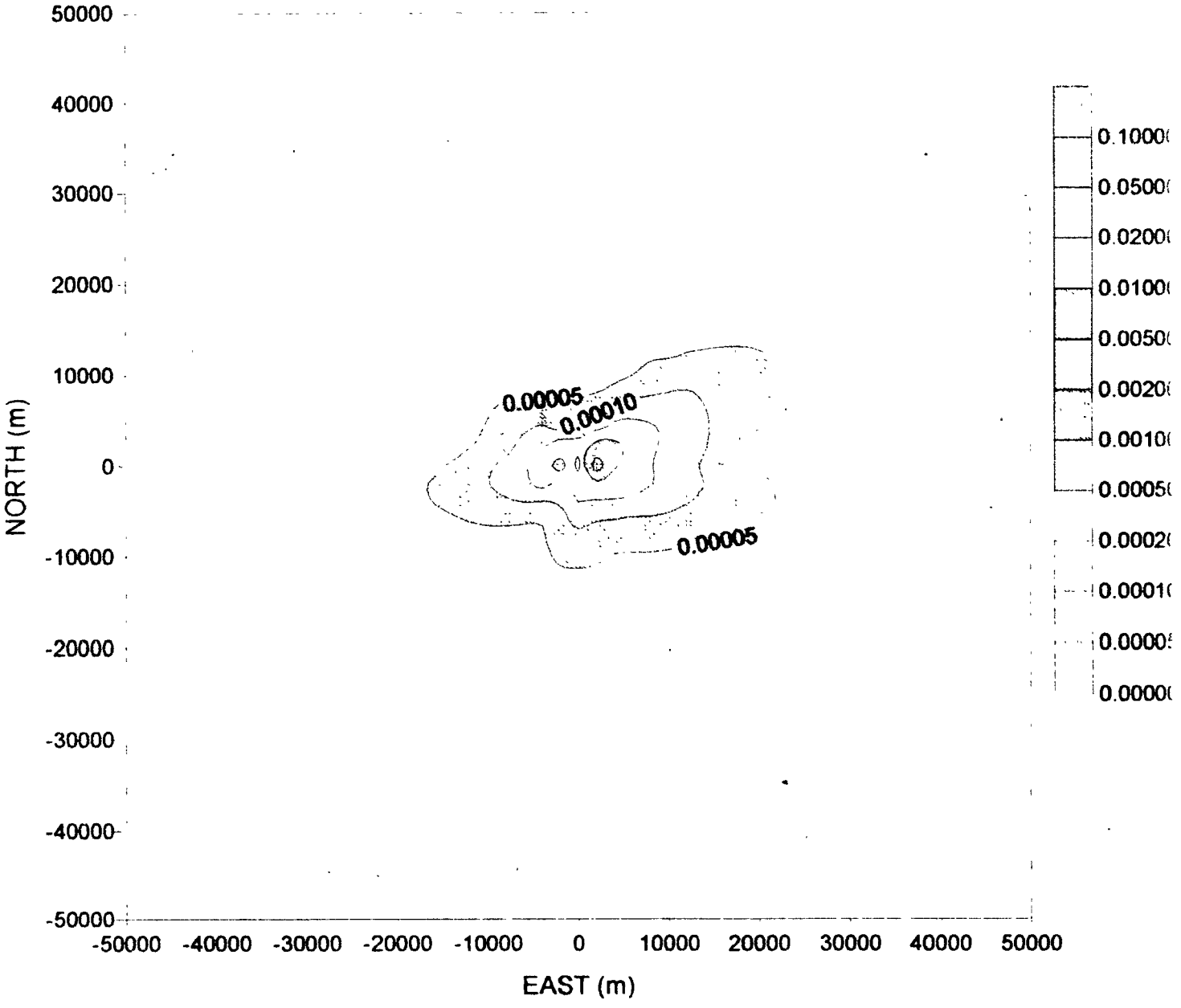

Figure IV-4-5. Annual dry deposition fluxes (g/m^2) for the incinerator stack - Run 1a (ISC-COMPDEP, base case, mass-weighted pollutant distribution). Modeling domain out to 50 km is displayed.

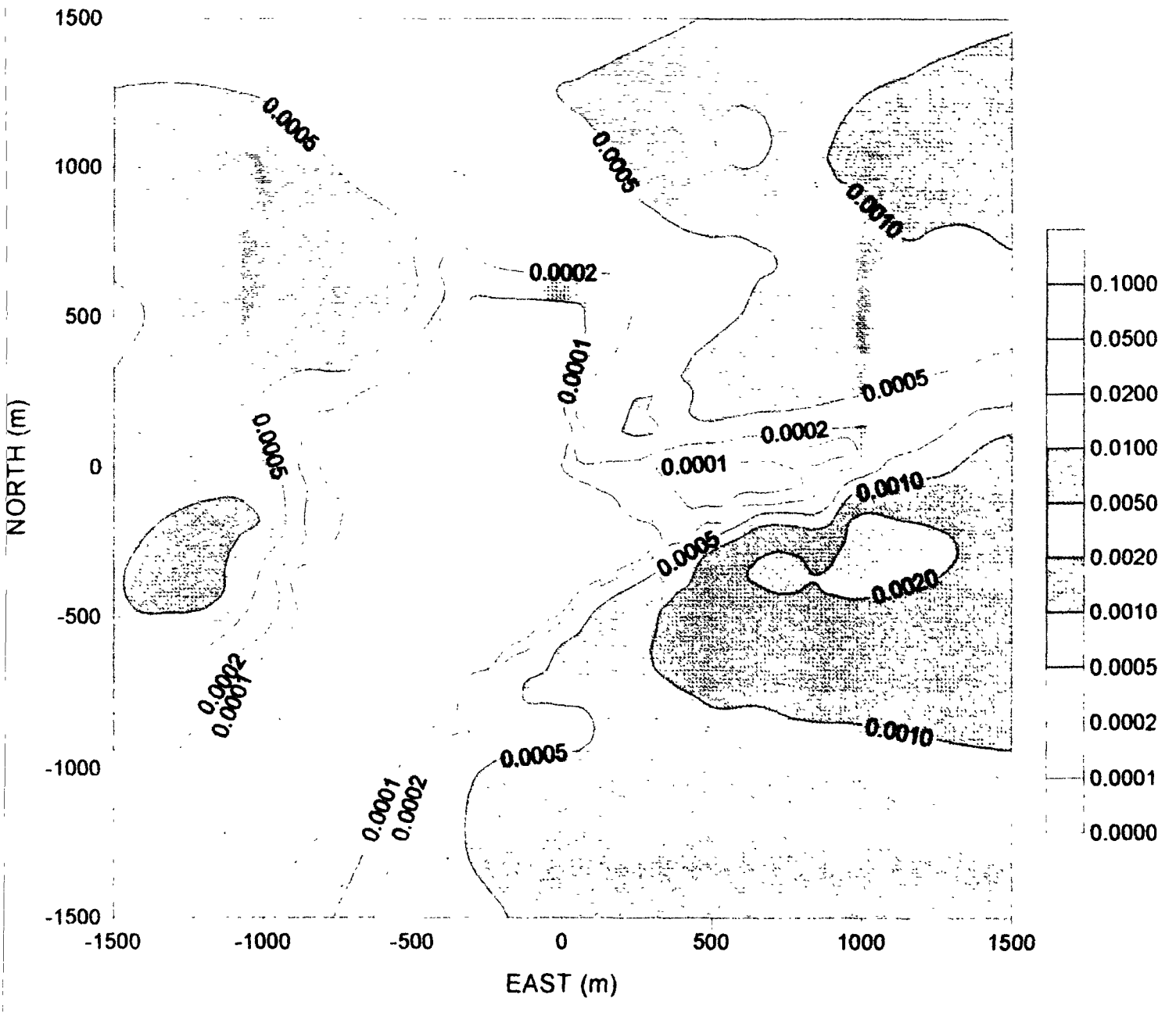

Figure IV-4-6. Annual dry deposition fluxes (g/m^2) for the incinerator stack - Run 1a (ISC-COMPDEP, base case, mass-weighted pollutant distribution). Modeling domain out to 1.5 km is displayed.

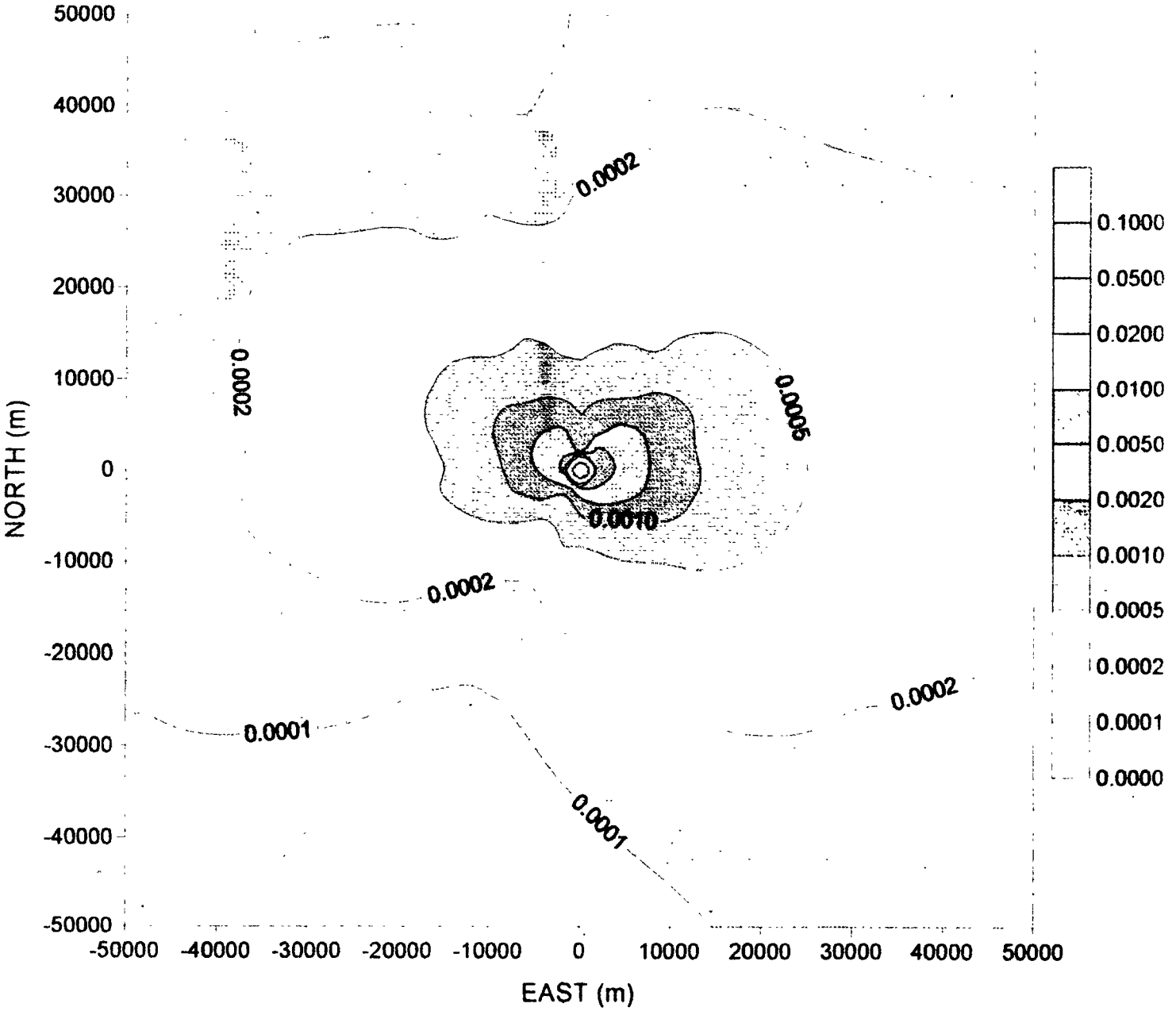

Figure IV-4-7. Annual total deposition fluxes (g/m^2) for the incinerator stack - Run 1a (ISC-COMPDEP, base case, mass-weighted pollutant distribution). Modeling domain out to 50 km is displayed.

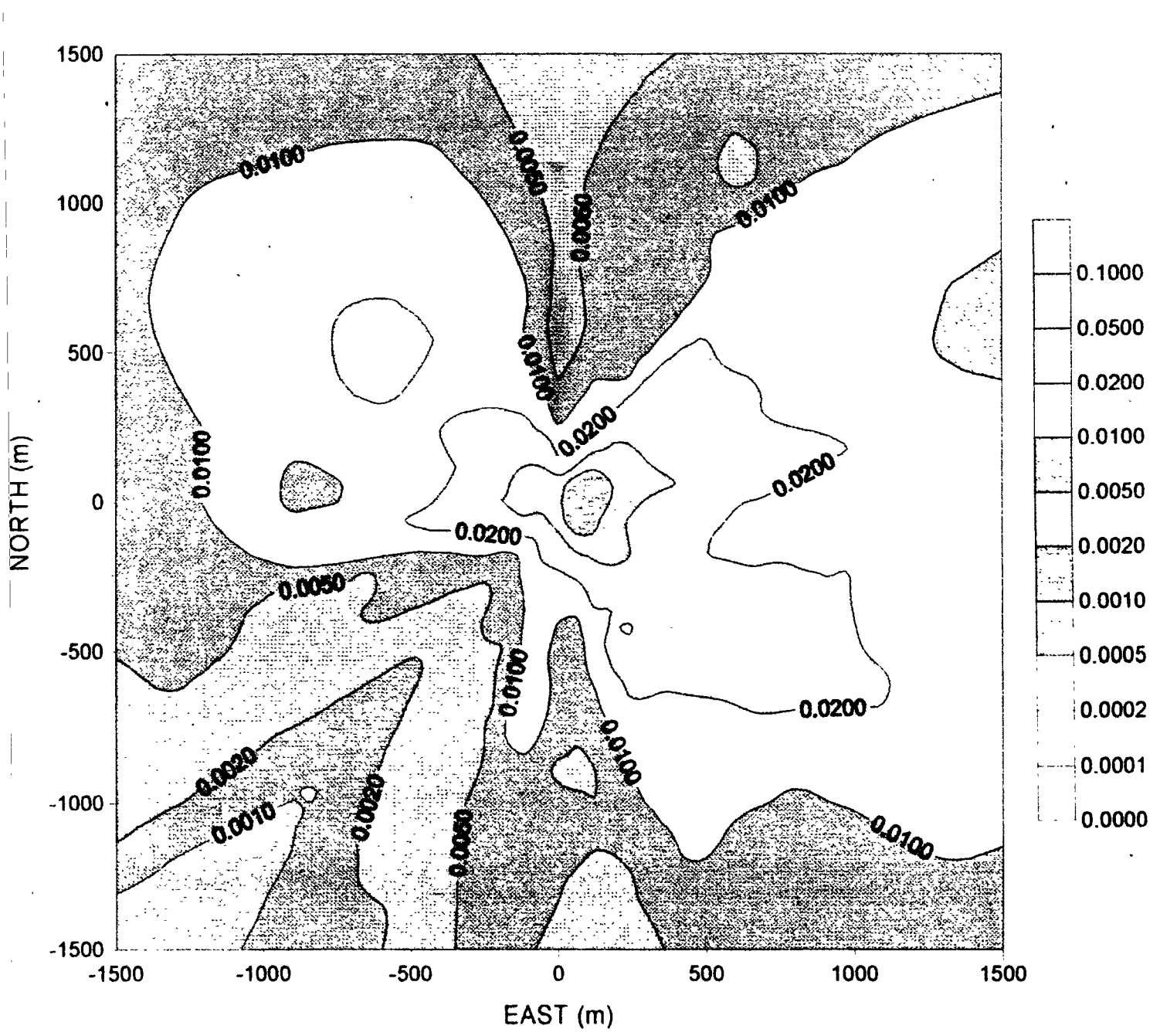

Figure IV-4-8. Annual total deposition fluxes (g/m^2) for the incinerator stack - Run 1a (ISC-COMPDEP, base case, mass-weighted pollutant distribution). Modeling domain out to 1.5 km is displayed.

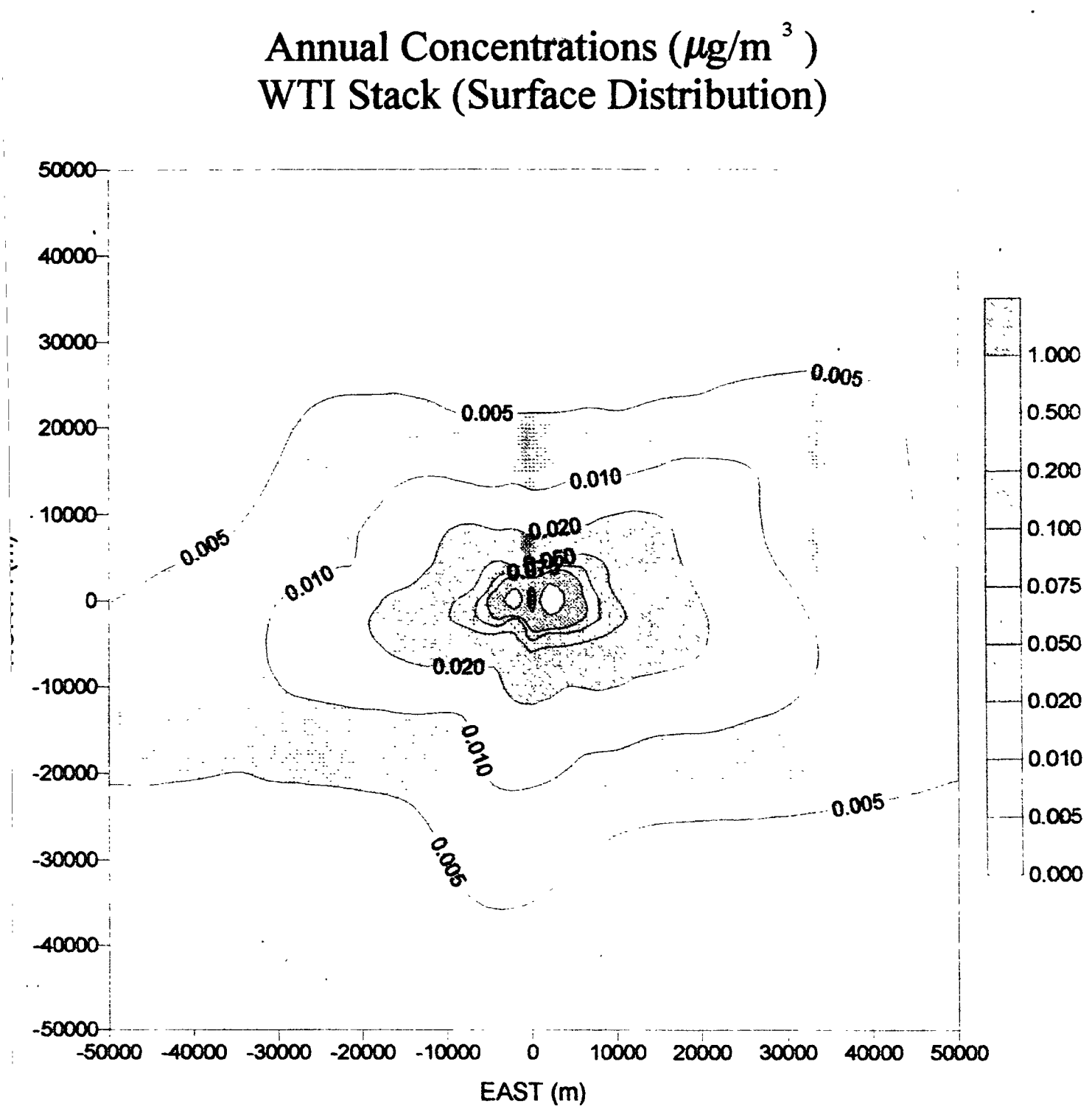

Figure IV-4-9. Annual average concentrations (μg/m^3) for the incinerator stack - Run 1b (ISC-COMPDEP, base case, surface area-weighted pollutant distribution). Modeling domain out to 50 km is displayed.

Annual Concentrations ($\mu g/m^3$)
WTI Stack (Surface Distribution)

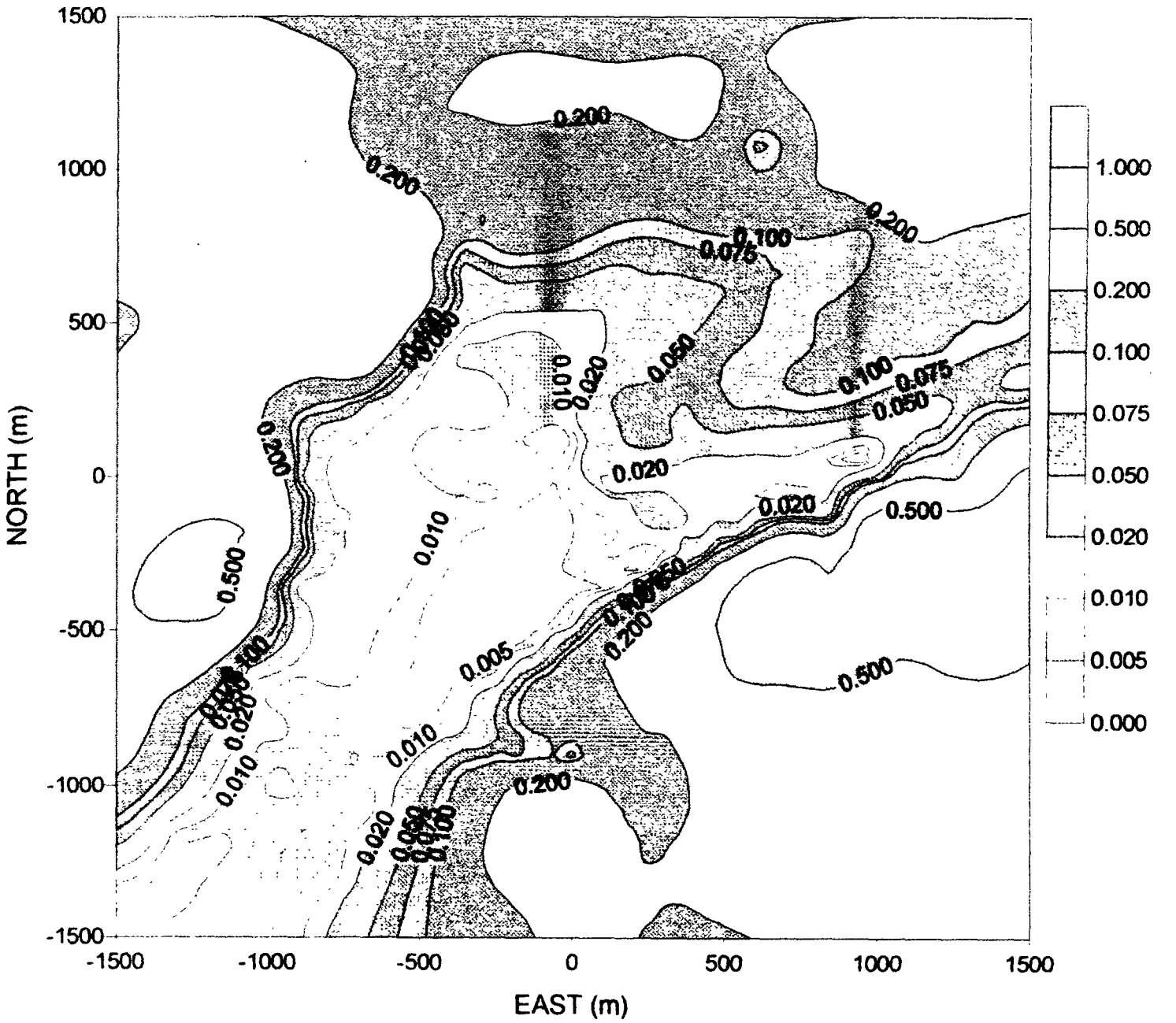

Figure IV-4-10. Annual average concentrations ($\mu g/m^3$) for the incinerator stack - Run 1b (ISC-COMPDEP, base case, surface area-weighted pollutant distribution). Modeling domain out to 1.5 km is displayed.

Annual Wet Deposition (g/m^2)
WTI Stack (Surface Distribution)

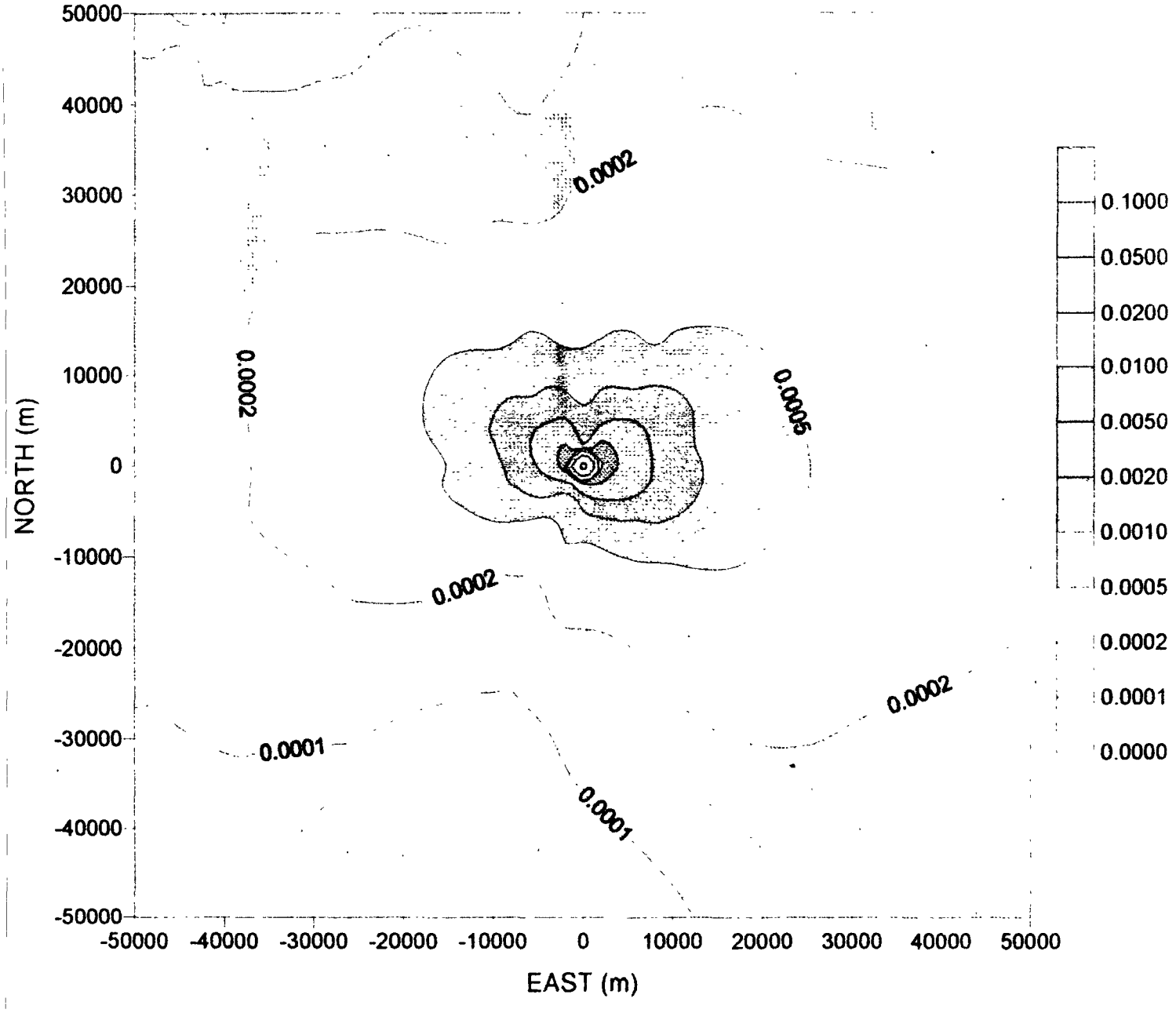

Figure IV-4-11. Annual wet deposition fluxes (g/m^2) for the incinerator stack - Run 1b (ISC-COMPDEP, base case, surface area-weighted pollutant distribution). Modeling domain out to 50 km is displayed.

Annual Wet Deposition (g/m^2)
WTI Stack (Surface Distribution)

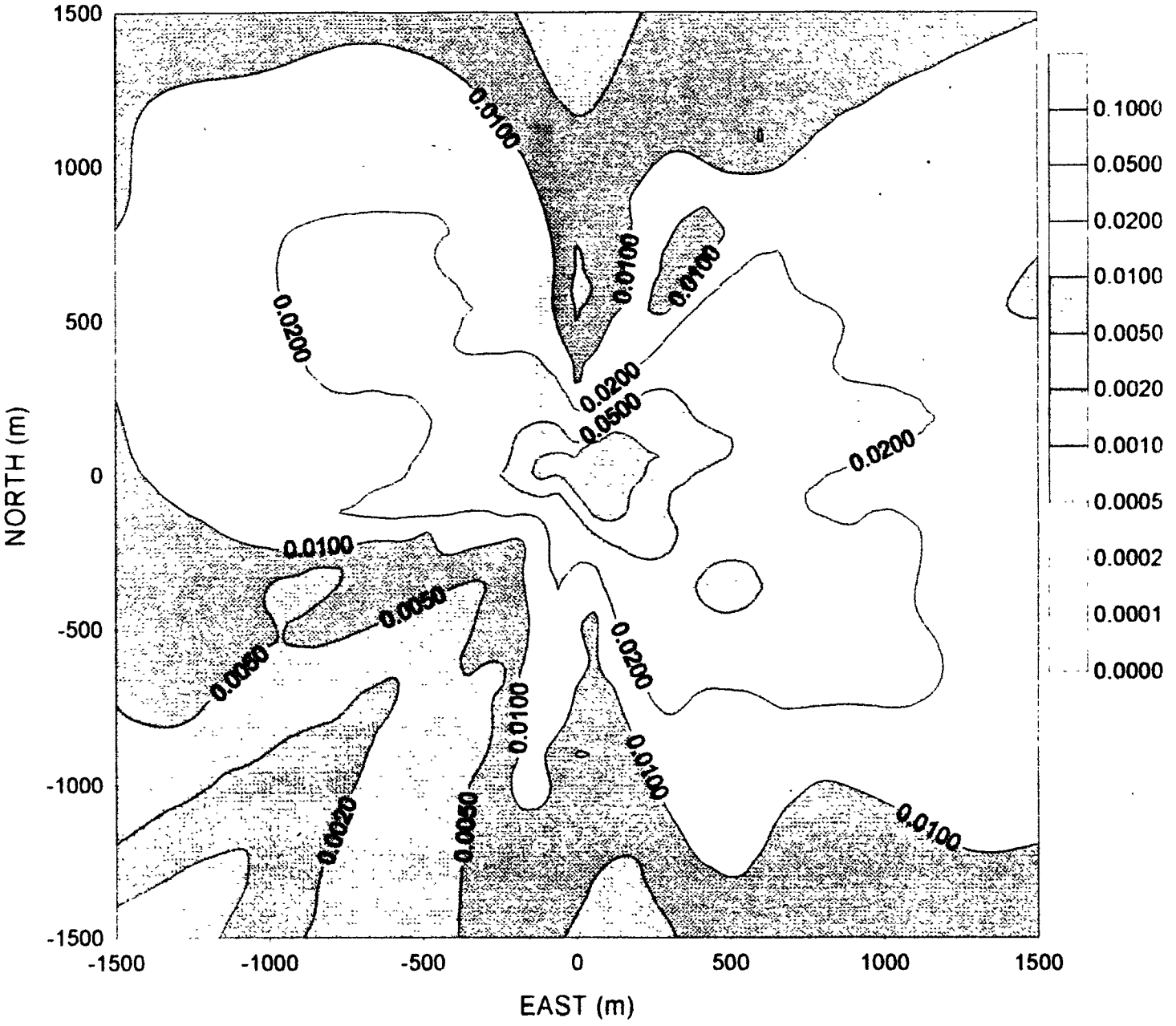

Figure IV-4-12. Annual wet deposition fluxes (g/m^2) for the incinerator stack - Run 1b (ISC-COMPDEP, base case, surface area-weighted pollutant distribution). Modeling domain out to 1.5 km is displayed.

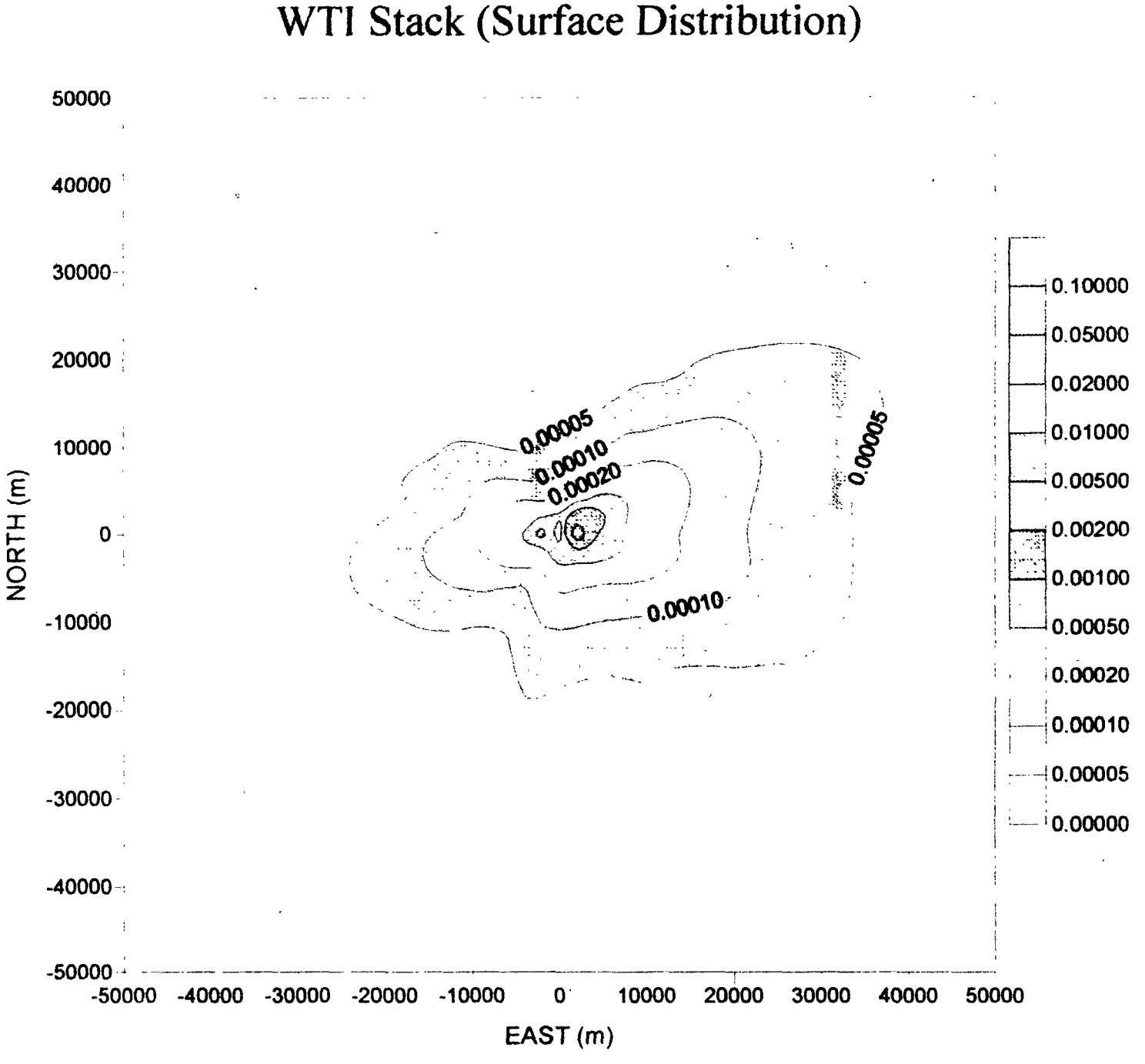

Figure IV-4-13. Annual dry deposition fluxes (g/m^2) for the incinerator stack - Run 1b (ISC-COMPDEP, base case, surface area-weighted pollutant distribution). Modeling domain out to 50 km is displayed.

Annual Dry Deposition (g/m^2)
WTI Stack (Surface Distribution)

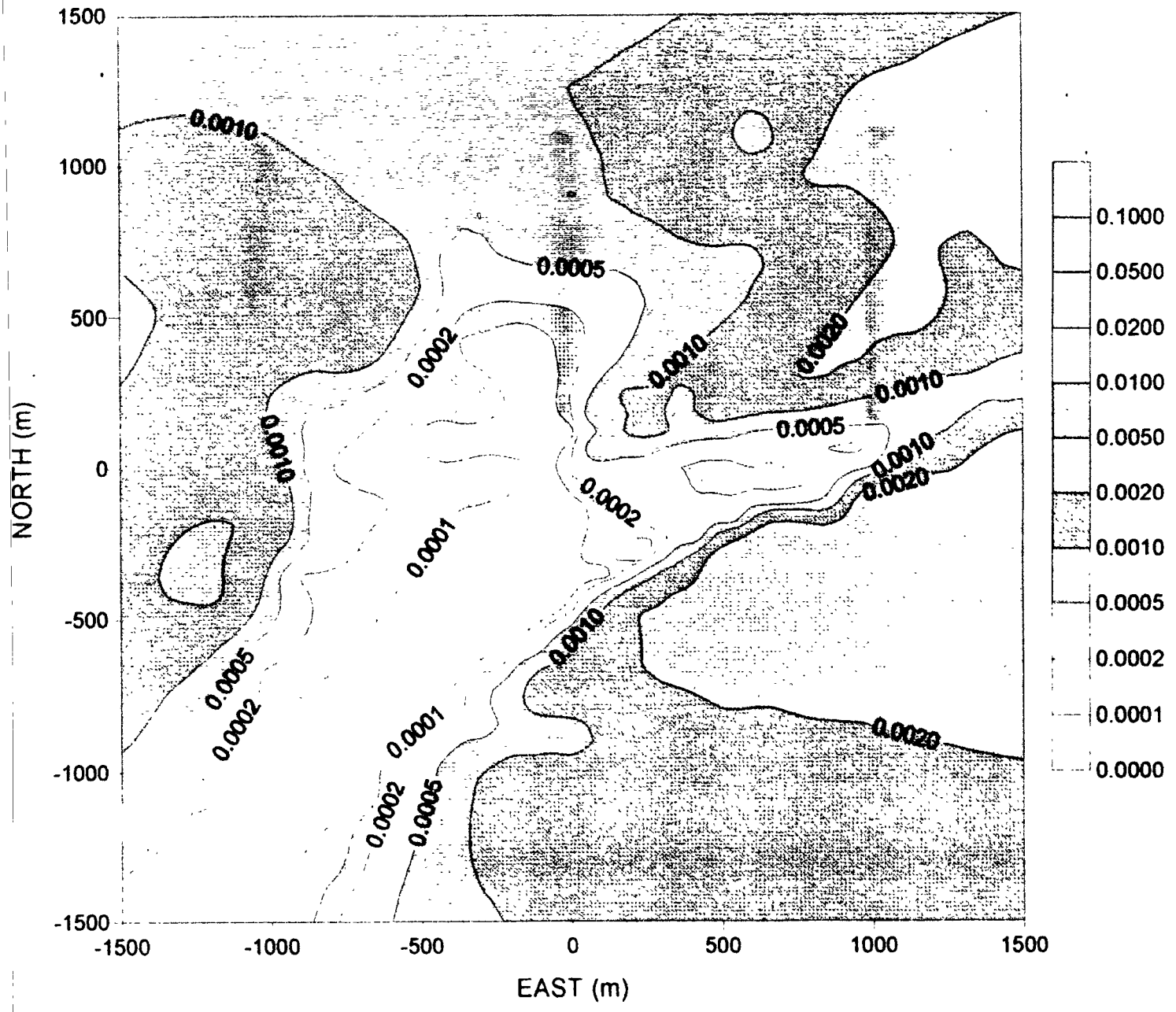

Figure IV-4-14. Annual dry deposition fluxes (g/m^2) for the incinerator stack - Run 1b (ISC-COMPDEP, base case, surface area-weighted pollutant distribution). Modeling domain out to 1.5 km is displayed.

Total Annual Deposition (g/m ^{2})
WTI Stack (Surface Distribution)

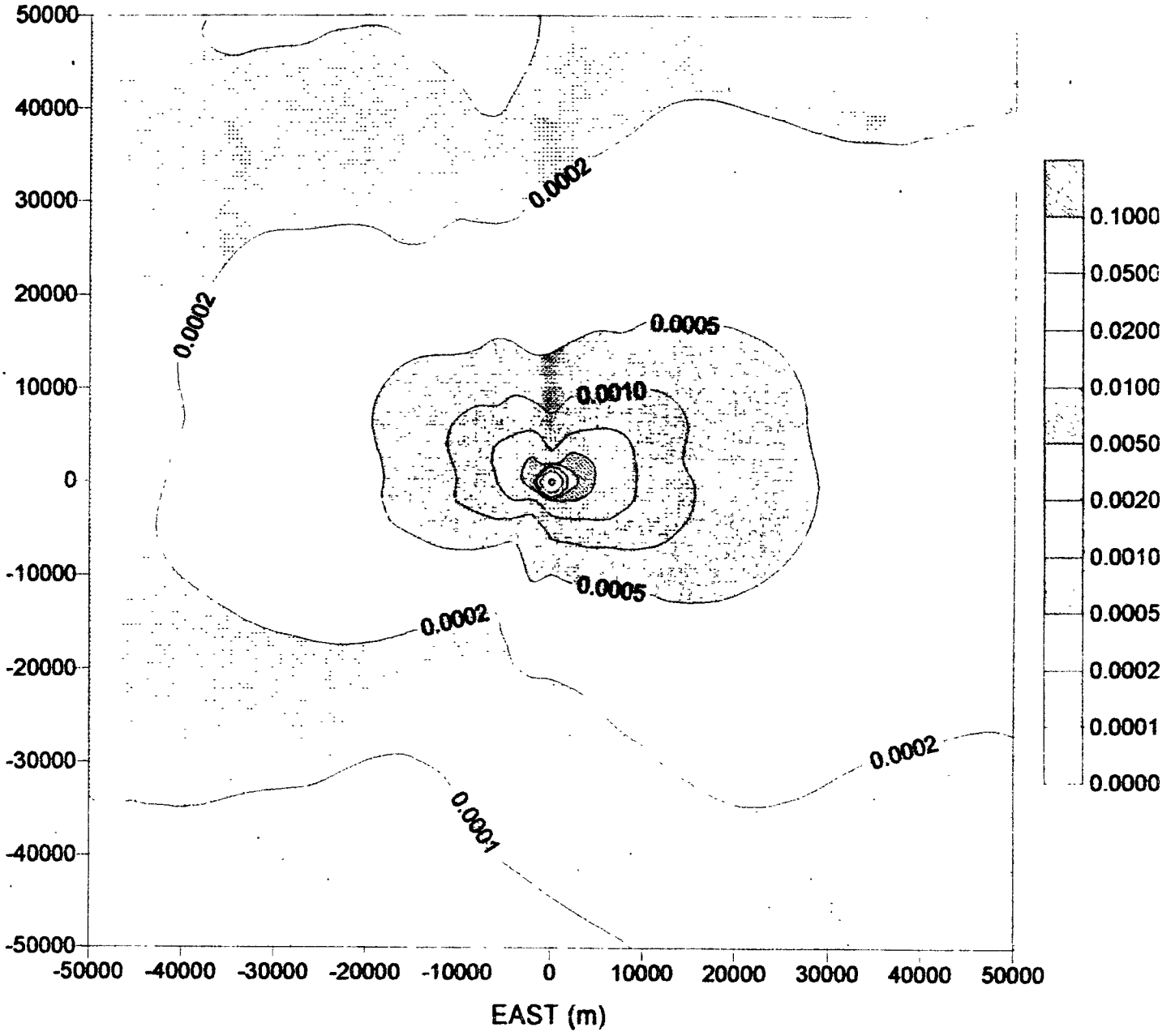

Figure IV-4-15. Annual total deposition fluxes (g/m^2) for the incinerator stack - Run 1b (ISC-COMPDEP, base case, surface area-weighted pollutant distribution). Modeling domain out to 50 km is displayed.

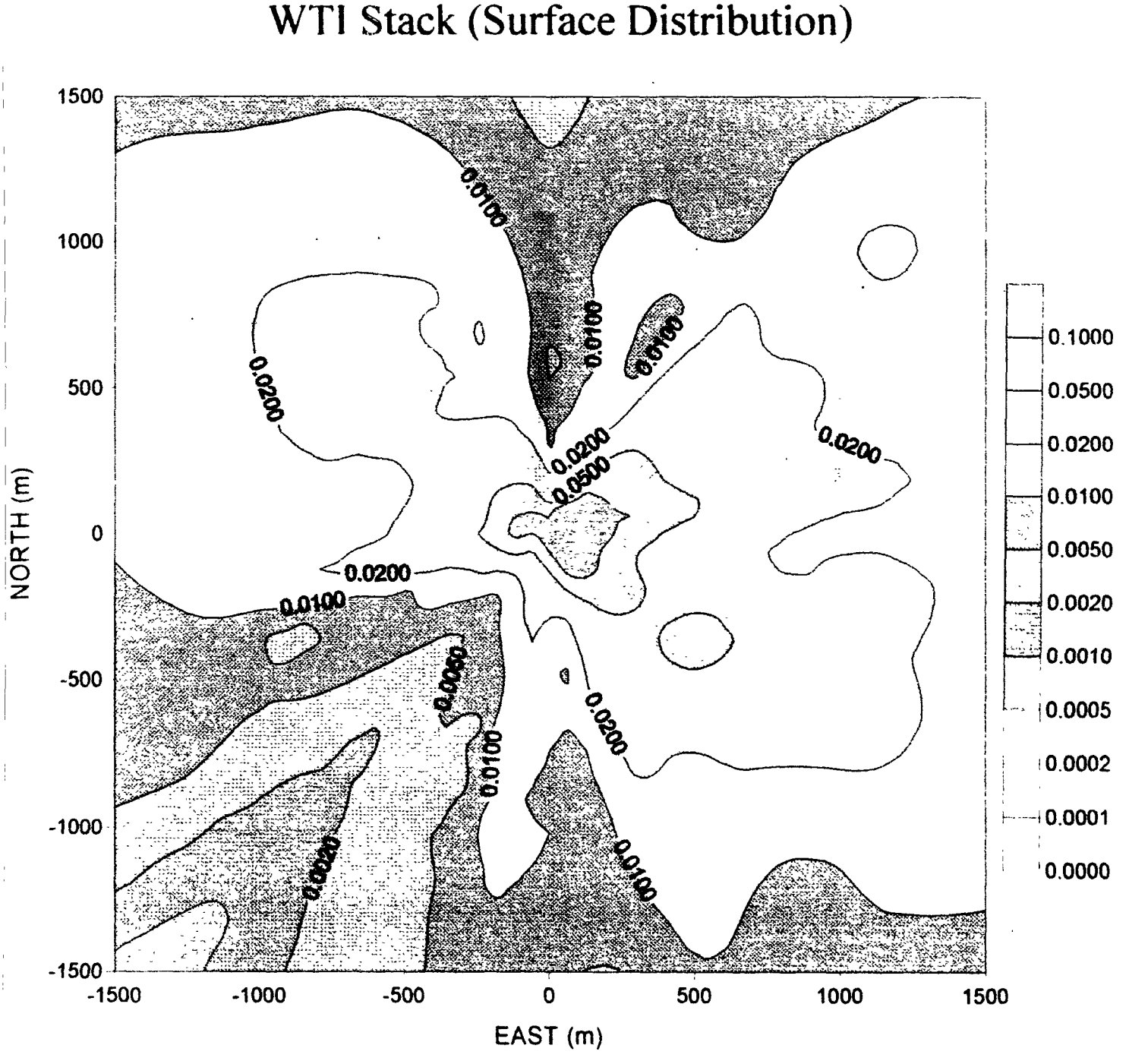

Figure IV-4-16. Annual total deposition fluxes (g/m^2) for the incinerator stack - Run 1b (ISC-COMPDEP, base case, surface area-weighted pollutant distribution). Modeling domain out to 1.5 km is displayed.

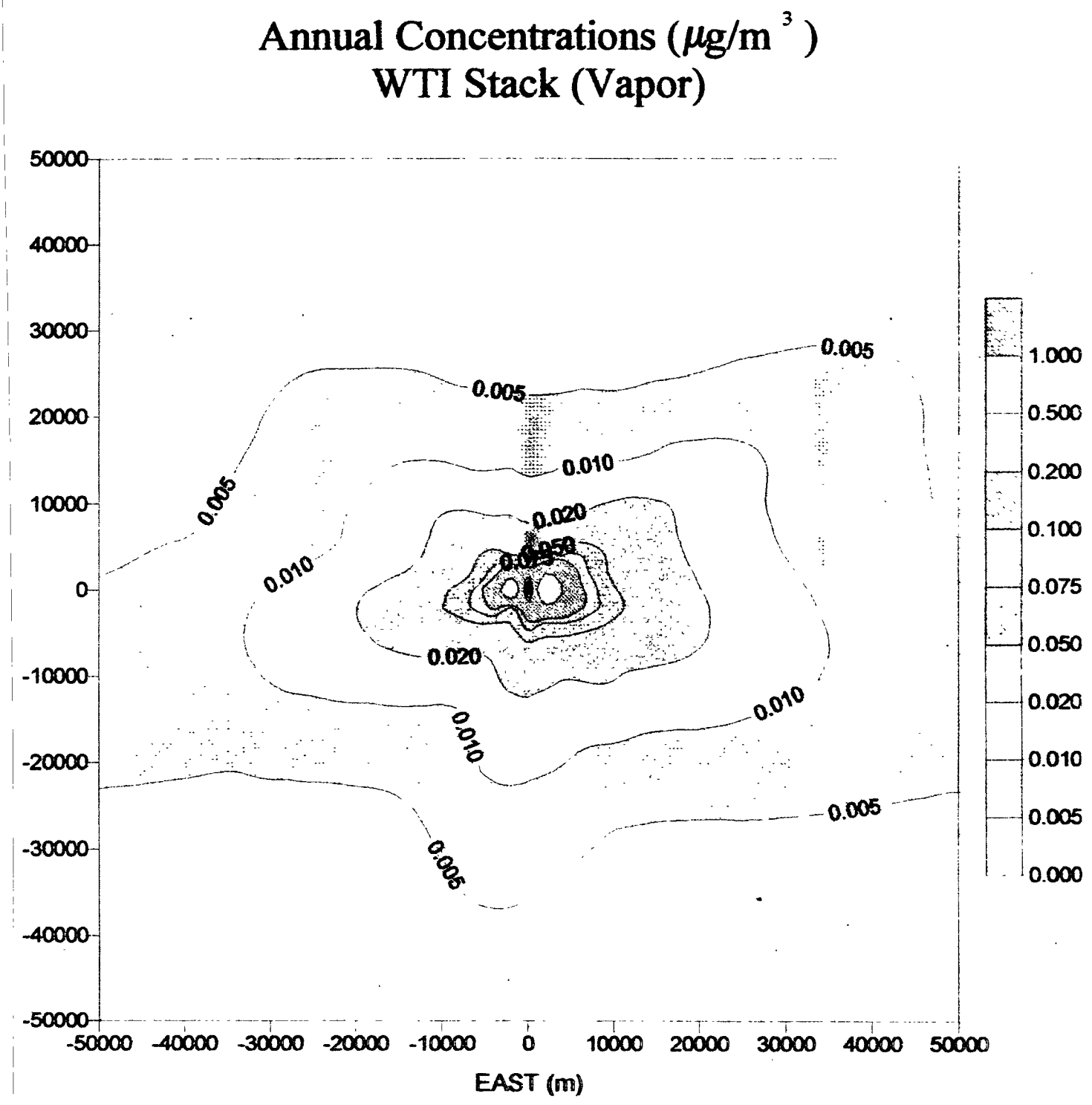

Figure IV-4-17. Annual average concentrations (μg/m^3) for the incinerator stack - Run 1c (ISC-COMPDEP, base case, vapor pollutant). Modeling domain out to 50 km is displayed.

Annual Concentrations ($\mu g/m^3$)
WTI Stack (Vapor)

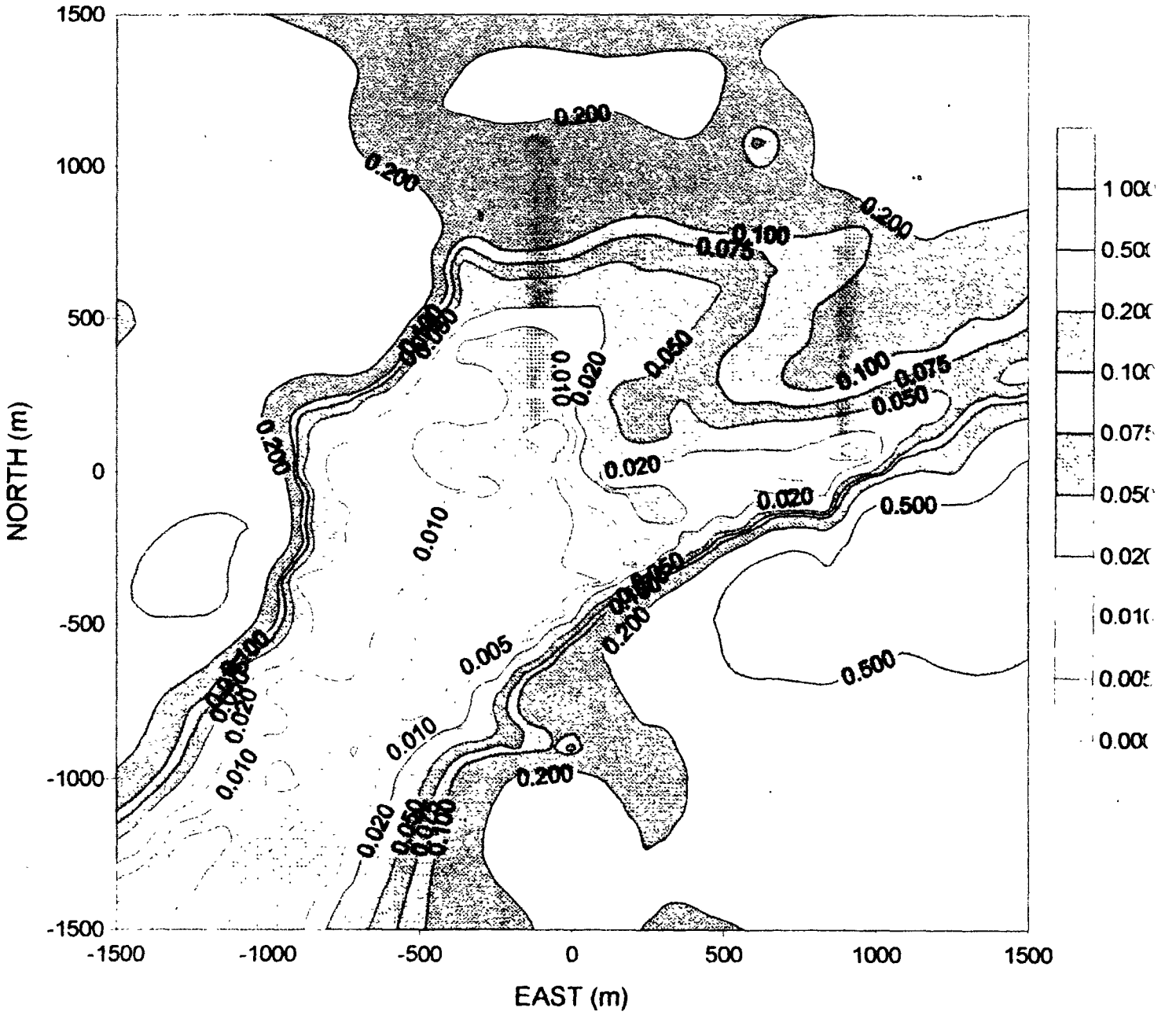

Figure IV-4-18. Annual average concentrations ($\mu g/m^3$) for the incinerator stack - Run 1c (ISC-COMPDEP, base case, vapor pollutant). Modeling domain out to 1.5 km is displayed.

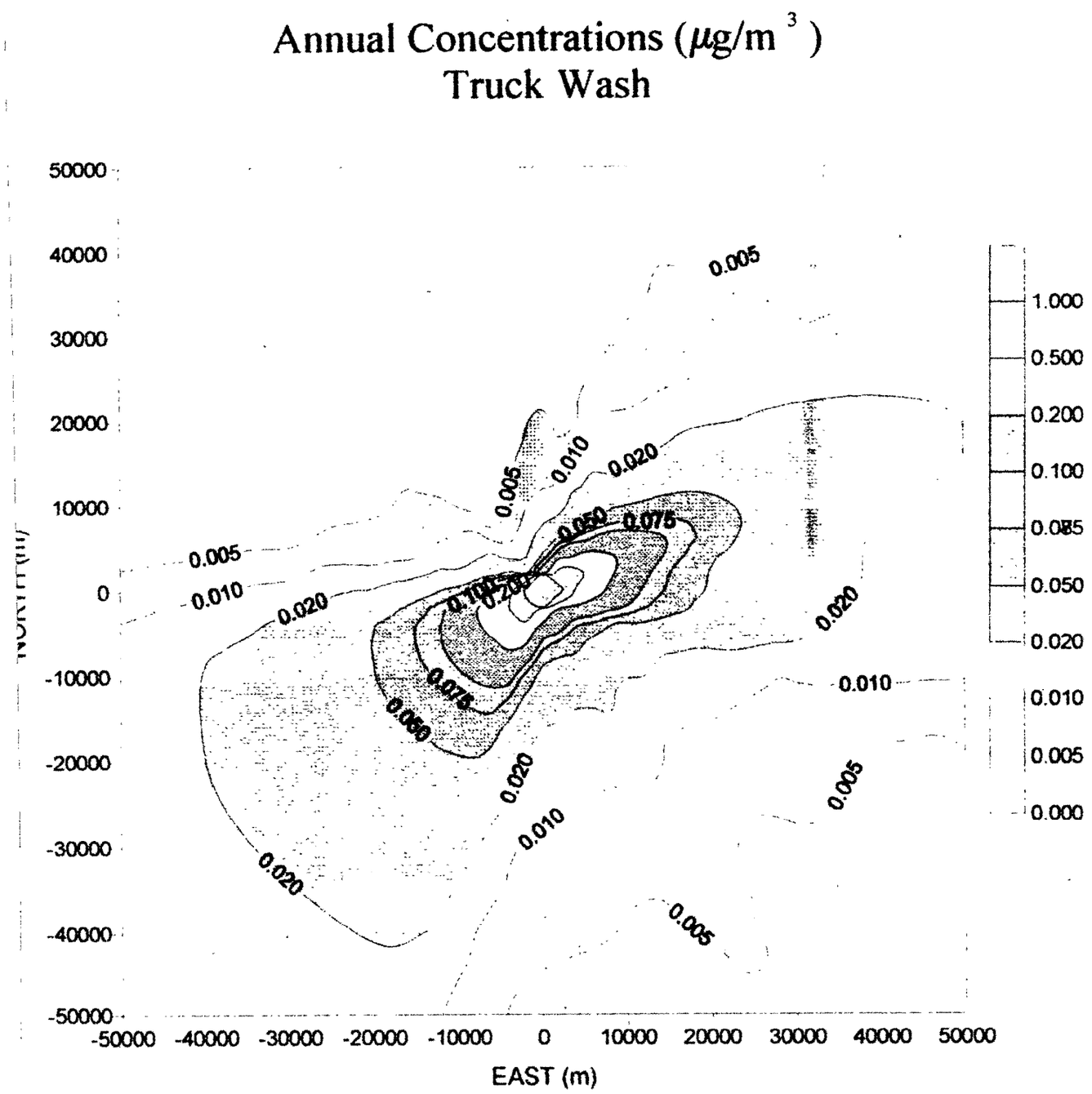

Figure IV-4-19. Annual average concentrations (μg/m^3) for the truck wash (ISC-COMPDEP, vapor pollutant). Modeling domain out to 50 km is displayed.

Annual Concentrations (μg/m ^{3})
Truck Wash

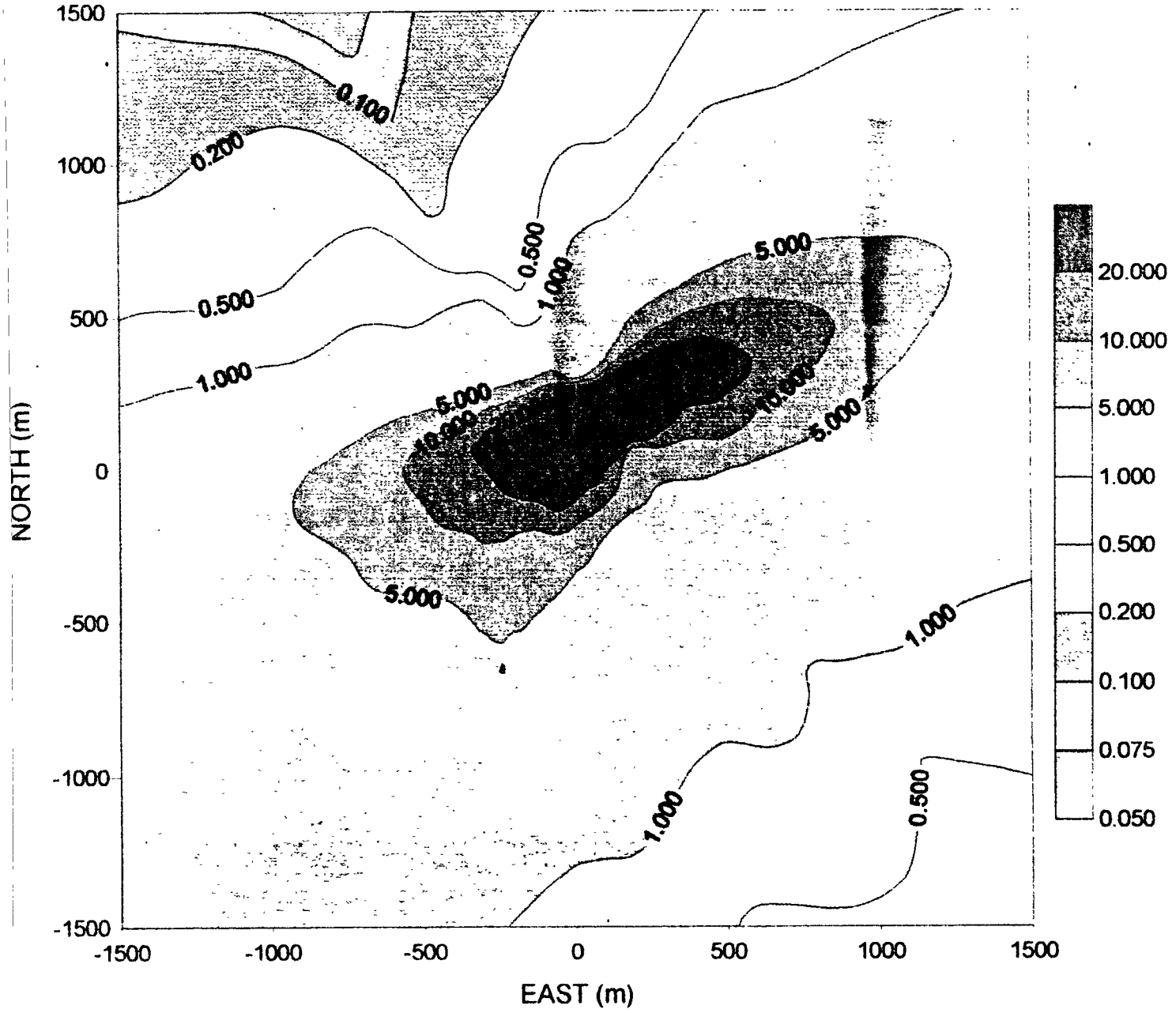

Figure IV-4-20. Annual average concentrations (μg/m^3) for the truck wash (ISC-COMPDEP, vapor pollutant). Modeling domain out to 1.5 km is displayed.

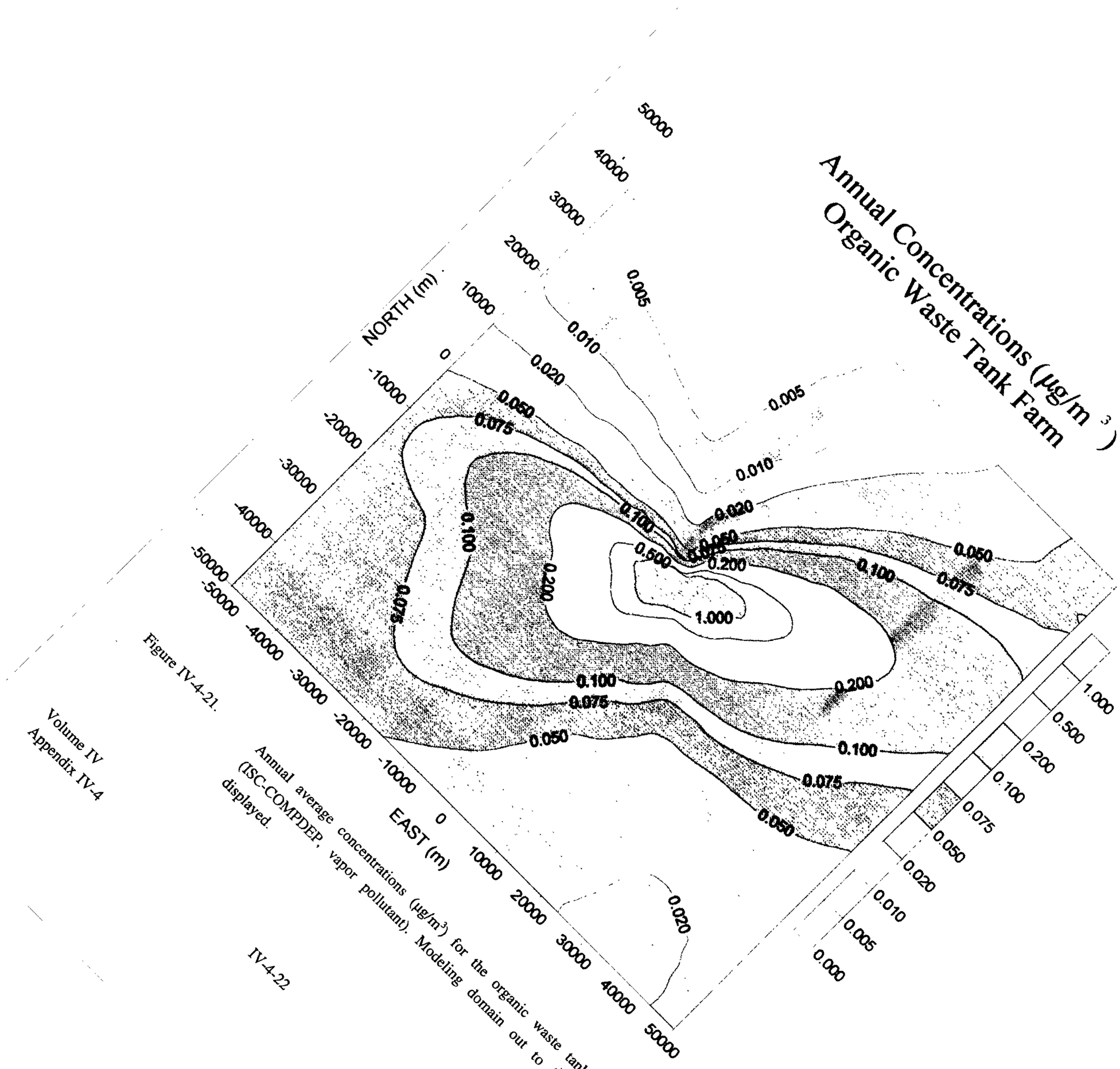

Figure IV-4-21. Annual average concentrations (μg/m^3) for the organic waste tank farm (ISC-COMPDEP, vapor pollutant). Modeling domain out to 50 km is displayed.

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Annual Concentrations ($\mu g/m^3$)
Organic Waste Tank Farm

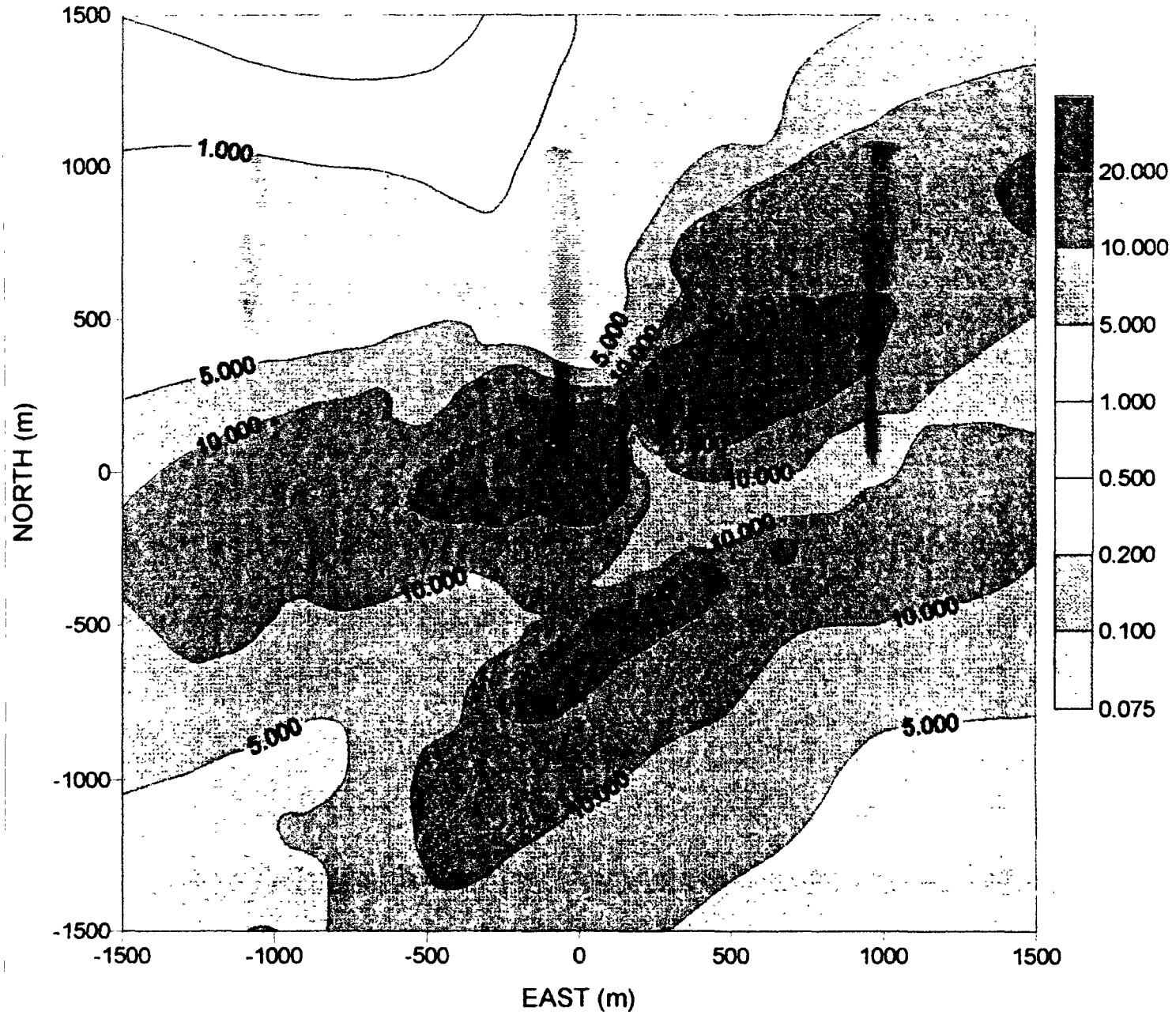


Figure IV-4-22. Annual average concentrations ($\mu g/m^3$) for the organic waste tank farm (ISC-COMPDEP, vapor pollutant). Modeling domain out to 1.5 km is displayed.

Annual Concentrations (μg/m ^{3})
Open Wastewater Tank

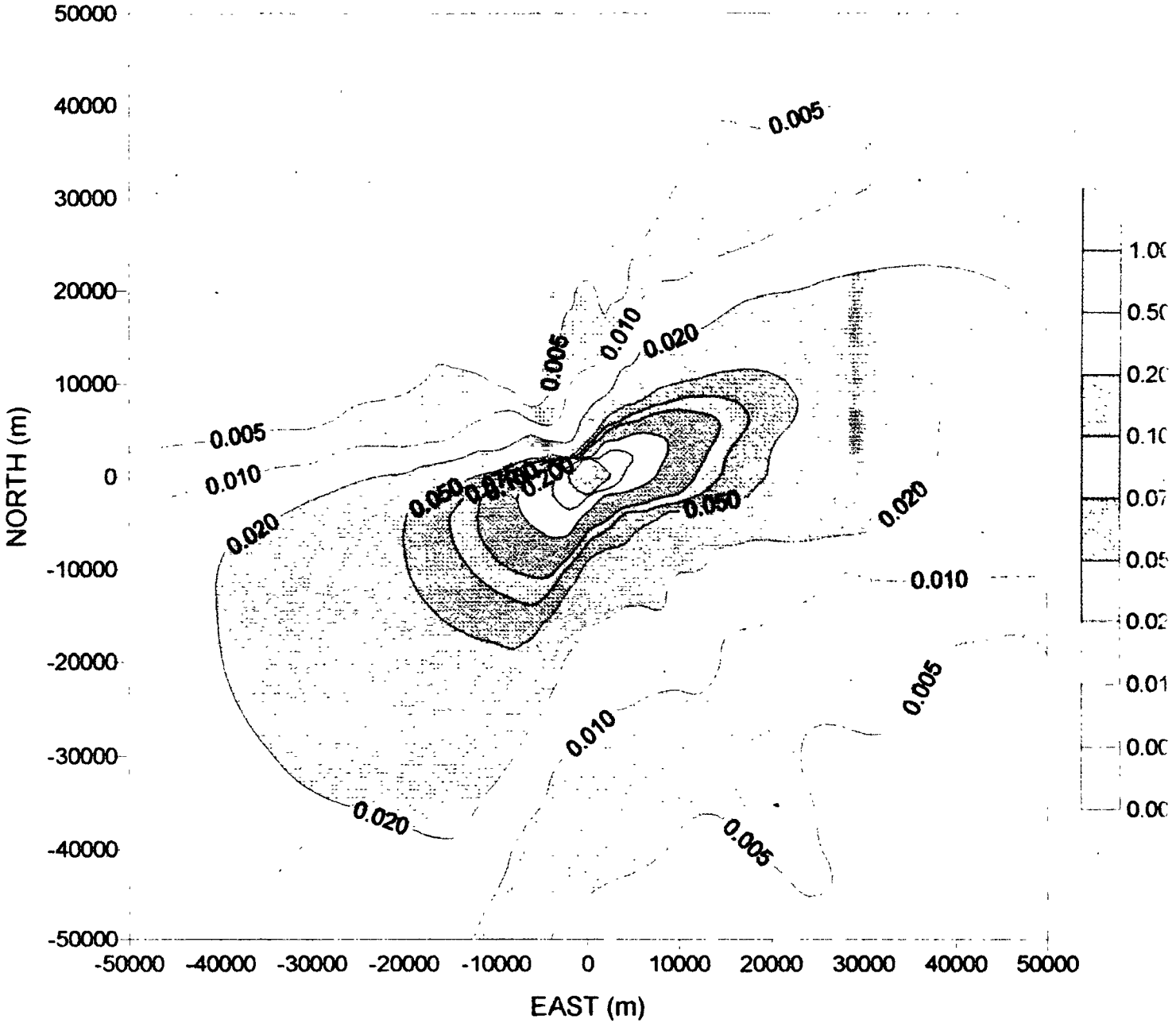


Figure IV-4-23. Annual average concentrations (μg/m^3) for the open wastewater tank (ISC-COMPDEP, vapor pollutant). Modeling domain out to 50 km is displayed.

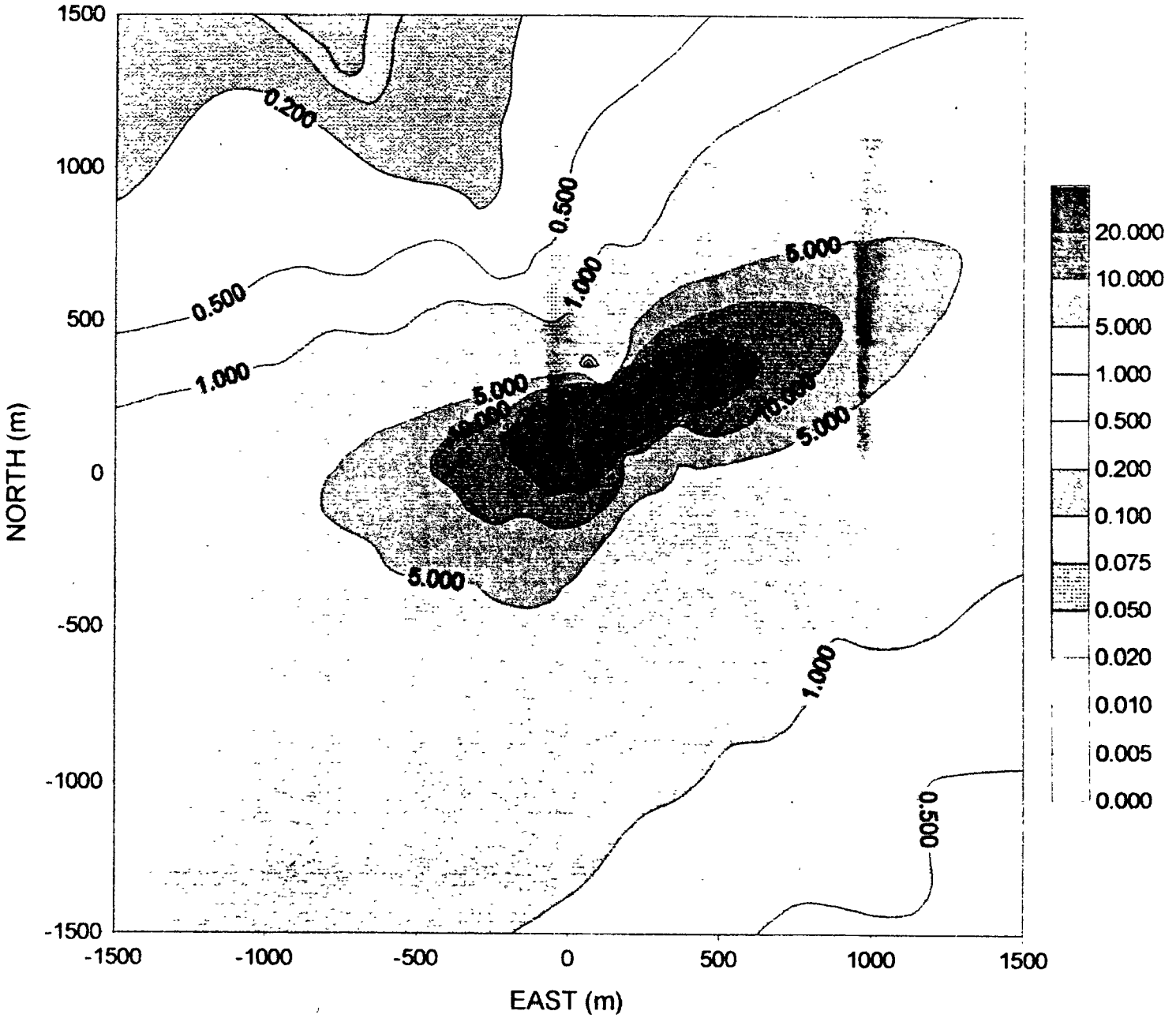


Figure IV-4-24. Annual average concentrations ($\mu g/m^3$) for the open wastewater tank (ISC-COMPDEP, vapor pollutant). Modeling domain out to 1.5 km is displayed.

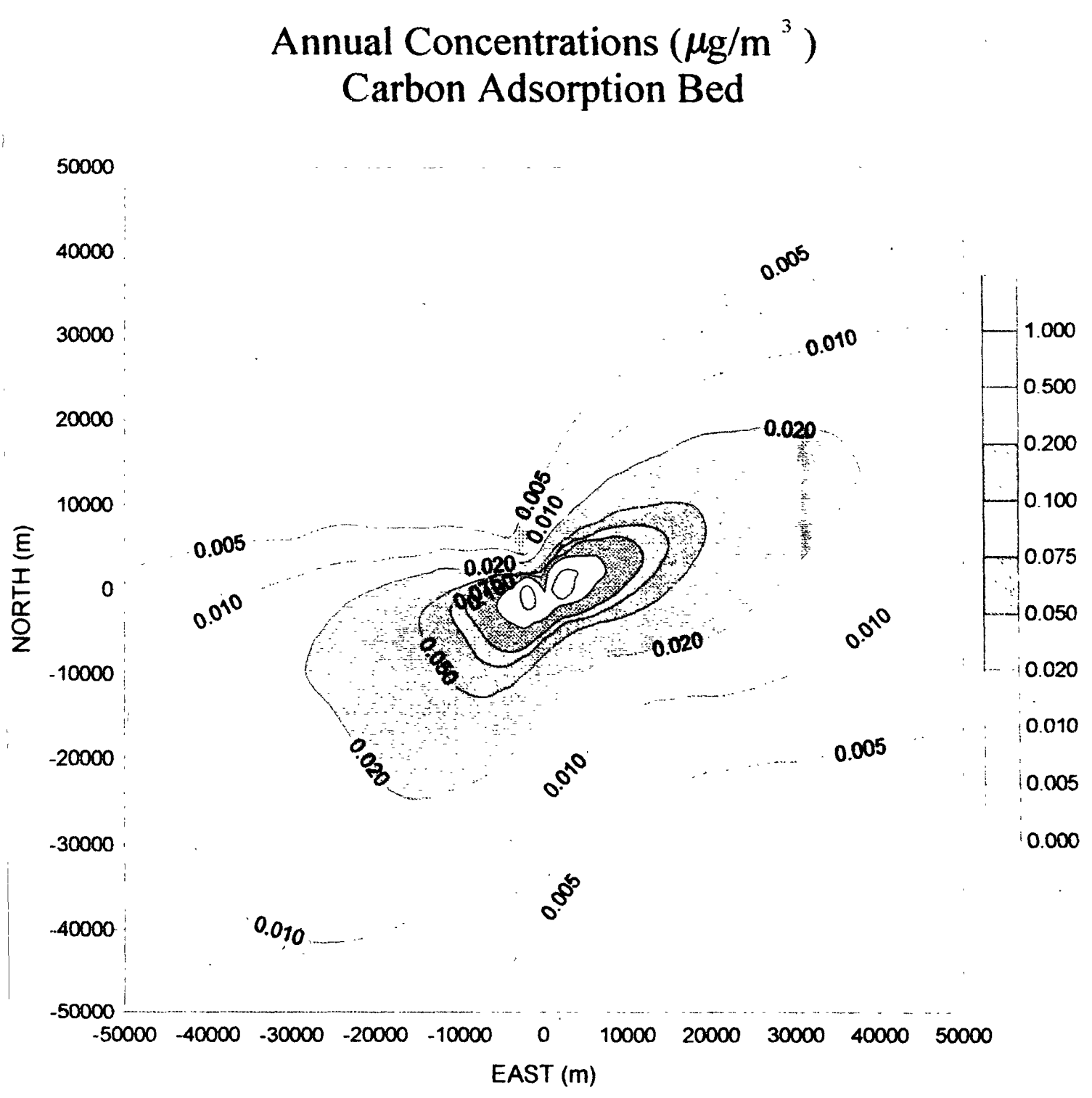
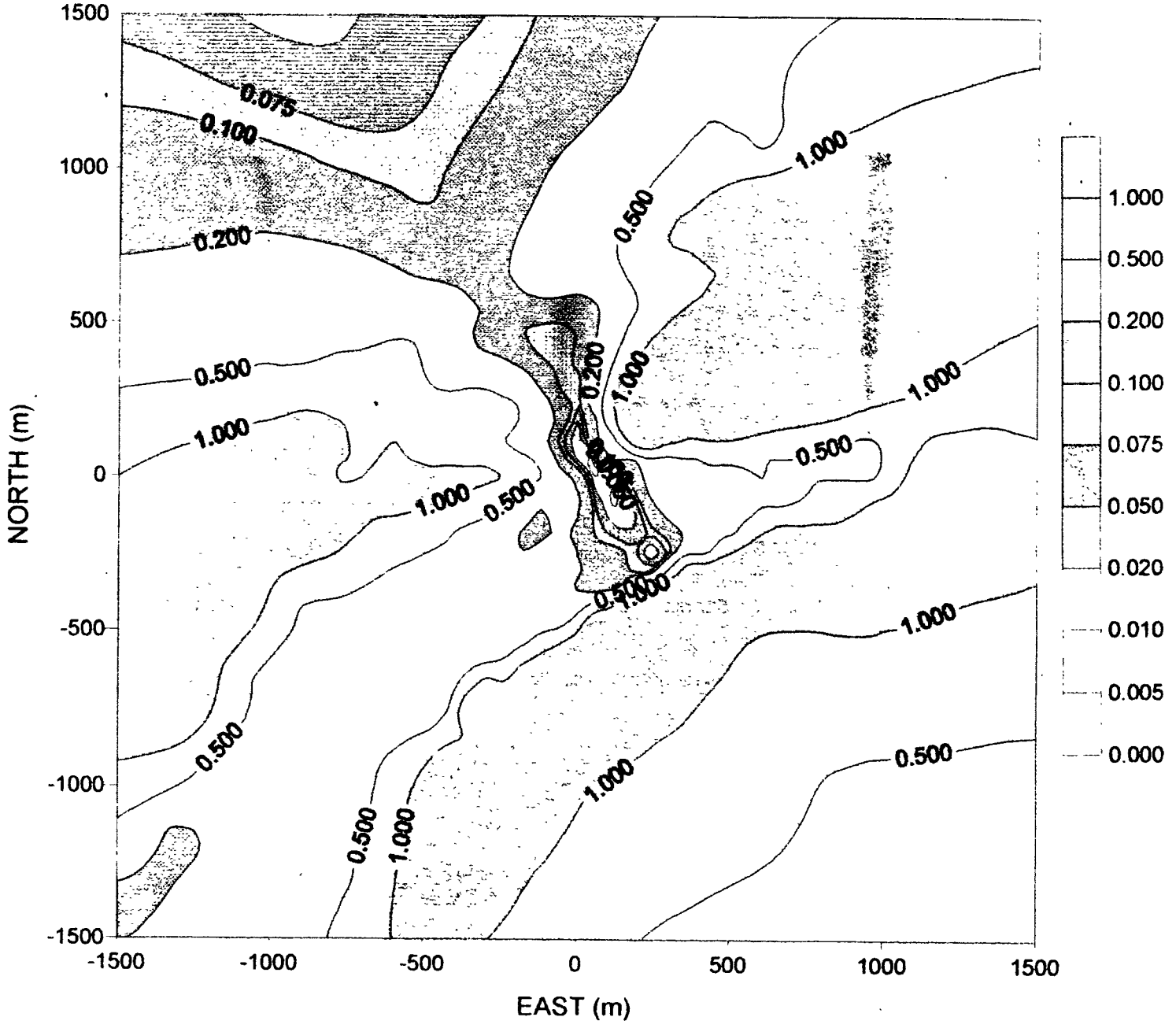


Figure IV-4-25. Annual average concentrations (μg/m^3) for the carbon adsorption bed (ISC-COMPDEP, vapor pollutant). Modeling domain out to 50 km is displayed.

Annual Concentrations ($\mu g/m^3$)
Carbon Adsorption Bed


1500
1000
500
0
-500
-1000
-1500
NORTH (m)
-1500
-1000
-500
0
500
1000
1500
EAST (m)
0.075
0.100
0.200
0.500
1.000
1.000
0.500
0.200
1.000
1.000
0.500
1.000
0.500
0.500
1.000
1.000
0.500
0.500
1.000
1.000
0.500
1.000
0.500
1.000
0.500

Annual Concentrations ($\mu g/m^3$)
Ash Handling (Mass Distribution)

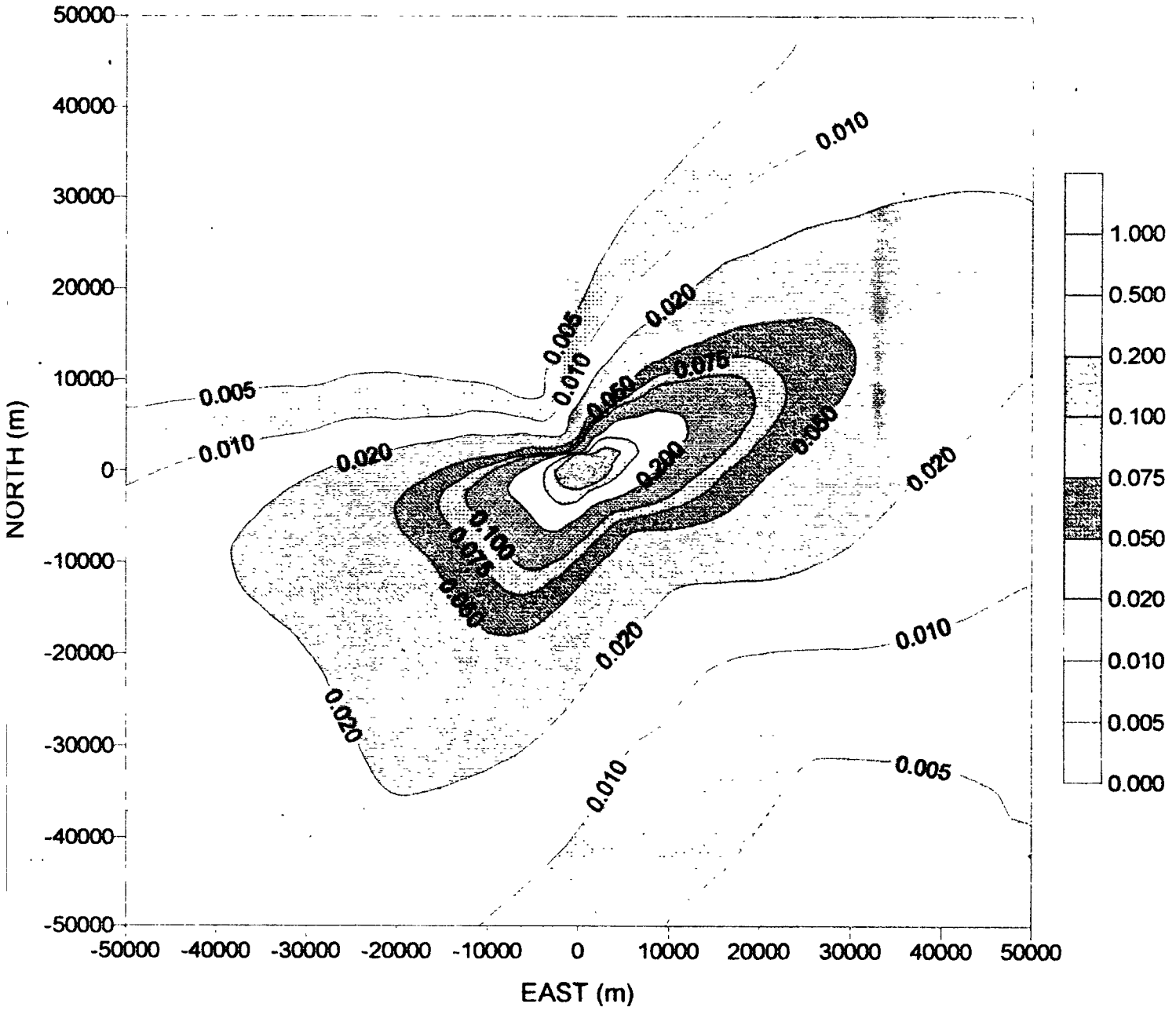


Figure IV-4-27. Annual average concentrations ($\mu g/m^3$) for the ash handling stack (ISC-COMPDEP, mass-weighted pollutant distribution). Modeling domain out to 50 km is displayed.

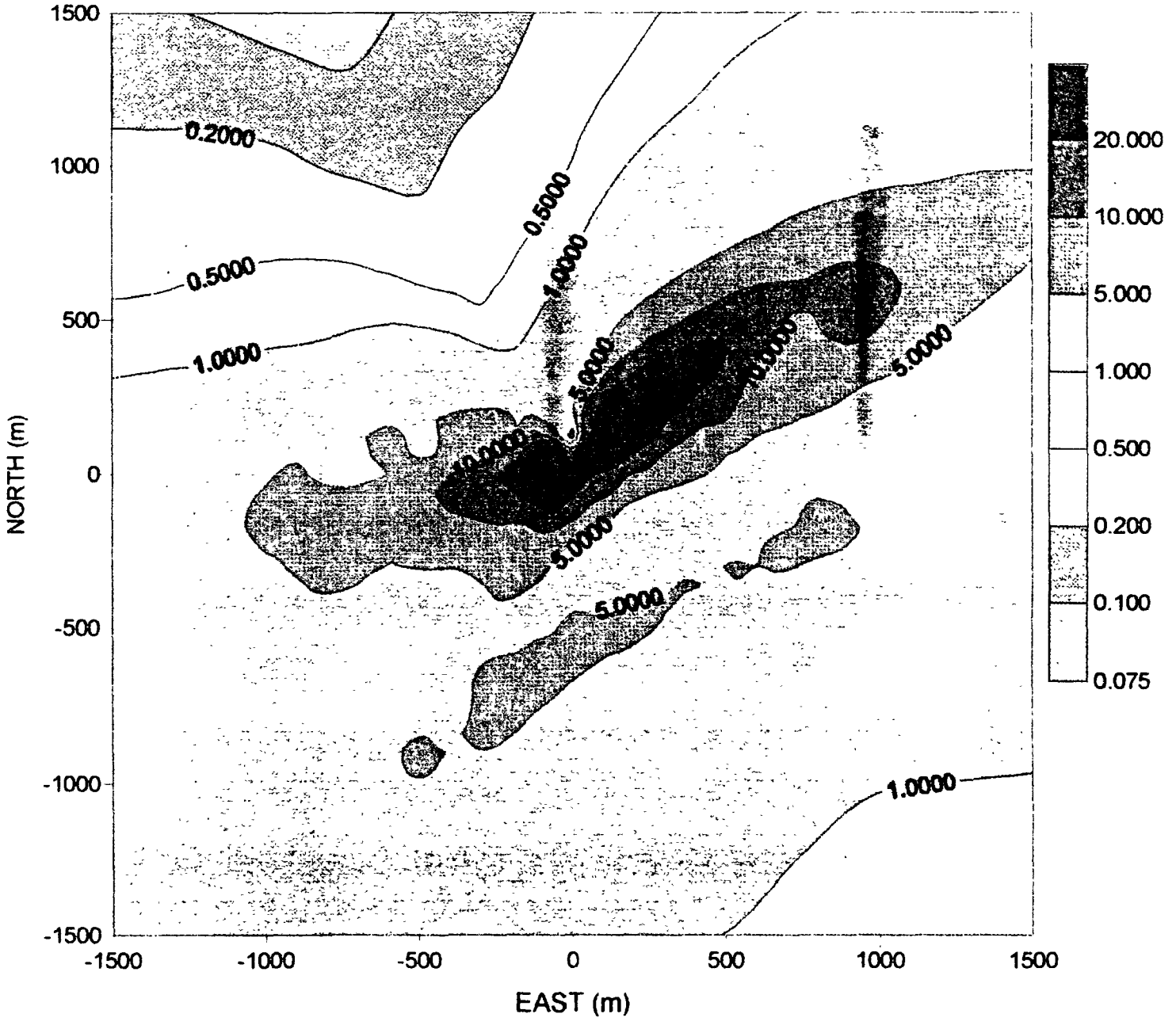


Figure IV-4-28. Annual average concentrations ($\mu g/m^3$) for the ash handling stack (ISC-COMPDEP, mass-weighted pollutant distribution). Modeling domain out to 1.5 km is displayed.

Annual Wet Deposition (g/m^2)
Ash Handling (Mass Distribution)

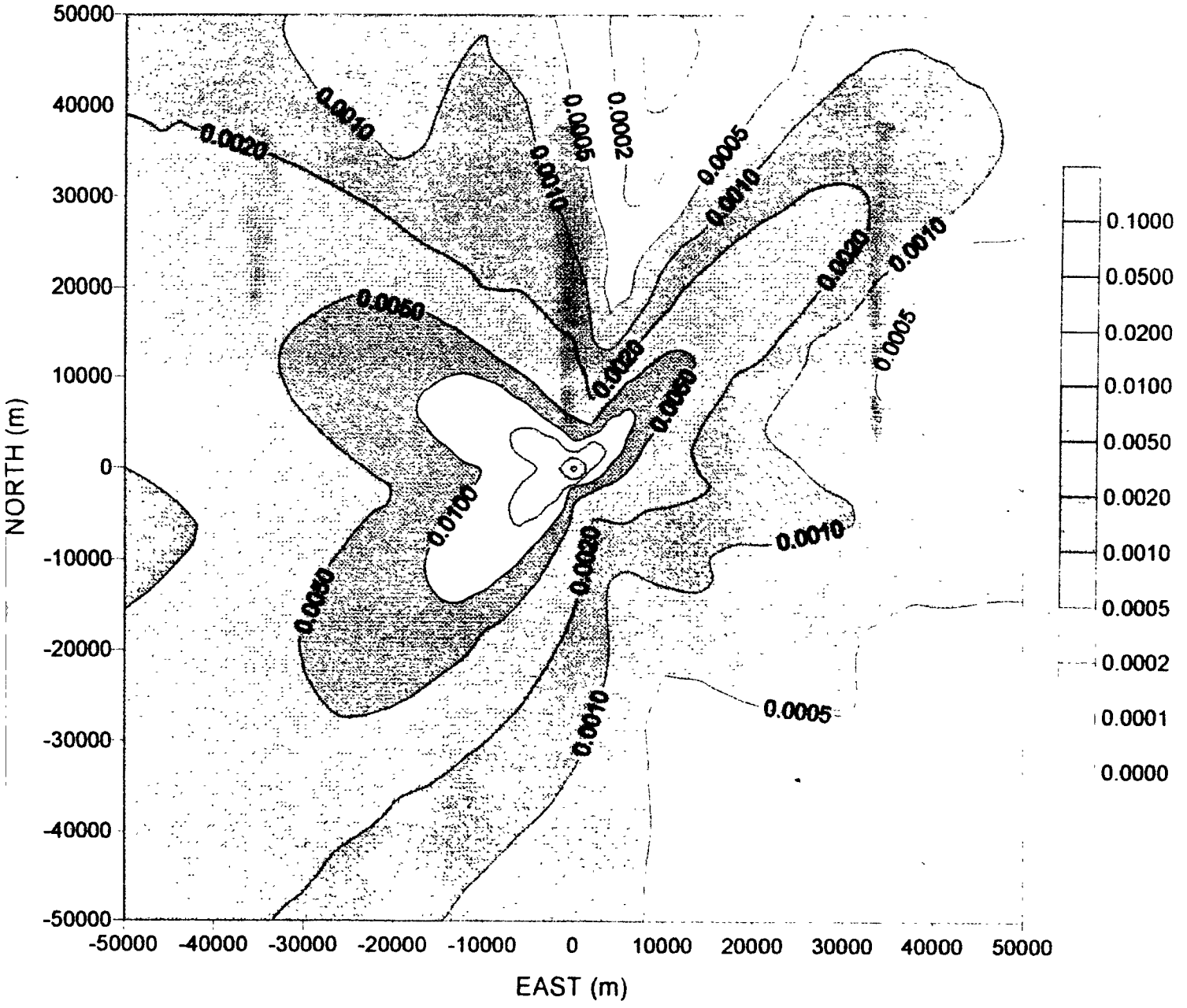


Figure IV-4-29. Annual wet deposition fluxes (g/m^2) for the ash handling stack (ISC-COMPDEP, mass-weighted pollutant distribution). Modeling domain out to 50 km is displayed.

Annual Wet Deposition (g/m^2)
Ash Handling (Mass Distribution)

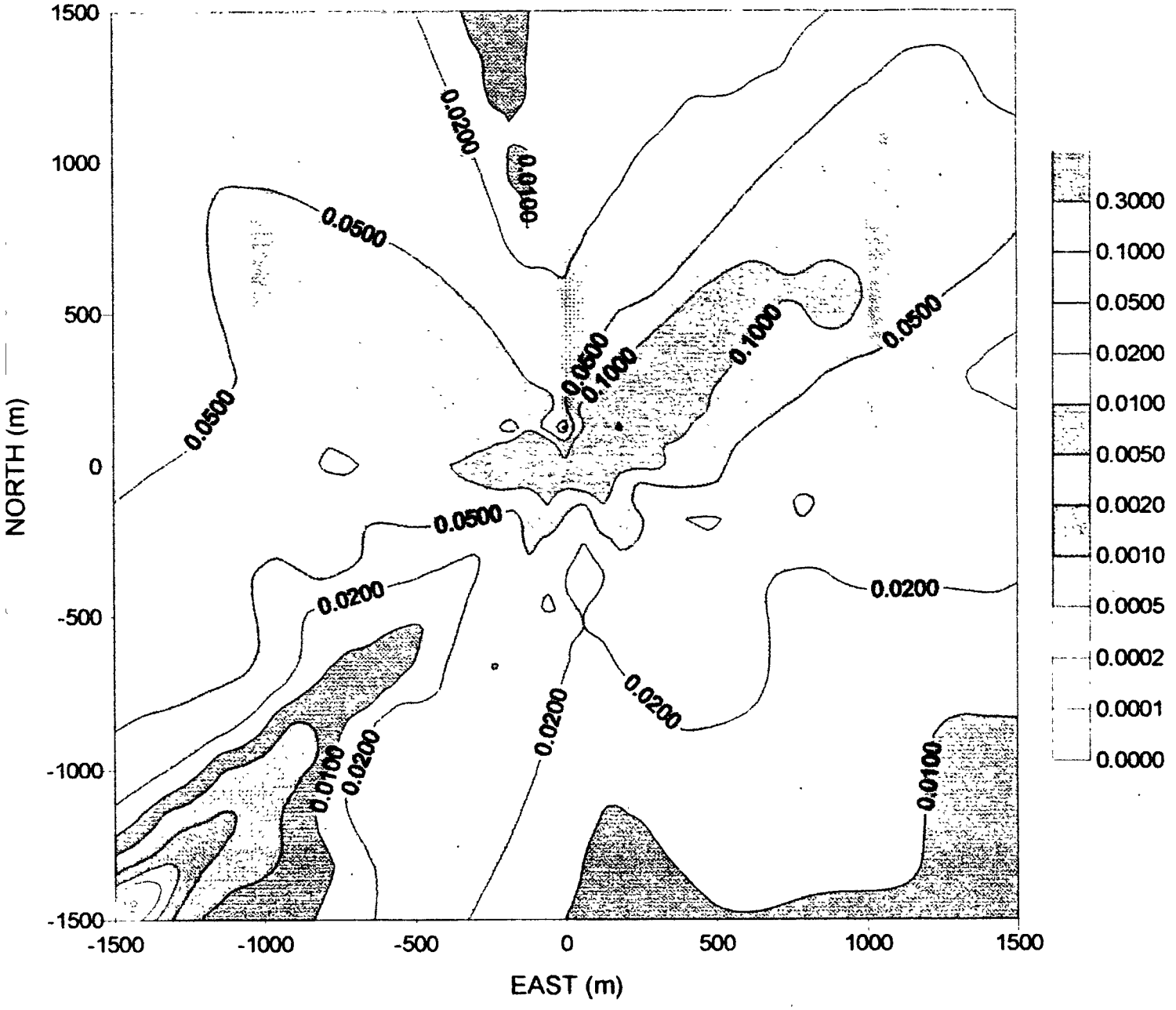


Figure IV-4-30. Annual wet deposition fluxes (g/m^2) for the ash handling stack (ISC-COMPDEP, mass-weighted pollutant distribution). Modeling domain out to 1.5 km is displayed.

Annual Dry Deposition (g/m^2)
Ash Handling (Mass Distribution)

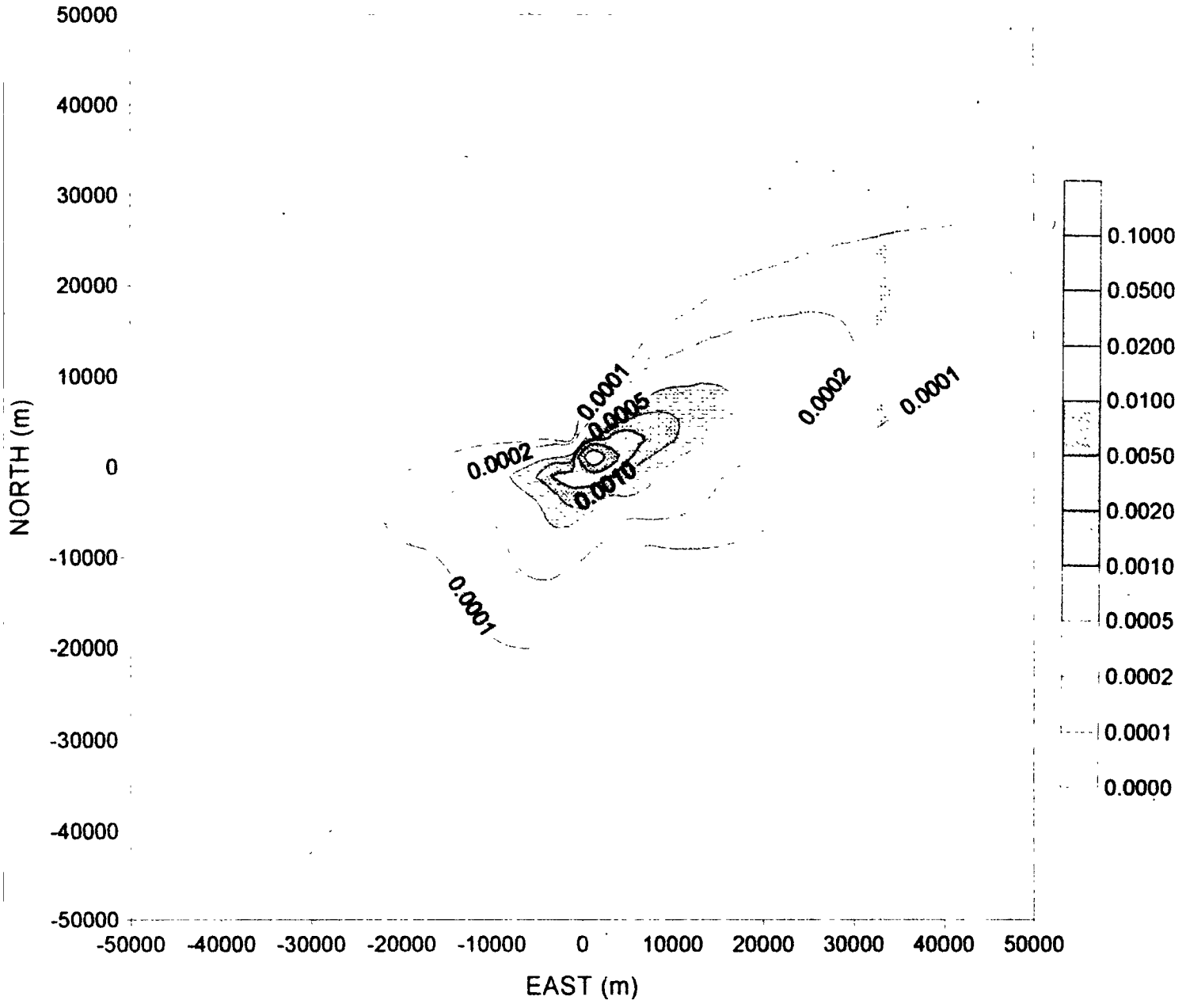


Figure IV-4-31. Annual dry deposition fluxes (g/m^2) for the ash handling stack (ISC-COMPDEP, mass-weighted pollutant distribution). Modeling domain out to 50 km is displayed.

Annual Dry Deposition (g/m^2)
Ash Handling (Mass Distribution)

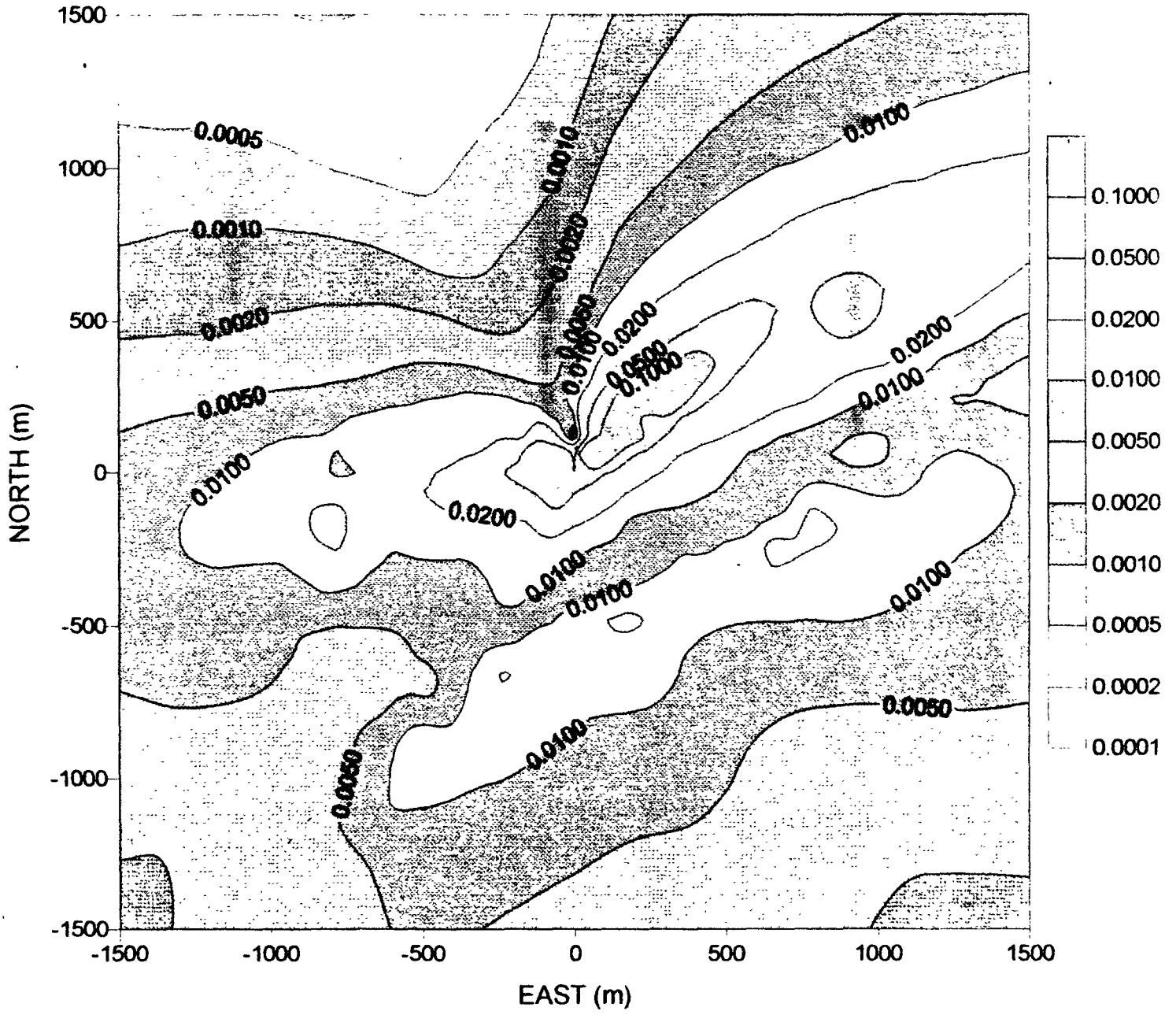


Figure IV-4-32. Annual dry deposition fluxes (g/m^2) for the ash handling stack (ISC-COMPDEP, mass-weighted pollutant distribution). Modeling domain out to 1.5 km is displayed.

Total Annual Deposition (g/m^2)
Ash Handling (Mass Distribution)

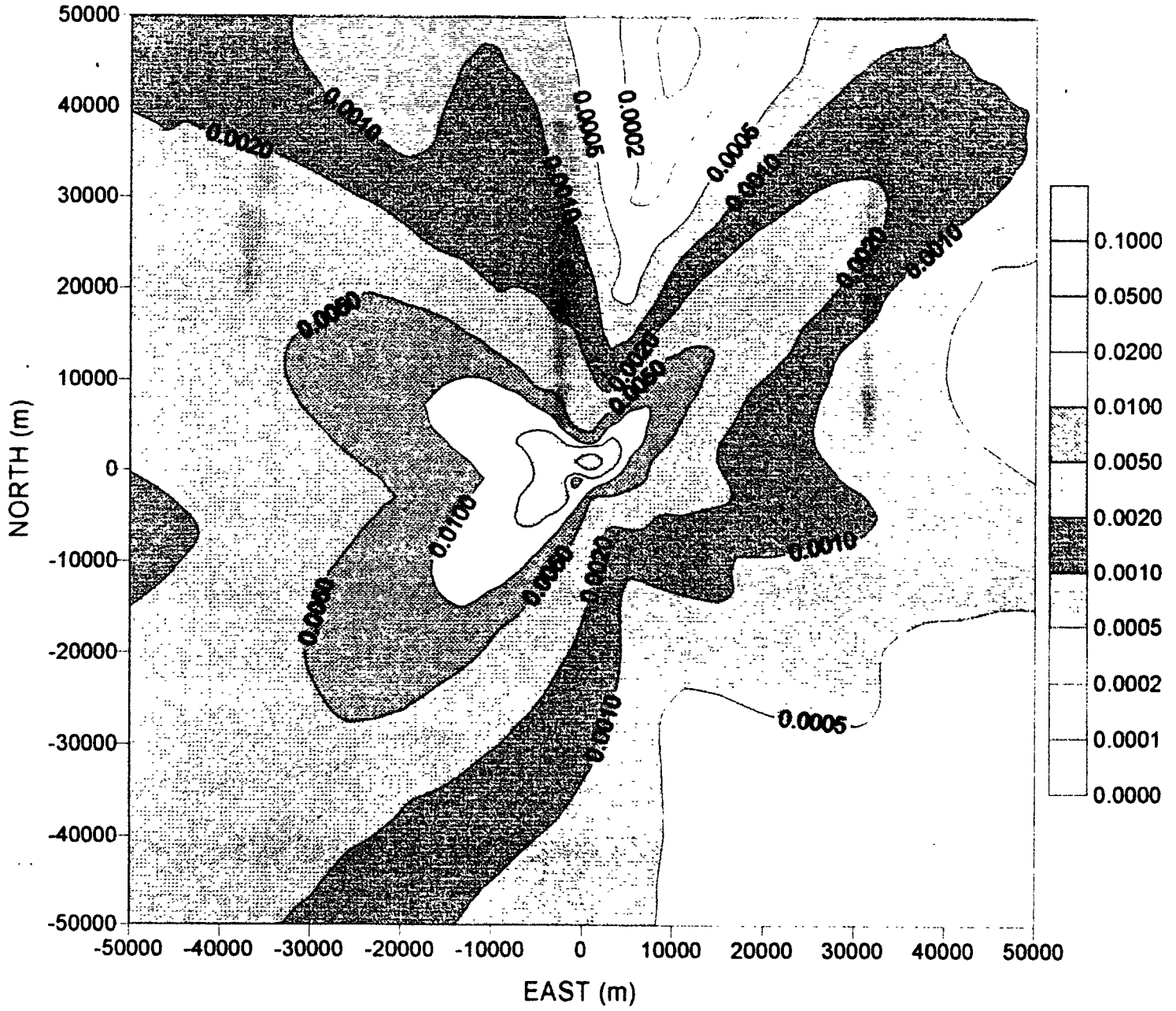


Figure IV-4-33. Annual total deposition fluxes (g/m^2) for the ash handling stack (ISC-COMPDEP, mass-weighted pollutant distribution). Modeling domain out to 50 km is displayed.

Total Annual Deposition (g/m ^{2})
Ash Handling (Mass Distribution)

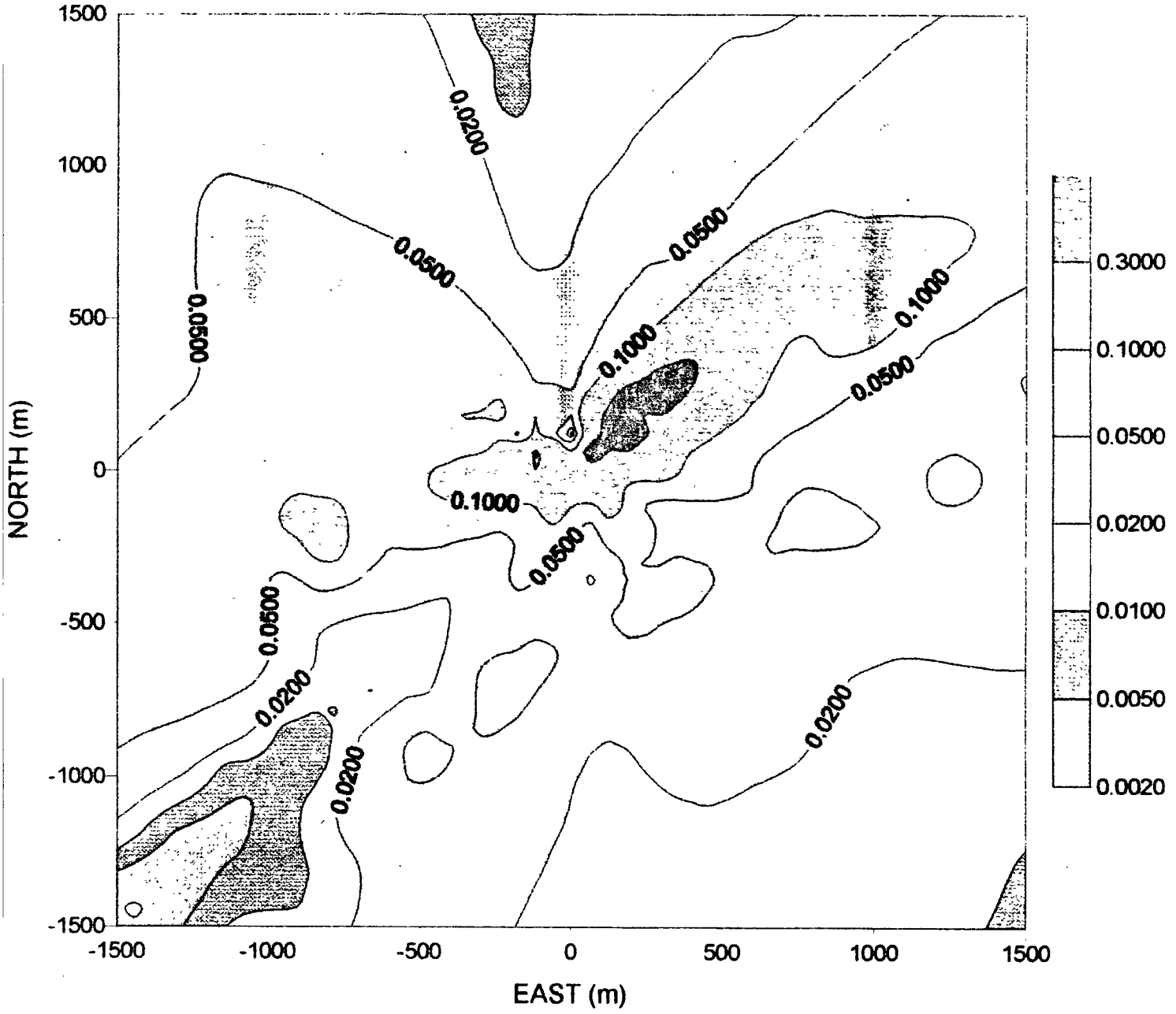


Figure IV-4-34. Annual total deposition fluxes (g/m^2) for the ash handling stack (ISC-COMPDEP, mass-weighted pollutant distribution). Modeling domain out to 1.5 km is displayed.

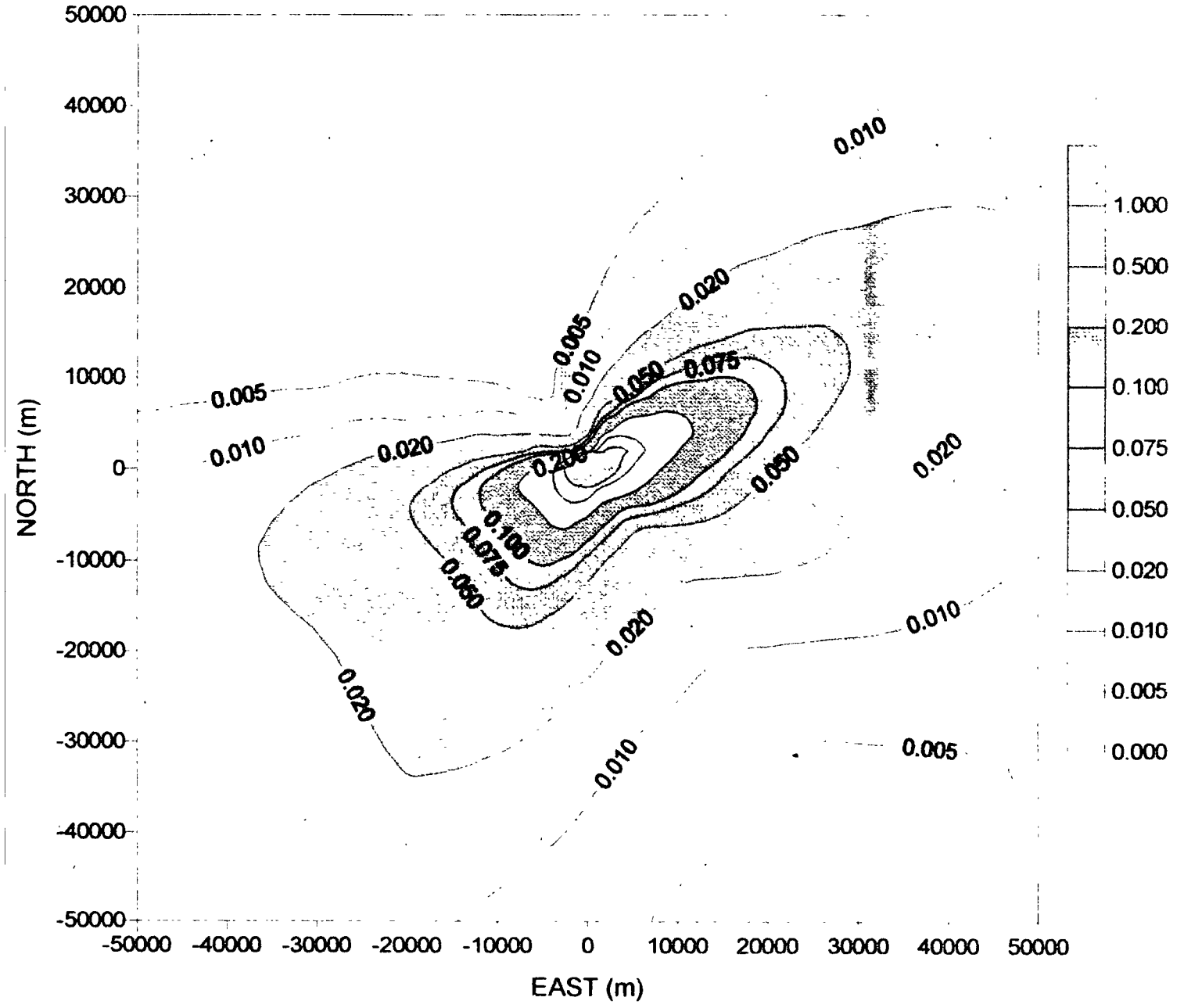


Figure IV-4-35. Annual average concentrations (μg/m^3) for the ash handling stack (ISC-COMPDEP, surface area-weighted pollutant distribution). Modeling domain out to 50 km is displayed.

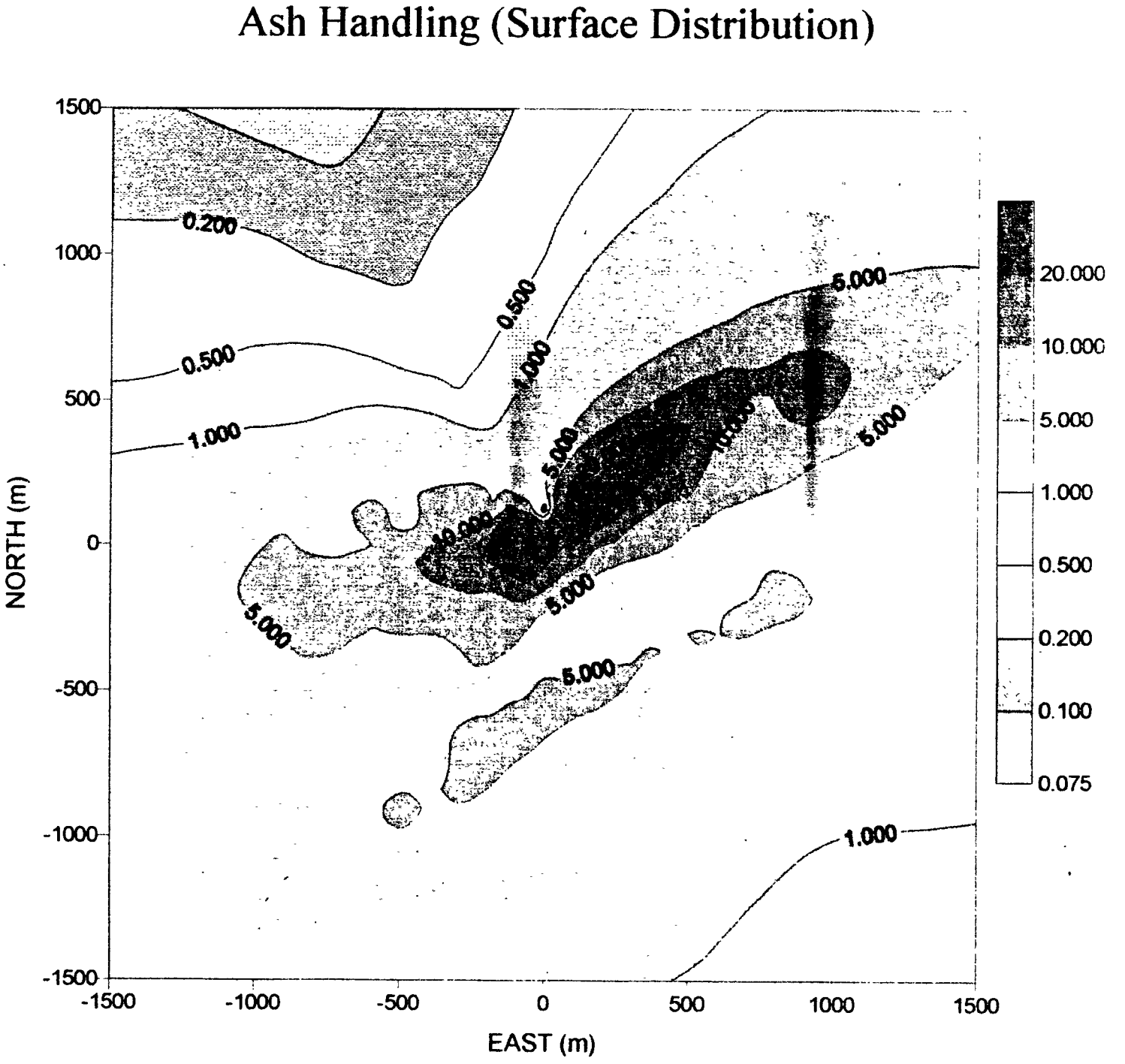


Figure IV-4-36. Annual average concentrations (μg/m^3) for the ash handling stack (ISC-COMPDEP, surface area-weighted pollutant distribution). Modeling domain out to 1.5 km is displayed.

Annual Wet Deposition (g/m^2)
Ash Handling (Surface Distribution)

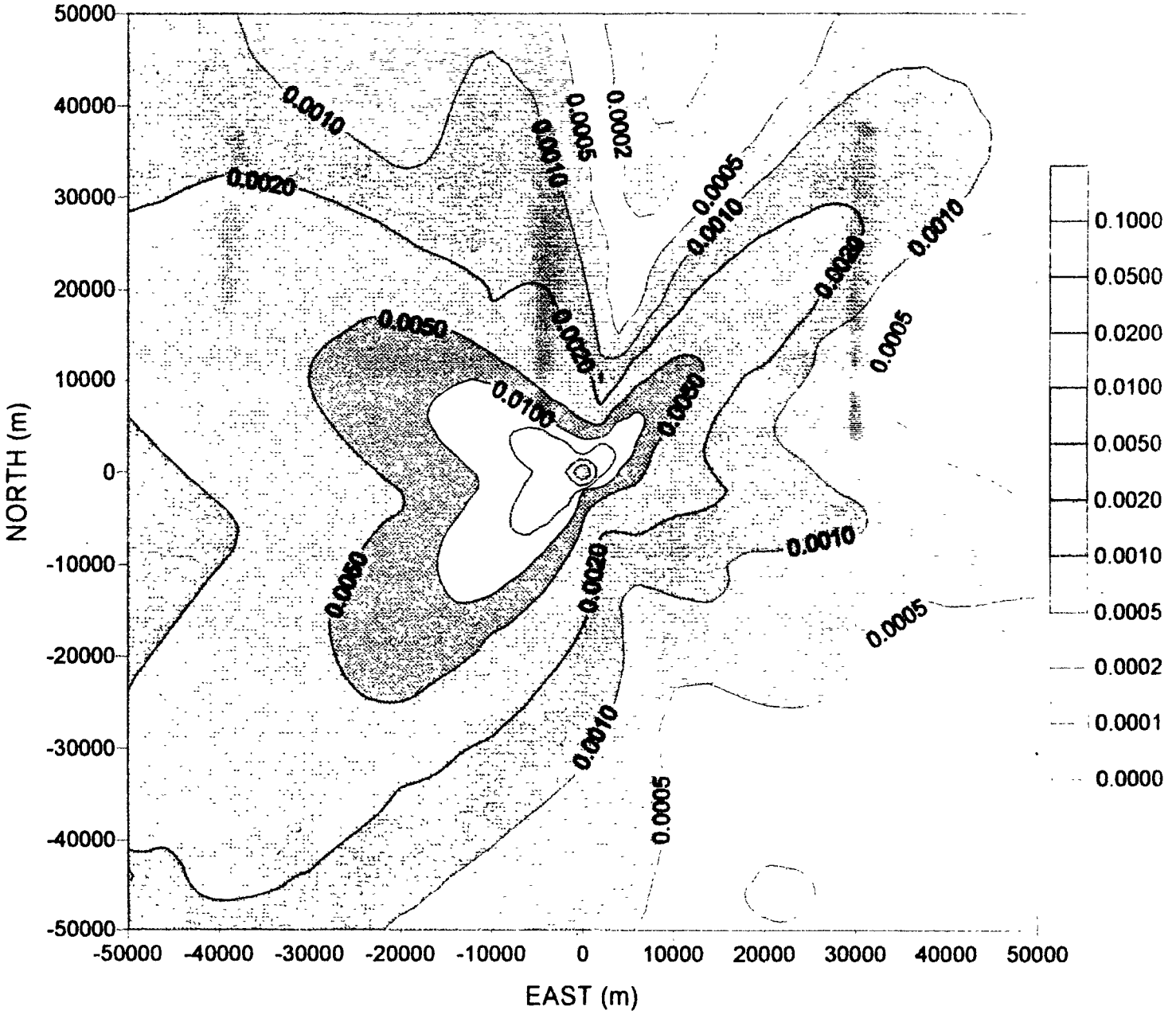


Figure IV-4-37. Annual wet deposition fluxes (g/m^2) for the ash handling stack (ISC-COMPDEP, surface area-weighted pollutant distribution). Modeling domain out to 50 km is displayed.

Annual Wet Deposition (g/m^2)
Ash Handling (Surface Distribution)

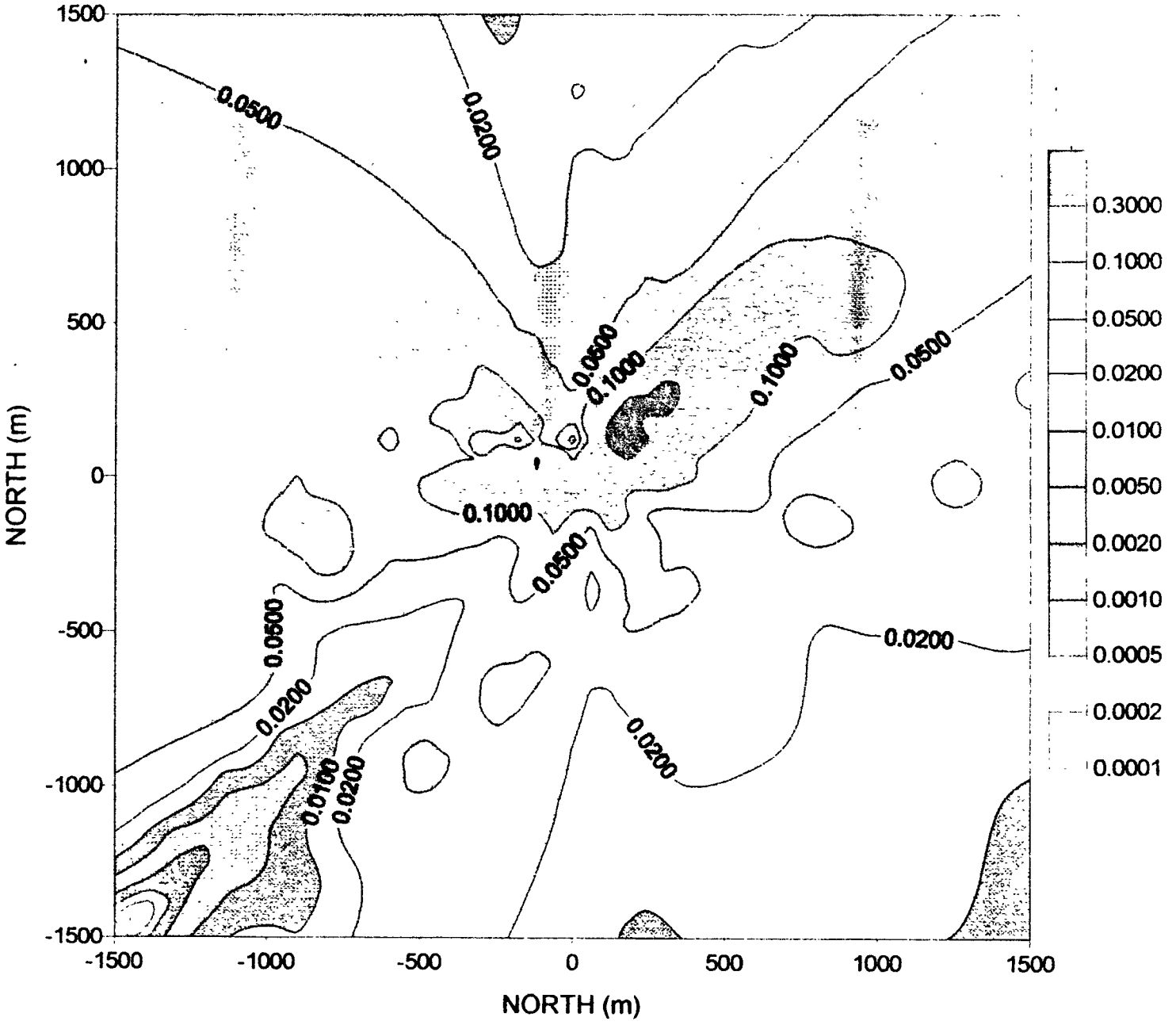


Figure IV-4-38. Annual wet deposition fluxes (g/m^2) for the ash handling stack (ISC-COMPDEP, surface area-weighted pollutant distribution). Modeling domain out to 1.5 km is displayed.

Annual Dry Deposition (g/m^2)
Ash Handling (Surface Distribution)

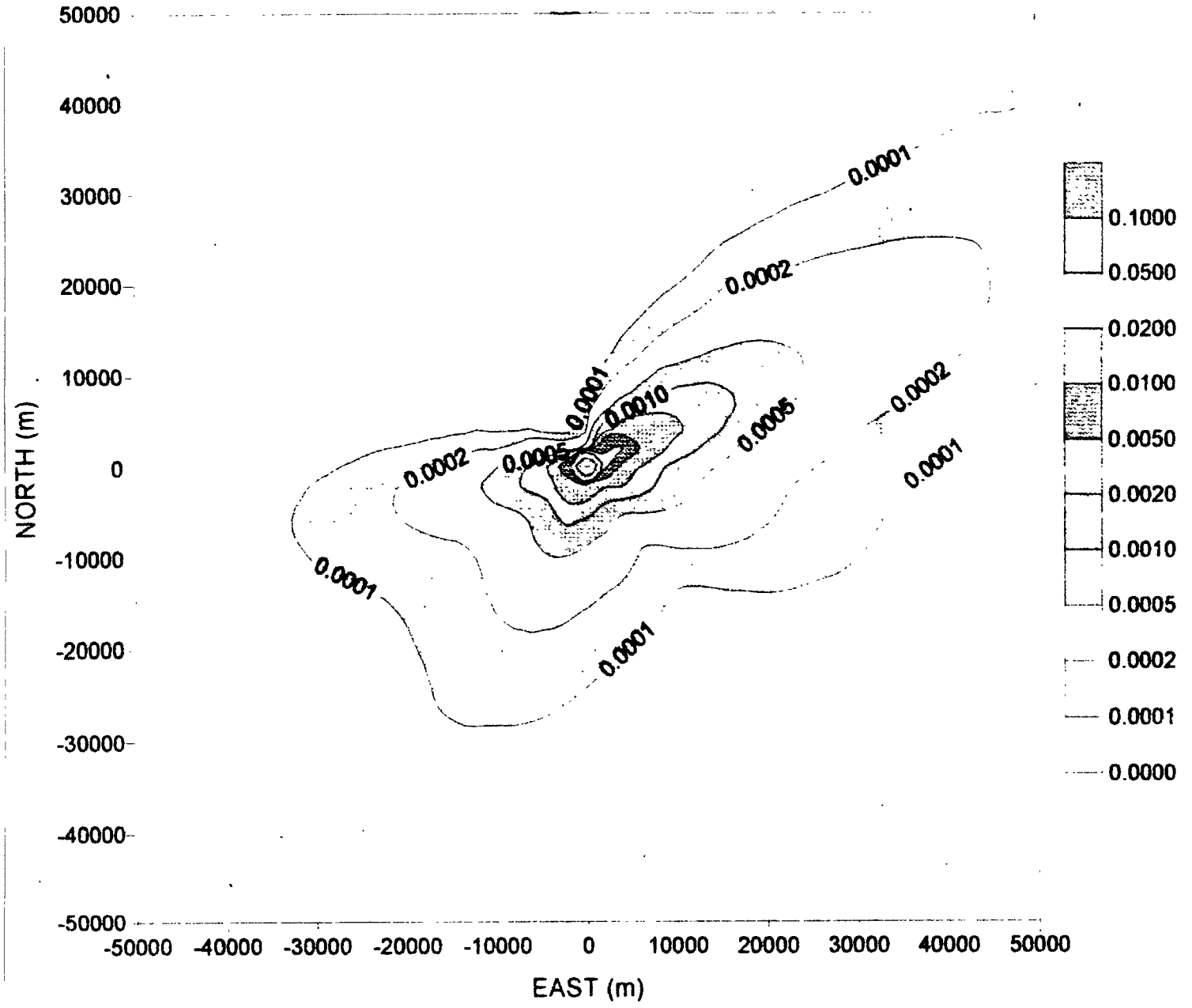


Figure IV-4-39. Annual dry deposition fluxes (g/m^2) for the ash handling stack (ISC-COMPDEP, surface area-weighted pollutant distribution). Modeling domain out to 50 km is displayed.

Annual Dry Deposition (g/m^2)
Ash Handling (Surface Distribution)

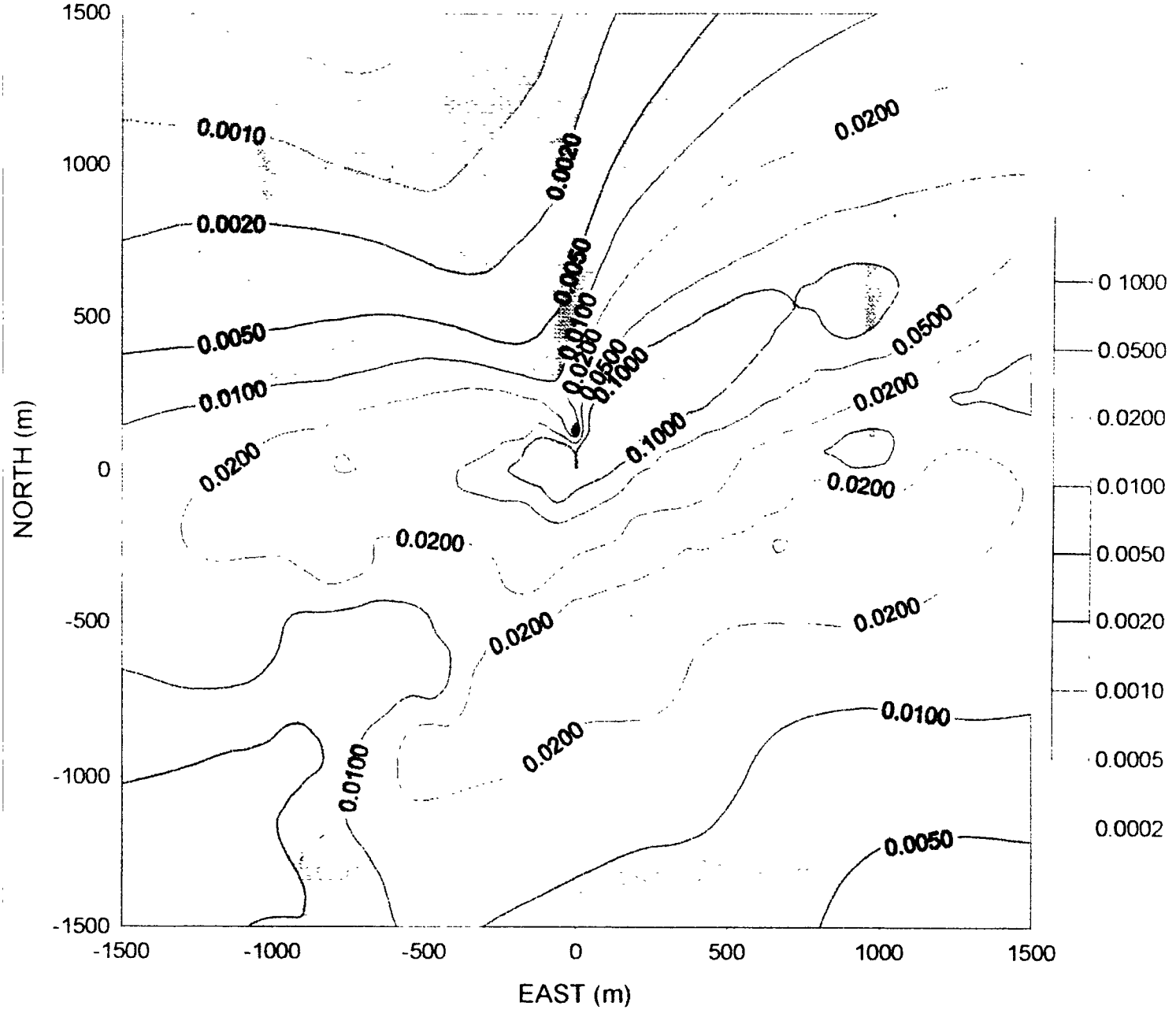


Figure IV-4-40. Annual dry deposition fluxes (g/m^2) for the ash handling stack (ISC-COMPDEP, surface area-weighted pollutant distribution). Modeling domain out to 1.5 km is displayed.

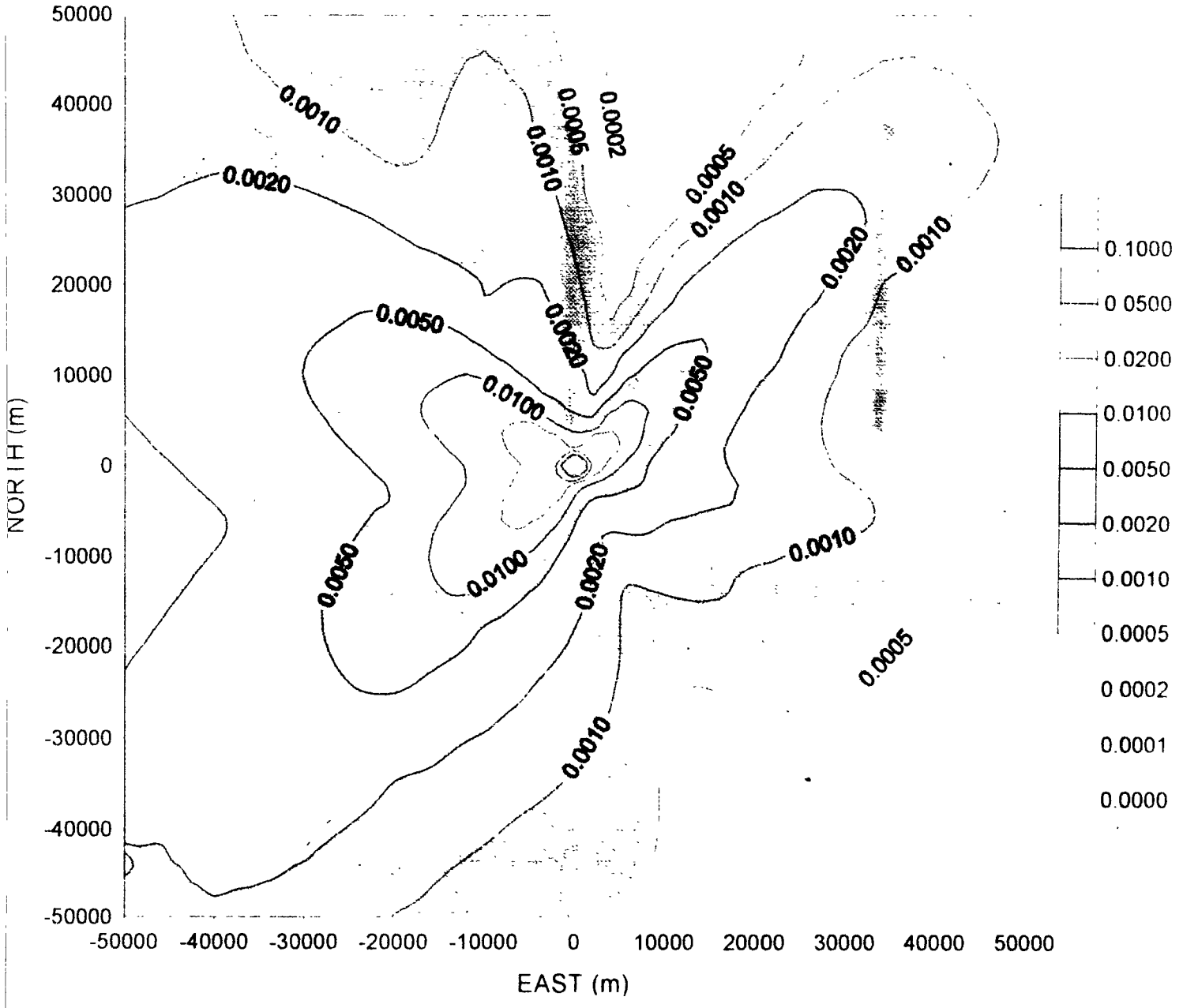


Figure IV-4-41. Annual total deposition fluxes (g/m^2) for the ash handling stack (ISC-COMPDEP, surface area-weighted pollutant distribution). Modeling domain out to 50 km is displayed.

Total Annual Deposition (g/m^2)
Ash Handling (Surface Distribution)

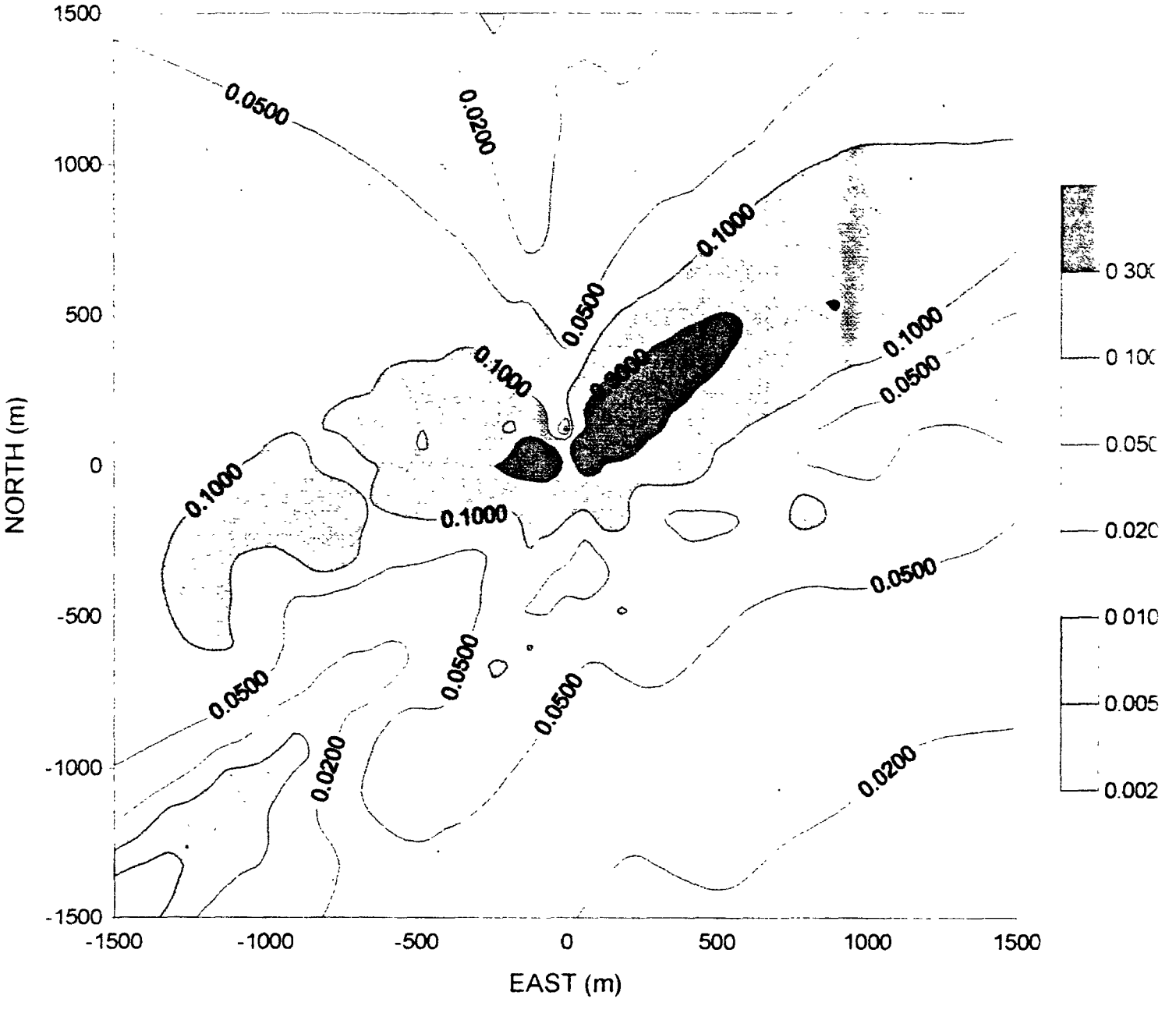


Figure IV-4-42. Annual total deposition fluxes (g/m^2) for the ash handling stack (ISC-COMPDEP, surface area-weighted pollutant distribution). Modeling domain out to 1.5 km is displayed.

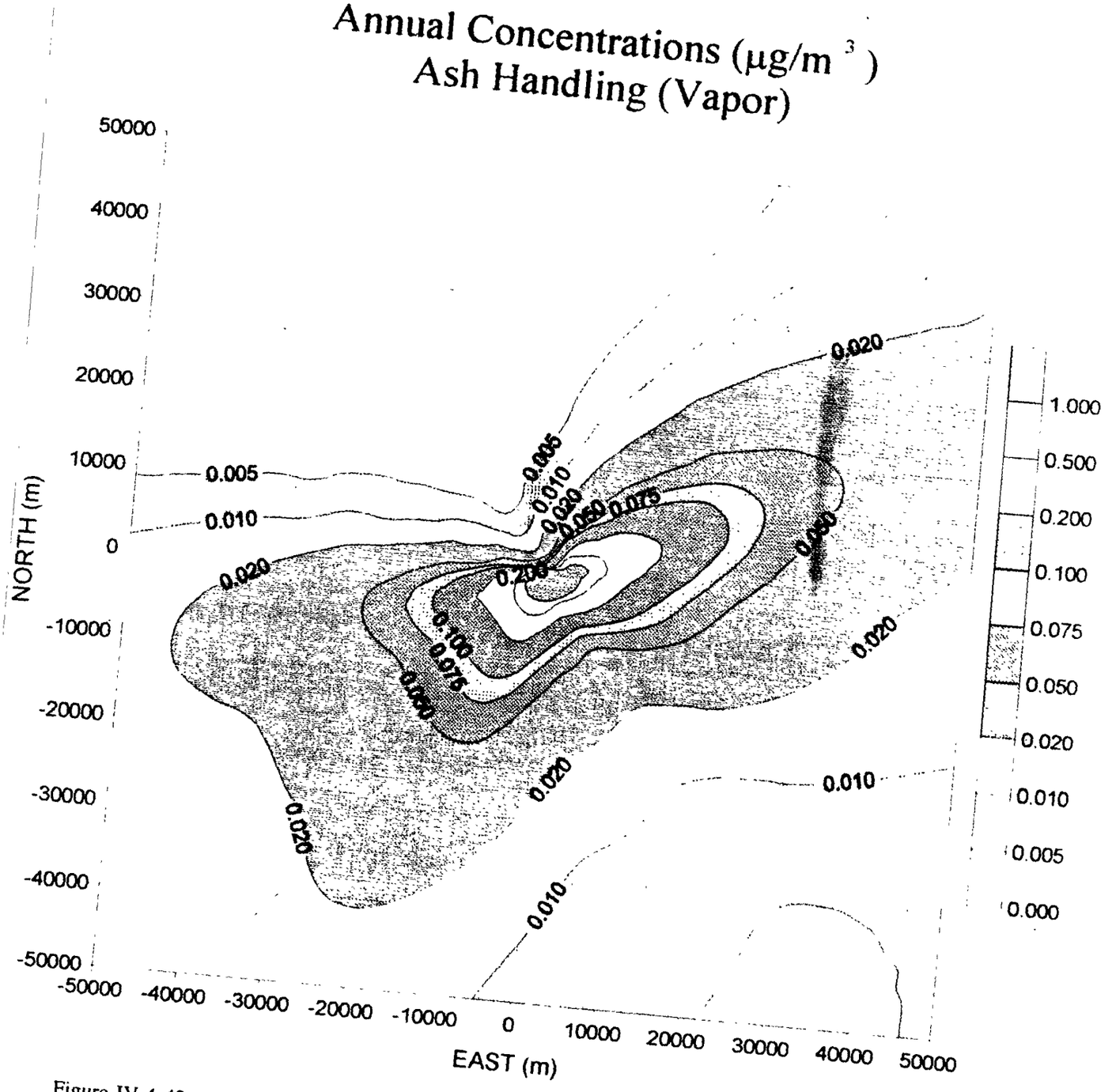


Figure IV-4-43. Annual average concentrations (µg/m^3) for the ash handling stack - Run 1c (ISC-COMPDEP, vapor pollutant). Modeling domain out to 50 km is displayed.

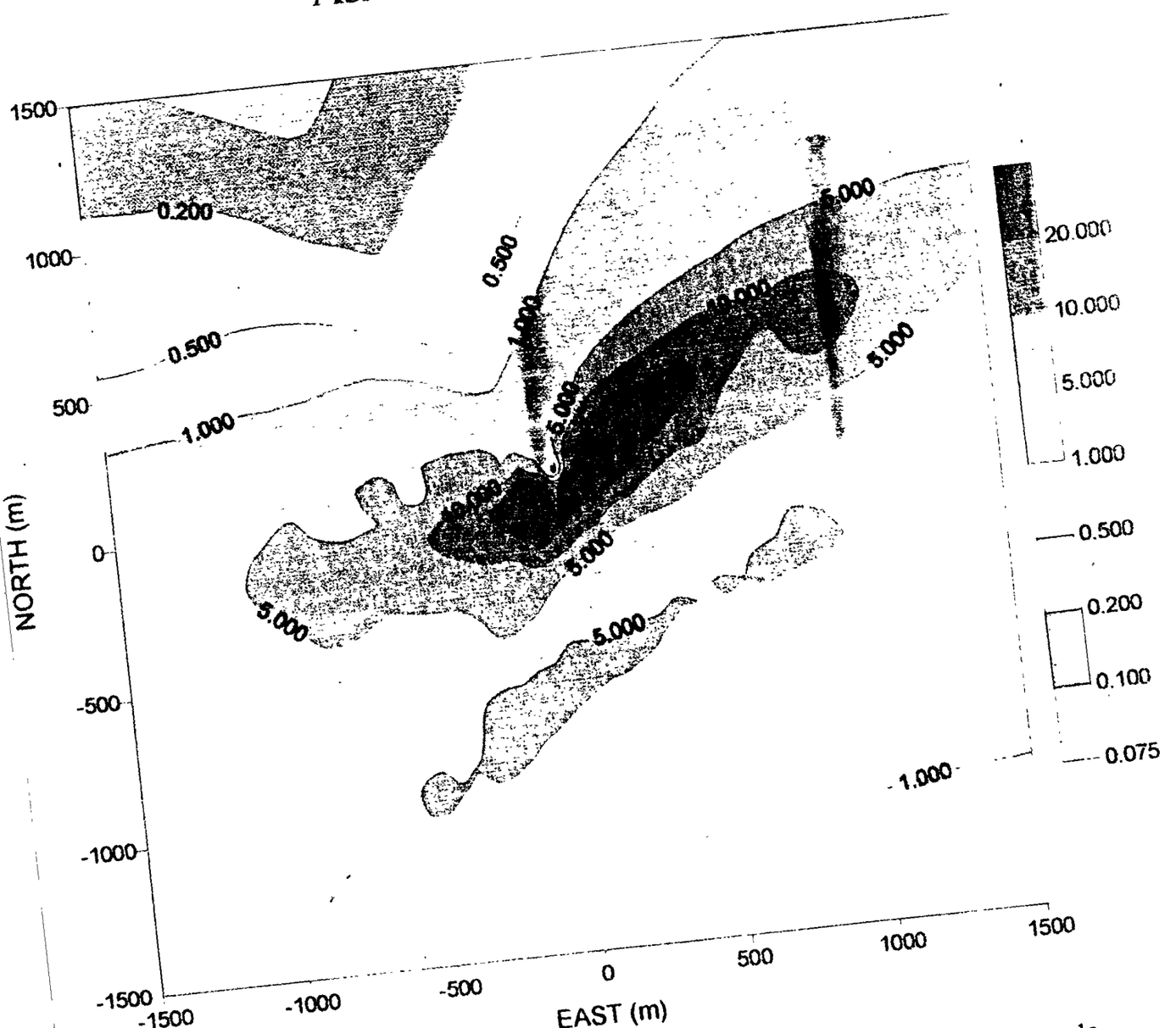


Figure IV-4-44. Annual average concentrations (μg/m^3) for the ash handling stack - Run 1c (ISC-COMPDEP, vapor pollutant). Modeling domain out to 1.5 km is displayed.

APPENDIX IV-5

Overview of the CALPUFF Non-Steady-State Dispersion Model

For Presentation at the Seventh Joint AMS-AWMA Conference on Application of Air Pollution Meteorology, New Orleans, LA January 13-17, 1991.

DEVELOPMENT OF THE CALPUFF NON-STEADY-STATE MODELING SYSTEM

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Robert J. Yamartino

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1. INTRODUCTION

Due to increased concerns over the effects of toxic pollutants, the California Air Resources Board (ARB) has sponsored the development of a generalized non-steady-state modeling system for toxic air pollutants. The model was intended for application to individual sources or entire air basins. The design criteria of the modeling system specified the following capabilities: (1) modeling of relevant processes on scales from tens of meters to hundreds of kilometers, (2) applicability to rough or complex terrain situations, (3) predictions for averaging times from one hour to one year, (4) point and area source capabilities, and (5) applicability to inert pollutants or those subject to linear conversion mechanisms.

In order to meet these objectives, a modeling system was designed which consists of three basic components: a meteorological modeling package with both diagnostic and prognostic wind field generators, a Gaussian puff dispersion model containing algorithms for building downwash, subgrid scale complex terrain, overwater transport and coastal interaction effects, chemical transformation, wet removal, and dry deposition, and postprocessing programs for the manipulation, time-averaging, and display of the meteorological data, concentrations, and deposition fluxes produced by the models.

The CALPUFF modeling system consists of a total of twelve models and processor programs. In this abstract, an overview of the modeling system is presented with a brief description of the major components of the dispersion model, CALPUFF. The meteorological and postprocessing components of the modeling system are also compatible with a new photochemical model, CALGRID, developed for ARB under a separate contract (Yamartino et al., 1989; Scire et al., 1989).

2. METEOROLOGICAL MODELING

The meteorological component of the modeling system consists of several meteorological data preprocessing programs, a diagnostic wind field and boundary layer model (CALMET), and a version of the Colorado State University Mesoscale Meteorological Model (CSUMM).

The meteorological preprocessors extract and process surface meteorological data, upper air observations and precipitation data in the standard formats available from the National Climatic Data Center (NCDC) (i.e., CD144 for surface data, TD-5600 or TD-6201 for upper air data, and TD-3240 formats for precipitation data). The programs perform selected quality assurance/missing value checks and prepare the data inputs for the meteorological models. These programs allow large periods of routinely available data to be used by the modeling system. Alternative data formats, more convenient for short simulations or for use with specialized data sets, are also allowed.

The diagnostic wind field module of CALMET was developed by Douglas and Kessler (1988). It computes three-dimensional gridded fields of horizontal and vertical wind components. The model contains parameterizations of slope flow effects, kinematic terrain influences, terrain blocking effects, three-dimensional divergence minimization, and an objective analysis scheme for including observational data in the generation of the wind fields.

The diagnostic model uses a two-step approach in developing the wind fields. In the first step, a domain-mean wind field is adjusted to account for the effects of terrain and is subjected to a divergence minimization procedure to produce a diagnostic Step 1 wind field. As an alternative, CALMET provides the option to use an externally generated gridded wind field (e.g., as produced by a prognostic wind field model) as a replacement for the diagnostic Step 1 winds. The replacement gridded field need not use the same grid resolution as the CALMET simulation. The Step 2 procedure involves the introduction of observations into the Step 1 wind field (either diagnostic or prognostic) through an objective analysis procedure followed by smoothing, and re-minimization of divergence. Observational data are weighted heavily by the objective analysis scheme in data rich areas of the modeling domain. In data sparse areas, the final wind field is determined primarily by the Step 1 wind field.

The option to use the prognostic wind field as the Step 1 winds provides a mechanism for introducing some of the features of the prognostic model simulations, such as a lake or sea breeze circulation with the return flow aloft, without the need for expensive fine grid execution of the prognostic model. In addition, it provides a simple method for adjusting the prognostic wind field predictions to reflect observations.

CALMET also contains boundary layer modules which compute surface heat and momentum fluxes over land and water surfaces. The overland boundary layer module is based on the energy balance method of Holtslag and van Ulden (1983). The aerodynamic and thermal properties of water

surfaces require that different methods be used in the marine environment. Over water, a profile method, using air-sea temperature differences, is used to compute the micrometeorological parameters in the marine boundary layer. A detailed description of CALMET is provided in Scire et al. (1990).

The prognostic wind field model included in the CALPUFF modeling system is the version of the CSUMM model most recently modified by Kessler (1989). CSUMM is a three-dimensional, hydrostatic, incompressible primitive equation model originally developed by Pielke (1974). CSUMM can simulate mesoscale wind flow patterns with horizontal scales of 10 to 300 km generated by differential surface heating such as sea breeze circulations as well as terrain influences such as slope flows and terrain blocking effects (Kessler, 1989). The model contains parameterizations for the atmospheric surface layer, planetary boundary layer, and a soil layer.

3. CALPUFF DISPERSION MODEL

CALPUFF is a multi-layer, multi-species non-steady-state puff dispersion model which can simulate the effects of time- and space-varying meteorological conditions on pollutant transport, chemical transformation, and plume depletion. CALPUFF contains algorithms for near-source effects such as building downwash, transitional plume rise, subgrid scale terrain interactions as well as processes important on larger scales such as pollutant removal (wet scavenging and dry deposition), chemical transformation, overwater transport and coastal interaction effects. It can accommodate arbitrarily-varying emissions from point sources and gridded or discrete area sources. Most of the algorithms contain options to treat the physical processes at different levels of detail depending on the model application. Scire et al. (1990) contains a complete description of the formulation, options and data requirements of CALPUFF.

3.1 CALPUFF Sampling Functions

Puff models represent a continuous plume as a number of discrete packets of pollutant material which can be independently subjected to advection, dispersion, transformation, and depletion. Many puff models evaluate the contribution of a puff to the concentration at a receptor by a snapshot approach. Each puff is frozen at particular time intervals (sampling steps) and the concentration due to the frozen puff is computed (or sampled). The puff is then allowed to move, evolving in size, strength, etc., until the next sampling step. The total concentration at a receptor is the sum of the contributions of all nearby puffs averaged over all sampling steps within the basic time step.

A traditional drawback of the puff approach has been the need for the release of many puffs to adequately represent a continuous plume close to a source. Ludwig et al. (1977) have shown that if the distance between adjacent puffs exceeds about 2 σ_y, inaccurate results may be obtained. If the puffs do not overlap sufficiently, the concentrations at receptors located in the gap between puffs at the time of the snapshot sampling are underestimated, while those at the puff centers are overestimated.

This characteristic of the snapshot sampling method requires uneconomically large numbers of puffs to generate sufficient puff overlap close to a source. Since the model desig criteria included applicability at source-recepto distances of just a few tens of meters for averaging times up to a year, the snapshot sampling algorithm was not considered feasible. Therefore, two alternative sampling algorithms ar used in CALPUFF which allow near-field as well as far field concentrations to be efficiently computed.

3.1.1 Elongated Puff (Slug) Sampling Function

One way to avoid puff overlap problems is to allow the puffs to be stretched in the along-w direction. These elongated puffs or slugs, can b visualized as a group of overlapping puffs with small separation distances traveling together. I fact, the slug represents the continuous emission of puffs, each containing the infinitesimal mass, q dt. The main body of the slug is of length u $\Delta\tau$, where u is the wind speed and $\Delta\tau$ is the tim of emission of the pollutant for a particular slug. The instantaneous concentration due to a slug can be described as:

$$\chi(t) = \frac{F\,q}{(2\pi)^{1/2} u' \sigma_y}\; g \exp\left[\frac{-d_c^2}{2\sigma_y^2}\,\frac{u^2}{u'^2}\right] \qquad (1)$$

$$F = \frac{1}{2}\left\{\operatorname{erf}\left[\frac{d_{a2}}{(2)^{1/2}\,\sigma_{y2}}\right] - \operatorname{erf}\left[\frac{-d_{a1}}{(2)^{1/2}\sigma_{y1}}\right]\right\} \qquad (2)$$

where u is the vector mean wind speed (m/s), u' i the scalar wind speed defined as $(u^2 + \sigma_v^2)^{1/2}$, σ_v is the wind speed variance, q is the source emission rate (g/s), F is a "causality" function, g is the vertical term of the Gaussian equation, d_c and d_a are cross-slug (i.e., perpendicular to the slug axis) and along-slug distances to the receptor, respectively, and the subscripts 1 and 2 refer to values at the oldest and youngest ends of the slug, respectively. The absence of a subscript indicates a sigma value at the receptor.

The slug formulation retains many of the important properties of the circular puff model, while significantly reducing puff overlap problems associated with snapshot sampling of circular puffs. The concentration distribution within the body of the slug, away from the slug endpoints, approaches that of a Gaussian plume under appropriate steady-state conditions. The concentrations near the slug endpoints (both inside and outside of the body of the slug) fall off in such a way that if adjacent slugs are present, the plume predictions will be reproduced (again, under steady-state conditions). As with circular puffs, each slug is free to evolve independently in response to the local effects of wind shear, dispersion, chemical transformation, removal, etc. The end points of adjacent slugs

are constrained to remain connected, which ensures continuity of a simulated plume without the gaps or duplicate overlap which can occur with segmented plume models. The factor (u/u') allows low wind speed and calm conditions to be properly treated.

To illustrate the slug sampling function, the isopleths of the instantaneous concentrations of a slug at two times are plotted in Figure 1. The distribution at the left represents the slug at the beginning of a time step, whereas the distribution on the right is at the end of the time step. The slug sampling function integrates the concentrations over the time step to produce the time averaged concentration shown in Figure 2, which is smooth and free of spurious gaps or peaks.

3.1.2 Integrated Puff Sampling Function

As a slug grows, the initial along-wind stretching of the slug becomes less important. Eventually, when $\sigma_y >> u\,\Delta\tau$, the slug can be replaced with a circular puff. For puffs, CALPUFF employs the integrated sampling function used in the MESOPUFF II model (Scire et al., 1984):

$$\bar{\chi} = \frac{1}{\Delta s} \int_{s_o}^{s_o + \Delta s} \frac{Q(s)}{2\pi\,\sigma_y^2(s)}\, g(s)\, \exp\left[\frac{-R^2(s)}{2\,\sigma_y^2(s)}\right] ds \quad (3)$$

where Q is the pollutant mass in the puff, R is the distance from the puff center to the receptor, s is the distance traveled by the puff, s_o is the value of s at the beginning of the time step, and Δs is the distance traveled during the time step.

If it is assumed that the most significant s dependencies during the sampling step are in the R(s) and Q(s) terms, an analytic solution to the integral can be obtained in terms of exponentials and error functions. In evaluating Eqn. (3), the horizontal dispersion coefficient, σ_y, and the vertical term, g, are evaluated at the receptor and held constant over the sampling step.

Results of tests with the integrated puff sampling function show the ability to reproduce continuous plume results under steady-state conditions without gaps or peaks in the distribution. Because the integrated puff equations can be solved analytically, its solution tends to be more efficient than numerical integration of the slug equations. However, the slug sampling can be more efficient in handling complex situations such as advection of a plume segment perpendicular its long axis (e.g., as produced by a 90° wind shift from one hour to the next -- see Fig. 1 and 2). Therefore, CALPUFF contains the option to perform slug sampling in the near-field of a source, with an internal transition to the integrated puff approach as the puff size grows into a more circular shape.

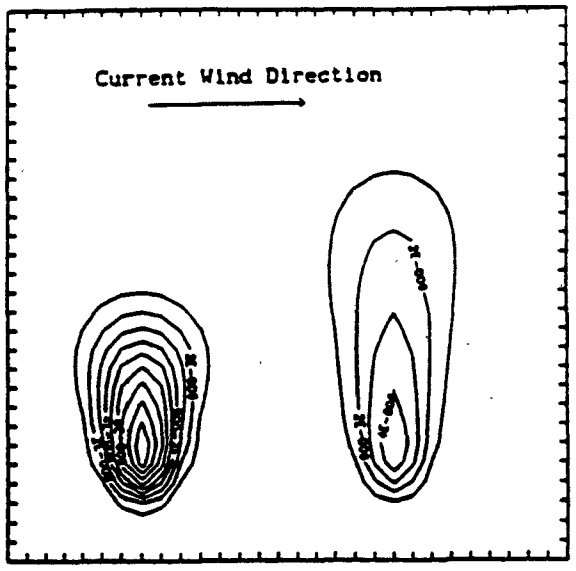

Fig. 1. Illustration of the transport and growth of a slug after a 90° shift in wind direction. Shown are the instantaneous concentration isopleths of the slug at the beginning and ending of a time step. The slug on the left represents the distribution of time, t. The slug on the right is the distribution at time t + Δt. During the time step, the slug experienced advection, diffusion, and some along-slug stretching due to wind shear.

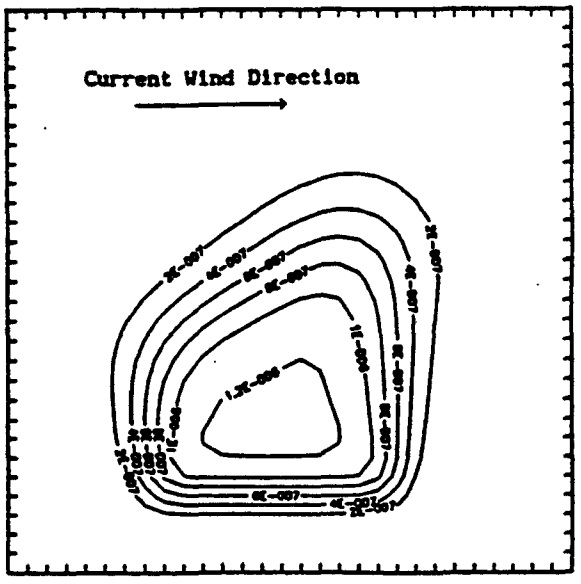

Fig. 2. Time averaged concentration resulting from the transport and evolution of the slug depicted in Figure 1.

3.2 Dispersion Coefficients

CALPUFF contains several options for computing the dispersion coefficients, σ_y and σ_z, involving different levels of data input:

(1) Use of direct measurements of the turbulence parameters σ_v and σ_w.

(2) Internal computation of σ_v and σ_w using similarity theory (Weil, 1985; Briggs, 1985) and the the gridded micrometeorological variables computed by the CALMET model (surface friction velocity, Monin-Obukhov length, convective velocity scale)

(3) Use of Pasquill-Gifford (PG) coefficients in rural grid cells and McElroy-Pooler (MP) coefficients in urban grid cells

The general forms of σ_y and σ_z (Hanna et al., 1977) used for Options (1) and (2) are:

$$\sigma_y = \sigma_v \, t \, f_y(t/t_{1y}) \quad (4)$$

$$\sigma_z = \sigma_w \, t \, f_z(t/t_{1z}) \quad (5)$$

where t_{1y} and t_{1z} are the horizontal and vertical Lagrangian time scales. The recommendations of Irwin (1983) are used to evaluate the f_y and f_z functions. At long transport distances, (e.g., beyond 10 km), an option is provided to switch to the Heffter (1963) equations (i.e., $\sigma_y \sim t$, $\sigma_z \sim t^{1/2}$).

If option (3) is selected, the dispersion coefficients are computed based on the input gridded fields of PGT stability class and land use. When a puff is in a rural region, PG curves are used. Likewise, the MP coefficients are used in urban areas. Thus, both rural and urban dispersion rates can apply to a particular plume at different points in its transport. During each time step, virtual distances are computed to account for temporal and spatial changes in stability class and/or spatial changes in land use.

In addition, the effects on the dispersion coefficients of plume buoyancy (Pasquill, 1976), vertical wind shear (Pasquill, 1976), building downwash, and initial area source size are included in CALPUFF.

3.2.1 Building Downwash

The parameterization of building downwash in CALPUFF is appropriate for use in the turbulent wake region and is based on the procedures used in the ISCST model. ISCST contains two building downwash algorithms: the Huber-Snyder model and the Schulman-Scire model. The differences in the treatment of downwash between ISCST and CALPUFF include the following.

(1) The height threshold determining which model is used is an input variable. This options allows the user to apply one of the models for all stacks, which has the desirable effect of eliminating the discontinuities of the ISCST approach.

(2) Wind-direction specific building dimension are allowed with the Huber-Snyder technique.

(3) In cases where the controlling building he varies as a function of wind direction, the model will allow the Huber-Snyder model to be applied f some wind directions (using wind direction specif values) and the Schulman-Scire model in other directions.

3.3 Complex Terrain

CALPUFF responds to the presence of terrai on two scales. The effect of terrain that extend over a scale large enough to be resolved by the grid used in the flow field model will be manifes in the boundary conditions for the flow field. A puff embedded in this flow will either rise with the flow along the surface of the terrain, or it will be steered by the flow along terrain, depending on the degree of stratification. Effects of terrain that are not resolved by the grid used in the flow field are treated in a separate module, CTSG (Complex Terrain algorithm for Sub-Grid scale features).

CTSG accepts the flow field produced by th meteorological model (both wind and temperature structure) in the vicinity of a terrain feature a the incident flow toward that feature. It then proceeds to simulate changes in the flow and in the rate of dispersion that are induced by the terrain feature. CTSG is based on the modeling approach developed in EPA's Complex Terrain Model Development program (CTDM), with some modifications to accommodate the puff formulation of CALPUFF.

As illustrated in Figure 3, the dividing streamline concept is a central feature of the CTSG treatment of terrain. In the layer above tl dividing streamline, the approach flow has sufficient energy to transport a fluid parcel up and over the hill against a stable potential temperature gradient. Puff material in this lay experiences an altered rate of diffusion in the deformed flow field over the hill. In the lower layer, the flow is constrained to travel around the hill. Puff material in the lower layer is deflected around the hill, being embedded in a horizontal two-dimensional flow. The stagnation streamline in this flow forms the boundary of th hill and therefore separates portions of the puf which travel around one side or the other. The center of the puff is able to impinge on the hillside only if the puff is centered on the stagnation streamline, and lies below the dividi streamline.

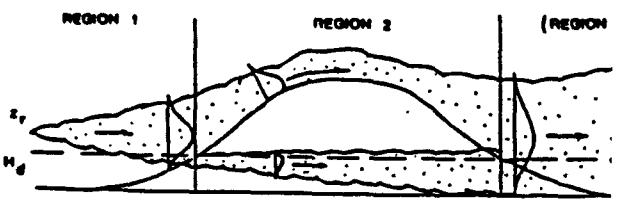

Fig. 3. Illustration of the modeling region and partitioning of the flow above and below the dividing streamline height, H_d, in the CTSG algorithm.

3.4 Overwater and Coastal Dispersion

There are important differences in the structure of the marine and continental boundary layers which can have significant effects on plume dispersion. The sensible heat flux over water is typically more than an order of magnitude less than over land. The absence of a strong sensible heat flux to drive the marine mixed-layer and the small surface roughness of the water surface result in relatively low mixing heights that offer potential for significant plume trapping effects.

Another difference is that diurnal and annual variations of stability over water are completely unrelated to the typical overland behavior. For example, temperature inversions persisting most of the day can occur during the summer, while unstable conditions may persist all day in the winter months. During other periods, the overwater diurnal stability cycle can be out of phase with the overland cycle (i.e., stable over water during the day and unstable at night). The CALMET meteorological model contains separate boundary layer modules for computing stability and turbulence levels in the overland and overwater boundary layers.

CALPUFF allows rapid changes in the dispersion characteristics along the coastal boundary. The land-sea interface is resolved on the scale of the computational grid in the model. CALMET provides the turbulence and dispersion characteristics of the overwater as well as overland boundary layers. The transition from marine to continental dispersion rates is assumed to occur at the coastal boundary determined from a gridded field of land use data entered into the model. Once a puff embedded in a marine layer encounters the overland boundary layer height, the puff growth is changed from that appropriate for the marine layer to that for the overland boundary layer.

3.5 Dry Deposition

CALPUFF provides three options for treating dry deposition of gases and particulate matter in the model.

(1) Full treatment of spatially and temporally varying gas/particle deposition rates predicted by a detailed resistance-based deposition model.

(2) User-specified 24-hour cycles of deposition velocities for each pollutant. This option allows the diurnal time variation of deposition to be incorporated, but does not allow any spatial dependencies.

(3) No dry deposition. A switch is provided to bypass all dry deposition and dry flux calculations in order to provide for faster model execution for screening runs or for pollutants not experiencing significant deposition.

3.6 Wet Removal

Wet scavenging of soluble or reactive pollutants can lead to high depletion rates (of the order of tens of percent per hour) during precipitation events (e.g., Barrie, 1981; Slinn et al., 1978). Gaseous pollutants are scavenged by dissolution into cloud droplets and precipitation. For SO_2, aqueous phase oxidation can be an important removal pathway. Over source-receptor distances of tens of kilometers, wet scavenging can deplete a significant fraction of the pollutant material from a puff.

CALPUFF uses the simple, empirically-based scavenging coefficient approach to estimate wet deposition and wet removal effects. The depletion of a pollutant is represented as:

$$\chi_{t+\Delta t} = \chi_t \exp [-\Lambda \Delta t] \quad (6)$$

$$\Lambda = \lambda (R/R_1) \quad (7)$$

where χ is the concentration at time t and t+Δt, Λ is the scavenging ratio, λ is the scavenging coefficient, R is the precipitation rate, and R_1 is a reference precipitation rate of 1 mm/hr. The user may specify different values λ as a function of precipitation type (i.e, liquid vs. frozen precipitation) for each pollutant. The precipitation rate used to compute depletion for a particular puff is based on the value at the nearest grid point to the puff. CALMET produces gridded fields of precipitation rates using routinely-available observations of hourly precipitation rates.

3.7 Chemical Transformation

One of the design criteria of the CALPUFF model required the capability to model linear chemical transformation effects in a manner consistent with the puff formulation of the model. The CALPUFF chemical module contains three options for dealing with chemical processes:

(1) A pseudo-first order reaction mechanism for the conversion of SO_2 to sulfate and NO_x ($NO + NO_2$) to HNO_3 and particulate nitrate. This mechanism allows for up to five pollutants (SO_2, $SO_4^=$, NO_x, HNO_3, and NO_3^-). It is based on the transformation scheme used in the MESOPUFF II model and incorporates the most significant spatially and temporally varying environmental variables on the transformation rates.

(2) User-specified 24-hour cycles of transformation rates. This option allows simulation of the diurnal, time-dependent variation in the chemical transformation rates, but precludes any spatial variability.

(3) No chemical transformation. The model will bypass the chemical transformation calculations if inert pollutants are being modeled.

4. POSTPROCESSING CAPABILITIES

The CALPUFF modeling system contains two postprocessing programs, PRTMET and POSTPRO. The PRTMET program reads the meteorological data file produced by the CALMET model and displays user-selected portions of the various wind, stability, micrometeorological fields, and geophysical fields in the file. The POSTPRO program computes time averaged concentrations and wet/dry deposition fluxes at gridded and discrete receptors, lists peak concentrations, and performs linear scaling operations.

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APPENDIX IV-6

Wind Tunnel Study of Terrain Downwash Effects

Wind-Tunnel Simulation to Assess Terrain Downwash Effects at the WTI Hazardous Waste Incinerator: Project Summary

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1. INTRODUCTION

A peer-review workshop organized by EPA's Risk Assessment Forum was held in Washington, DC on December 8 and 9, 1993, for the purpose of evaluating a draft project plan prepared by EPA Region 5 for assessing risk at an incinerator operated by Waste Technologies Industries (WTI) in East Liverpool, Ohio. One of the concerns of the peer-review panel was expressed: "terrain-induced downwash is expected to be a serious problem at the WTI site (at least for moderate- and high-wind cases)", and "none of the EPA Guideline dispersion models is able to simulate these effects". This panel recommended that "a wind-tunnel study . . . be undertaken for this purpose in the case of the WTI risk assessment." It further cited "additional benefits of such modeling are the quantification of the near- and mid-field three-dimensional wind flow within and downwind of the river valley and the quantification of the combined effects of terrain and buildings on the near-field dispersion." As a result of these recommendations, EPA Region 5 and the Office of Solid Waste and Emergency Response requested that the Fluid Modeling Facility conduct such a wind-tunnel study. This report summarizes that wind-tunnel study -- conducted to examine possible terrain-downwash effects and to assess the resulting values and patterns of ground-level concentration.

We took as our primary charge the recommendation of the peer-review panel, that is, to conduct a wind-tunnel study to examine terrain effects at the WTI site under moderate and high-wind conditions. With regard to the additional benefits, we did make measurements to quantify the wind field within the river valley, but we did *not* perform a full assessment of *building*-downwash effects. Proper wind-tunnel modeling procedures, even in a relatively large tunnel, require that *terrain*-downwash and *building*-downwash studies be conducted at quite different scales.

A model of the terrain was constructed at a scale ratio of 1:480, representing a full-scale section approximately 1 mile wide and 3 miles long. The wind direction chosen was that expected to produce the most severe terrain-downwash effects, *i.e.*, with the most prominent hill directly upwind of the stack. This model, centered on the incinerator stack, was placed in the meteorological wind tunnel, with a simulated atmospheric boundary layer approaching it. The flow structure of the approaching boundary layer and that within the valley was measured with hot-wire and pulsed-wire anemometry.

Methane was metered from the model stack as a tracer to simulate the buoyant effluent, and flame ionization detectors were used to measure time-averaged concentrations, primarily ground-level values, downwind. Three stack heights were examined, including the existing stack height of 45.7m, the calculated "good-engineering-practice" (GEP) stack height of 72.7m, and an arbitrarily chosen "tall" stack height of 120m. (This tall stack was approximately 80% of the valley depth.) At each stack height, ground-level concentration (glc) patterns were measured over a range of wind speeds to ascertain the maximum possible glc's. The model was then turned around by 180° and a similar set of measurements was performed. Finally, we replaced the terrain model by a flat-terrain model with equivalent surface roughness in order that terrain effects could be determined with reference to those in flat terrain.

A companion data report provides a full description of the experimental details and compiles the data collected. A five-minute videotape provides an overview of the project.

2. DESIGN DETAILS

The WTI Site and Climatology

The WTI hazardous waste incinerator is located adjacent to the Ohio River in East Liverpool, Ohio. It is across-river from West Virginia and down-river (by 1½ miles or 2.5km) from Pennsylvania. A topographical map of the site is shown in Figure 1. The area in the immediate vicinity of the facility is mixed residential and commercial with light industrial activity. The terrain is quite rugged, and in the immediate vicinity of the site, the south bank of the river rises quite steeply to 520ft (155m) above the river level.

Meteorological data are collected by WTI at three sites on or near the facility grounds. Wind roses from these sites clearly show strong channeling by the river valley, and are clearly not representative of the transport conditions in the terrain above and adjacent to the WTI site. Fortunately, more appropriate wind data were available from a 500ft (152m) meteorological tower at the Beaver Valley Power Station (BVPS), which is located near Shippingport, PA, about 8 miles east of the WTI site. The terrain surrounding this site is very similar to that at the WTI site, with comparable hill heights, valley depth, and river orientation. The 500-ft level of the tower, 1235ft (376m) above sea level, is at or above the terrain surrounding the river valley. Measurements from the 500-ft level at this tower are mostly free of channeling effects and were used to represent transport conditions above and adjacent to the Ohio River Valley at East Liverpool.

Since our primary goal was to examine terrain-downwash effects, we chose the wind direction (125°) that put the most prominent hill upwind of the stack. Fortuitously, this direction resulted in the most prominent hill in the opposite direction being directly downwind from the stack. We rotated the model by 180° and thereby also studied terrain-downwash effects at a wind direction of 305°. Because model construction to enable simulations at other wind directions would have required substantial additional effort and because we believed other wind directions would result in less severe downwash effects, only the 125° and 305° simulations were conducted. In future discussions, these wind directions will frequently be referred to as SE (from 125°) and NW (from 305°) winds.

Analysis of the wind speeds in 20° sectors surrounding 125° and 305° at the BVPS (5-year record) suggested that SE winds occur a total of 4% of the time, with speeds between 9 and 10m/s being quite rare (0.01% of the time). NW winds were observed 6.4% of the time, with speeds between 12 and 15m/s being observed 0.03% of the time. Of these two sets of directionally specific winds, the 98th percentile values were 8m/s for SE wind and 10m/s for NW winds.

Similarity Criteria

Because of the large scale reduction required to fit the terrain model into the wind tunnel as well as the requirement to simulate the buoyancy of the exhaust gas from the WTI stack, some compromises had to be made in order to insure a realistic simulation. We chose to exaggerate the stack diameter and the density difference between the exhaust gas and ambient air in such a manner

as to match momentum and buoyancy length scales of the exhaust; this assures that the full-scale trajectory of the plume will be matched in the wind-tunnel model. This "distorted scaling" is a compromise that allowed us to proceed with a realistic simulation, but it is not without sacrifice. The stack diameter was doubled, so that the plume width at the stack exit was also doubled, and the requirement of geometric similarity was clearly violated close to the stack. Thus, we cannot expect to match the concentration pattern in the near field but, beyond a few tens of stack diameters, where ambient turbulence dominates the dispersion process, we may expect a reasonable simulation of the concentration fields.

As will be shown later, building influences were clearly observed with the existing stack at the higher wind speeds, but we do not claim to have done a full and proper simulation of building-downwash effects; those results should perhaps be viewed as qualitatively but not quantitatively correct. A proper simulation of building-downwash effects would have been conducted at a much larger scale, perhaps in the neighborhood of 1:100. At the scale of the present study, 1:480, building influences cannot be expected to be simulated correctly. Therefore, concentration measurements at distances less than about $10H_b$ (250m) from the stack should not be considered as truly representative of those that would occur under building downwash conditions.

A simulated neutral (high wind speed) atmospheric boundary layer was generated using spires at the entrance to the test section and roughness on the floor of the tunnel. The boundary-layer depth was scaled down from the full-scale value (600m) using the geometrical scale ratio of 1:480. The wind profile approaching the model terrain was chosen to match that typical over forested terrain, and sufficient upwind terrain was included in the model to properly shape the approach-flow profile.

Research Plan

As mentioned above, our primary goal was to simulate worst-case terrain-downwash effects. First, we chose the area to be modeled such that the largest and most prominent hill was directly upstream of the stack. It was not known *a priori* what wind speed would produce the maximum ground-level concentration. At low wind speed the buoyancy and momentum of the exhaust will carry the plume to high elevations, so that the location of the maximum glc will be far downwind and its value will be relatively small. At some intermediate wind speed, the plume will be strongly bent over so that effluent will diffuse to ground level a short distance downwind, with a higher maximum glc. At even larger wind speeds, the plume cannot be bent over much farther; thus the wind stretches the plume farther and farther, with greater dilution at the source and a smaller maximum glc. Hence, a critical wind speed exists at which the glc is an absolute maximum. The worst terrain-downwash effects will occur at the critical wind speed, which may vary with stack height and wind direction.

Because the critical wind speeds were not known *a priori*, each model simulation was done over a range of wind speeds in an attempt to ascertain the critical value. The overall plan, then, was to run the simulations with the terrain model at the two wind directions of 125° and 305°. At each of these wind directions, we measured glc patterns for each of the 3 stack heights. For each stack height, we made measurements over a range of wind speeds in an attempt to ascertain the critical wind speed and, hence, the maximum terrain-downwash effect. We then removed the terrain model from the wind tunnel and replaced it with flat terrain with equivalent roughness characteristics. Measurements were again made of the glc patterns resulting from the same three stacks and over

ranges of wind speeds to ascertain the critical values. The purpose of these latter measurements was, of course, to establish a flat-terrain basis with which the complex-terrain measurements could be compared -- so that effects of the surrounding terrain could be isolated and quantified.

Various supplemental measurements were made to verify the adequacy of our simulation and to aid in understanding of the transport and dispersion processes. These included:

(1) Hot-wire anemometry measurements to characterize the flow structure of the boundary layer in terms of mean velocity and turbulence intensities,
(2) Pulsed-wire anemometry measurements to characterize the three-dimensional, highly turbulent and recirculating flow within the Ohio River valley.
(3) Vertical profiles of concentration at various downwind distances in both flat and complex terrain and at various wind speeds to characterize the plume rise and structure, and
(4) Concentration measurements from a "point source" in our flat-terrain boundary layer to show that the dispersion properties match those of a comparable full-scale atmospheric boundary layer.

3. APPARATUS AND INSTRUMENTATION

Wind Tunnel and Model Construction

Figure 2 provides a schematic diagram of the wind-tunnel setup. Because of the large height of the model, blockage of the test section was too large; we therefore modified the wind tunnel by lowering a large section of the floor by 7in (18cm) to accommodate the river valley. Even so, ramps were necessary to provide smooth transitions from the flat wind-tunnel floor to the terrain at the upwind edge of the model.

A simulated atmospheric boundary layer was generated using a system of "spires" and roughness on the floor downwind. For the terrain models, the block roughness covered the tunnel floor from the spires to the edge of the terrain model. For the flat-terrain model, the block roughness covered the entire floor of the test section of the tunnel. This roughness was intended to match the roughness of the full-scale terrain, which is densely forested over a large majority of the model area.

A terraced model was constructed from ½ in plywood sheets, with each thickness of plywood corresponding to a 20ft elevation interval of the U.S. Geological Survey (USGS) topographic maps. The overall size of the model in the tunnel was 12 × 38ft, corresponding to 1.1 × 3.5mi at full scale. A photograph of the model installed in the tunnel is provided in Figure 3. Note that the terrain steps were not smoothed, but were purposely left terraced. These steps plus the house/building blocks distributed over the model surface, provided an adequate simulation of the full-scale roughness.

A site map of the WTI facility was also enlarged appropriately and cemented onto the terrain model. Major structures on the facility grounds were reproduced to scale. Dimensions of other major buildings in the vicinity of the site were estimated from aerial photographs. A group of six prominent buildings nearest the stack was removed for some measurements with northwest winds to examine possible building-downwash effects. This same group of buildings was included in the flat-

terrain model (and also removed for examination of building-downwash effects).

Velocity and Concentration Measurements

A hot-wire anemometer was used to measure the mean wind and turbulence intensities at various positions over the model terrain as well as over the flat terrain. These were supplemented with pulsed-wire measurements within the highly turbulent, reversing flows within the river valley.

High purity methane was emitted from the model stack. It served as a tracer so that concentration fields downwind could be measured with flame ionization detectors; its low density permitted the simulation of the buoyancy of the full-scale exhaust. The prescribed stack/effluent conditions for the WTI incinerator were an effluent speed of 15.8m/s, temperature of 361°K, and stack diameter of 1.83m. Concentration measurements were made by drawing samples through sets of small brass tubes comprising sampling rakes.

The results are presented in terms of normalized full-scale units, C_f/Q_f (μsec/m^3), where C_f is the full-scale concentration of the contaminant (μg/m^3) and Q_f is the emission rate (g/sec) of the contaminant. Full-scale concentrations are thus easily obtained by multiplying our value of C_f/Q_f by the full-scale emission rate of the contaminant, Q_f.

4. PRESENTATION AND DISCUSSION OF RESULTS

Velocity Measurements and Atmospheric Dispersion Comparability Tests

The hot-wire anemometry measurements showed that the flow structure of the flat-terrain boundary layer was representative of an atmospheric boundary layer over rough terrain; it could be characterized in the surface layer by a logarithmic velocity profile with a roughness length of 0.6m (full scale) or over the full depth by a power-law profile with an exponent of 0.21.

Measurements over the terrain showed quite strong reductions of wind speed induced by the hills upwind of the river valley. Thus, the plumes released within the valley are quite effectively *shielded* by the upwind terrain and thus may tend to rise to greater heights within the valley. This effect had rather unexpected consequences on the concentration fields to be observed.

Pulsed-wire measurements were made of the wind velocity components in the centerplane of the valley for the 125° wind direction. These were used to construct the flow vectors shown in Figure 4. The three-dimensional nature of the flow is clearly seen near the upstream valley wall, where the vectors indicate that the flow is directly along the valley axis and up the slope. Note also that there is a significant downward component of the flow as it approaches the location of the stack.

Observation of these features of the flow within the valley were also made using smoke visualization. When the smoke source was placed at low levels near the upwind edge of the valley, a small region of recirculating flow was observed that was quite consistent with the vector field of Figure 4. The smoke would follow helical trajectories along the valley axis as it moved to the southwest (positive y direction) until it dispersed and was swept downwind.

As a demonstration of how well dispersion in the atmospheric boundary layer is simulated in the wind-tunnel, concentration measurements were made downwind of a non-buoyant, low-momentum release from a point source. These measurements showed that the dispersion characteristics of the flat-terrain boundary layer were representative of a neutral atmospheric flow over a surface with a roughness length of approximately 60cm.

Concentration Measurements

The concentration measurements were conducted in three phases. The process proceeded as follows. First, the model was installed at a wind direction of 125° (SE). The existing stack was installed, the wind speed corresponding to the full-scale value at the 500-ft level was set to a particular value (*e.g.*, 6.8m/s), and surface concentration measurements were made, with the primary emphasis being to determine the location and value of the maximum ground-level concentration (glc). The wind speed was then increased and/or decreased in steps, each time measuring the surface concentrations to ascertain the location and value of the maximum glc. The maximum value at each wind speed was then plotted to determine the *critical* wind speed, as discussed in Section 2.

Having determined the critical wind speed (and, of course, the location and value of the maximum glc at this critical wind speed), the stack height was then raised to the good-engineering-practice (GEP) value, and a similar procedure was followed to obtain another value for the critical wind speed -- at the GEP stack height. A similar procedure was followed for each terrain configuration (including the wind direction of northwest or 305° and flat terrain) and for each stack height. A large number (461) of concentration files was collected, the majority of which represent surface concentrations.

Each surface concentration map was given a case identifier consisting of two letters and a number. The first letter indicates the terrain setup: S for Southeast winds, N for Northwest winds, or F for Flat terrain. The second letter indicates the stack height: E for Existing stack height (45.7m), G for Good-engineering-practice stack height (72.7m), or H for Highest stack height (120m). The number indicates the 500ft-level wind speed in m/s. An example is case SE6.8, indicating the terrain model with winds from the southeast, existing stack height, and 500ft wind speed of 6.8m/s.

Southeast wind direction

Table 1 provides an example list of all relevant full-scale and model parameters used in the tests to ascertain the critical wind speeds and values and locations of the maximum concentrations on the surface of the terrain, in this case, with the existing stack (45.7m) and winds from the southeast (125°). A total of 18 cases was studied at this wind direction, including 7 cases (7 different wind speeds) with the existing stack, 6 with the GEP stack, and 5 with the highest stack.

Some explanations are in order concerning the values in Table 1. It is a printout of a spreadsheet file in which were entered values of the full-scale parameters such as effluent speed and temperature, pertinent dimensions, and the wind speed at the 500ft elevation. The spreadsheet was programmed to calculate the momentum and buoyancy length scales and wind speeds at other

Table 1. Test Parameters for Concentration Measurements over Terrain with SE Winds.

03-Oct-94	Pg. 1: 45.7m STACK			WTI-SCL1.WB1			
CASE	SE3.4	SE5.0	SE6.8	SE9.0	SE10.4	SE12.0	SE13.5
FULL SCALE VALUES							
Stk top wind spd (m/s) =	2.84	4.18	5.64	7.53	8.70	10.03	11.29
Temp. ambient (oK) =	293	293	293	293	293	293	293
Temp. stack (oK)=	361	361	361	361	361	361	361
Stack diameter (m) =	1.83	1.83	1.83	1.83	1.83	1.83	1.83
Effluent speed (m/s) =	15.8	15.8	15.8	15.8	15.8	15.8	15.8
Gravity (m/s**2)	9.8	9.8	9.8	9.8	9.8	9.8	9.8
Bldg height (m) =	25.9	25.9	25.9	25.9	25.9	25.9	25.9
Stk den/amb den =	0.812	0.812	0.812	0.812	0.812	0.812	0.812
Lm (m) =	4.58	3.12	2.31	1.73	1.50	1.30	1.15
Lb (m) =	1.063	0.334	0.136	0.057	0.037	0.024	0.017
Froude No. (based on Ta) =	60.0	60.0	60.0	60.0	60.0	60.0	60.0
Stack height (m) =	45.7	45.7	45.7	45.7	45.7	45.7	45.7
500-ft wind speed (m/s) =	3.40	5.00	6.75	9.00	10.40	12.00	13.50
Free-strm wind spd (m/s) =	5.07	7.46	10.07	13.43	15.52	17.91	20.15
Wnd spd @ 10m (m/s) =	2.64	3.88	5.24	6.99	8.07	9.31	10.48
MODEL SCALE VALUES							
Scale ratio =	480	480	480	480	480	480	480
Exaggeration	Dens & D	Dens & D	Dens & D	Dens & D	Dens & D	Dens & D	Dens & D
Lm (cm) =	0.95	0.65	0.48	0.36	0.31	0.27	0.24
Lb (cm) =	0.221	0.070	0.028	0.012	0.008	0.005	0.004
Stack exagg. factor =	2.08	2.08	2.08	2.08	2.08	2.08	2.08
Stack diameter (cm) =	0.793	0.793	0.793	0.793	0.793	0.793	0.793
Stack height (cm)=	9.5	9.5	9.5	9.5	9.5	9.5	9.5
Stk den / amb den =	0.561	0.561	0.561	0.561	0.561	0.561	0.561
Density exagg. factor =	2.33	2.33	2.33	2.33	2.33	2.33	2.33
Stk top wind spd (m/s) =	0.31	0.46	0.62	0.83	0.96	1.11	1.24
Effluent speed (m/s) =	1.01	1.01	1.01	1.01	1.01	1.01	1.01
Effl. spd / Wind spd =	3.21	2.19	1.62	1.21	1.05	0.91	0.81
Volume flow (cc/min) =	2984	2984	2984	2984	2984	2984	2984
Froude No. (based on Ta) =	16.7	16.7	16.7	16.7	16.7	16.7	16.7
Effl. viscosity (cm2/s) =	0.165	0.165	0.165	0.165	0.165	0.165	0.165
Stk Reynolds no. =	483	483	483	483	483	483	483
For 45.7-m stack:							
500-ft wind speed (m/s) =	0.37	0.55	0.74	0.99	1.15	1.32	1.49
Free-strm wind spd (m/s) =	0.56	0.82	1.11	1.48	1.71	1.97	2.22
Wnd spd @ 10m (m/s) =	0.29	0.43	0.58	0.77	0.89	1.03	1.16
Tach	66	92	121	158	181	208	232
Bldg height (cm) =	5.4	5.4	5.4	5.4	5.4	5.4	5.4
Bldg ht wnd spd (m/s) =	0.30	0.44	0.60	0.80	0.92	1.07	1.20
Bldg Reynolds no. =	1087	1598	2158	2877	3324	3836	4315

Note: Properties of methane: rhos/rhoa=0.561 & nu=0.1654 cm2/s.

pertinent elevations such as at the stack top, the 10m elevation, the building elevation, and in the freestream above the boundary layer. These various speeds were calculated on the basis of the assumption that the full-scale wind profile matched the measured model profile.

The model values of momentum and buoyancy length scales were matched to the full-scale values, *i.e.*, the model values were set equal to the full-scale values divided by the geometric scaling ratio of 480. Recall that we chose to exaggerate the stack diameter (by a factor of 2.08) and the density difference ratio (by a factor of 2.33) in order to satisfy minimum Reynolds-number requirements. With all these considerations in mind, the spreadsheet was programmed to calculate the various model-scale values for each case, including the volume flow rate of methane from the stack, the required fan speed (TACH), the model wind speeds at the various elevations, and several nondimensional parameters.

A typical surface concentration map is shown in Figure 5. We have underlined the values of the maximum glc at each downwind distance and circled the overall maximum. In this case (SE6.8), the maximum glc is located at the upwind base of the first hill directly downwind of the stack. It has a value (C_f/Q_f) of 5.17μsec/m^3. We have drawn isoconcentration lines so that the set of measurements is more readily understood. There is a slight indication of the plume being diverted around the south side of this first hill.

A complete set of these surface glc maps for the southeast wind direction is provided in the data report. From each of these surface maps, we picked off the maximum glcs at each downwind location (*e.g.*, the underlined values on Figures 5). These data were then plotted graphically, a hand-drawn curve was faired through the data points, and the location x_{mx} and value of the maximum glc was determined from this hand-drawn curve. Figure 6 shows a typical example; in this case, the maximum concentration was determined to be 5.65μsec/m^3, and its location was 500m downwind of the source. Note that the C_{mx} and x_{mx} values are not measured values *per se*; we believe this method to be the most reasonable in view of the inherent variability in the data and the finite distance between measurement points. The C_{mx} and x_{mx} values were determined for each wind speed and entered into files so that critical wind speeds and locations of absolute maximum concentrations (at the critical wind speeds could be determined.

$(C_f/Q_f)_{mx}$ is plotted as a function of wind speed in Figure 7. Critical wind speeds (those resulting in the highest glcs) are observed for the GEP and highest stacks, but not for the existing stack. For the highest stack, the critical wind speed (500ft level) is in the neighborhood of 7m/s. For the GEP stack, it is around 11m/s. A critical wind speed certainly exists for the shortest stack height (45.7m), but it exceeds the highest speed tested (13.5m/s); testing at even higher wind speeds was deemed pointless, as such are very rarely, if ever, observed at this site (*cf.*, Sect. 2). The values of the maximum concentrations at the critical wind speeds are 2.0 at the highest stack height, 4.2 at the GEP stack height, and greater than 10.5 at the existing stack height. Hence, very considerable reductions in maximum glcs are observed as the stack height is increased.

Figure 8 shows the location x_{mx} of the maximum glc as a function of wind speed. As expected, the distance to the maximum glc increases as the stack height increases, and decreases as the wind speed increases.

As an aid to further understanding transport and dispersion of the plumes in this complex terrain, two series of vertical concentration profiles were measured downwind of the stacks. In the first series, the *stack height* was maintained constant and vertical profiles were measured at each of 6 downwind positions (x = 240, 480, 960, 1440, 1920 and 2400m) at each of 3 wind speeds (4.5, 9.0 and 15.0m/s). In the second series, the *wind speed* was maintained constant at 9m/s, and profiles were measured at each of the 6 downwind positions for each of the 3 stack heights. The interested reader should consult the full data report for more details and results.

Northwest wind direction

A total of 16 cases was studied at the northwest wind direction, including 6 cases (6 different wind speeds) with the existing stack and 5 each with the GEP and highest stacks. Two additional cases included measurements with the buildings removed.

The results are summarized in Figure 9, which shows $(C_f/Q_f)_{mx}$ plotted as a function of wind speed for the northwest wind direction. As for the southeast wind case, critical wind speeds were observed for the GEP and highest stacks, but, within the range of observed winds near the site, not for the existing stack. As a matter of academic interest, we extended the wind speed range to verify that one did indeed exist; it was found to be in the neighborhood of 18m/s, a value far in excess of the highest value observed at the 500ft level during the 5-year period analyzed (*cf.*, Sect. 2). For the GEP and highest stacks, the critical wind speeds were approximately 7 and 6m/s, respectively, although the maximum glcs vary little as the wind speed ranges between about 5 and 10m/s. The values of the maximum glcs at the critical wind speeds are about 7.5 with the existing stack, 3.0 with the GEP stack, and 1.9 with the highest stack. These values are somewhat smaller than observed with southeast winds, presumably because with southeast winds the higher hill is upwind.

Notice also from Figure 9 that we have plotted two points labelled "no buildings". Because we felt the tallest buildings in the vicinity of the stack were exerting substantial downwash influence on the plumes, we removed them and remeasured the surface concentrations (at one wind speed only, 13.5m/s). The maximum value in the presence of the buildings was found to be substantially higher than that in the absence of the buildings (C_B/C_{NB} = 1.57) with the existing stack. With the GEP stack, the maximum was marginally higher (C_B/C_{NB} = 1.14). (Note that a GEP stack height study would establish the GEP stack height as that which resulted in an excessive concentration of 40%, or C_B/C_{NB} = 1.40.) As mentioned in Section 2, a proper building downwash study would have been done at a much larger scale. Hence, we believe the building-downwash observations are *indicative* of problems at full scale, but are perhaps not quantitatively valid.

The downwash distances x_{mx} to the maximum glcs (not shown) increased as the stack height increased, of course, and decreased as the wind speed increased. The x_{mx} values for the two cases without the buildings were substantially larger than those in the absence of the buildings, again indicating serious building-downwash effects.

Flat terrain

The flat-terrain measurements were made to form the basis with which the measurements in the presence of the terrain could be compared. A total of 14 cases with buildings was studied,

including 5 cases each with the existing and GEP stacks, and 4 cases with the highest stack. Three cases were done without buildings, FE9.0N, FE13.5N and FG13.5N (the suffix N indicates No buildings). The "building" model used for most of the flat-terrain measurements consisted of the group of six buildings closest to the stack.

A note on matching of wind speeds: the conceptual design of this study included measurements in flat terrain, and the question to be answered was phrased as "what is the effect of the terrain on the plume behavior and resulting concentration patterns?" or, asked another way, "if the terrain were flat, how would the concentration patterns differ?" The question that arose immediately was what wind speed should be used in the flat-terrain simulations. Obviously, the wind speed at the stack top should not be set equal to its value in the presence of the terrain; the shielding by the upwind terrain greatly reduces the speed at the stack top from what would have existed had the upwind terrain been flat. Even the 500ft-level wind speed is influence by the terrain, as this elevation is just above the tops of the hills surrounding the river valley. We chose instead to match the wind speed above the boundary layer -- the freestream wind speed. In other words, we will compare concentration patterns measured in the presence of the complex terrain with those measured in flat terrain *where the freestream wind speeds are the same in both cases.*

The wind speed profile in flat terrain was markedly different from the in-terrain profiles, having much higher speeds at the lower levels. Note that, for the same freestream wind speeds, the stack-top wind speeds are substantially higher than those in the complex terrain.

$(C_f/Q_f)_{mx}$ is plotted as a function of wind speed in the flat-terrain case in Figure 10. Again, critical wind speeds are found for the GEP and highest stacks, but not for the existing stack. For the GEP stack the critical wind speed is approximately 10m/s; for the highest stack, the glc is practically independent of wind speed over the range tested, but a very slight maximum appears around 7m/s. The data for the existing stack appear to be leveling off at the higher wind speeds tested, and we may *speculate* that the critical wind speed is around 16m/s, with a maximum glc around $10\mu sec/m^3$. Hence, the maximum concentrations at the critical wind speeds are ~10 with the existing stack, 3.2 with the GEP stack, and 1.2 with the highest stack; very considerable reductions are observed as the stack height is increased.

Three additional data points are included on Figure 10; these represent measurements in the absence of the buildings. Comparisons with the measurements in the presence of the buildings show very strong building-downwash effects -- more so than were observed in the presence of terrain; presumably, this is because the higher wind speed at stack top in the flat-terrain case reduced the plume rise -- the plume was therefore more readily downwashed into the building wake. Also, the data suggest (and other studies support) that building downwash is less severe at the lower wind speeds -- the plume rise is much more substantial, so that the plume escapes the building wake. Note finally that the data of Figure 10 (also Fig. 9 for northwest winds) suggest that critical wind speeds are *increased* by the presence of the buildings.

Finally as an aid to further understanding, we measured four sets of vertical concentration profiles at each of six downwind positions in the flat-terrain case. The interested reader is referred to the data report.

Analysis of Terrain Effects

In this section, we compare and contrast the plume behavior, patterns, critical wind speeds, and locations and values of the maximum glcs, with the primary goal being to deduce the effects of the terrain. $(C_f/Q_f)_{mx}$ is plotted as a function of wind speed in Figure 11 for both wind directions in complex terrain as well as for flat terrain. In all cases shown in this figure, all buildings on the WTI site were present. In spite of all the extra measurements that were made, we find it difficult to provide satisfactory explanations for some of the detailed results shown in this figure. The broad features shown are understandable:

(1) Maximum glcs clearly and substantially decrease as the stack height increases in each of the three terrain types; this is also generally true when taken by groups, *i.e.*, the curves in the short-stack group are generally above the curves in the GEP-stack group, which are generally above the curves in the highest stack group. Hence, the differences due to changes in stack height are much more significant than changes in terrain type or wind direction.

(2) Critical wind speeds are observed with the GEP and highest stacks, but are not observed for the shortest stack within the normal range of wind speeds observed near the site. These critical wind speeds consistently decrease as the stack height is increased.

When trying to differentiate between the three terrain types, however, the results appear somewhat inconsistent and are, perhaps, indefinable. The curve for the short stack in flat terrain is quite similar to that for the southeast wind direction, but both these curves show substantially higher glcs than observed with the northwest wind. Perhaps most surprising, at first, is that neither complex terrain case exhibits higher glcs than does flat terrain. This may be partially explained as a result of the increased plume rise in the complex terrain; recall that we matched freestream wind speeds, so that the complex terrain provided a shielding or reduction of wind speeds at the stack top, which would enhance the plume rise and reduce the glcs. As is well known from previous studies, however, the centerline of a plume may approach the surface of a three-dimensional hill much more closely than it may a two-dimensional hill; and, of course, the same plume will approach the surface of a two-dimensional hill more closely than it will a flat underlying surface. Hence, the effect of the larger plume rise in the complex terrain (smaller glcs) may be counteracted by the effect of the closer approach of the plume centerline to the surface in complex terrain (larger glcs). In the present case, we may speculate that these counteracting effects were balanced with the short stack and southeast winds, resulting in glcs approximately equal to those in flat terrain.

Many other factors are involved in the transport and dispersion process, however, and the above explanation is a gross oversimplification. Two other very important factors include the high-intensity, large-scale turbulence generated by the terrain features and, especially, the distorted mean streamline patterns. The primary factor causing the glcs with the southeast winds to be higher than those with the northwest winds is almost certainly the more strongly descending streamlines in the southeast wind case. Our pulsed-wire and hot-wire measurements in this case showed strong downwash from the higher, more nearly two-dimensional hill upwind of the stack. We did not make such measurements under northwest winds, but streamline descent would surely be less steep; the upwind hill in this case is substantially lower and substantially narrower in the crosswind direction ("less two-dimensional"). Hence, we might expect glcs to be lower with northwest winds, which was,

in fact, observed.

Critical wind speeds and maximum glcs observed at those critical wind speeds for each terrain configuration and stack height are collected in Tables 2 and 3.

Table 2. Critical wind speed, m/s.

	Stack height, m		
Configuration	45.7	72.7	120
125°	>13.5	11	7
305°	18	7	6
Flat	~16	10	7

Table 3. Maximum concentrations $(C_f/Q_f)_{mx}$, $\mu sec/m^3$, at critical wind speeds.

	Stack height, m		
Configuration	45.7	72.7	120
125°	>10.5	4.2	2.0
305°	7.5	3	1.9
Flat	~10	3.2	1.2

Figure 12 shows the location x_{mx} of the maximum glc as a function of wind speed for both wind directions in complex terrain and in flat terrain. Again, the broad features are understandable:

(1) the distances to the maximum glcs increase as the stack height increases in each of the three terrain types. This is also true, at least for the higher wind speeds, when taken by groups, *i.e.*, the curves in the high-stack group are above those of the GEP-stack group, which are above those of the existing-stack group. Again, the differences due to changes in stack height appear to be more significant than the changes in terrain type or wind direction.

(2) the largest distances to the maximum glcs occur by wide margins with the highest stack in the flat terrain. The shortest distances occur consistently with the existing stack in complex terrain; of the two wind directions, the southeast one (largest hill upwind) results in the maximum glcs closest to the source.

Comparisons of the vertical concentration profiles in the presence of terrain with those over flat terrain suggest that our earlier arguments concerning the differences in plume rise because of the shielding by the complex terrain are highly oversimplified; the data, in fact, suggested that the plume-rise values a short distance downwind were virtually identical with the two taller stacks. These data suggest that the higher level of turbulence induced by the terrain increases the lateral and vertical

widths of the plumes by substantial amounts (25 to 35%) and decreases the maximum concentrations within the plumes (by about 30%). On the other hand, it is exceedingly difficult to interpret these observations and show how they translate to the observations of Figure 11. For example, the two plumes from the lowest stack were of different elevation (7m out of 45.7m), yet resulted in virtually the same maximum glcs. The plumes from the taller stacks were at essentially identical elevations at x= 240m, yet the maximum glcs were substantially different in the two cases.

We must conclude that the terrain effects are so complex as to defy satisfactory detailed explanations. The distortion of mean streamline patterns by the terrain, enhancement of turbulence, shielding and reduction of wind speeds, and plume rise and building-downwash effects combine in what appear to be mysterious ways -- a large number of additional measurements would be required to fully understand and interpret the results. Nevertheless, the broad features of the results are reasonably consistent and understandable.

5. SUMMARY AND CONCLUSIONS

A wind-tunnel study of transport and dispersion of plumes from the Waste Technologies Industries smokestack was performed in the EPA Meteorological Wind Tunnel to examine terrain downwash effects and to assess the resulting values and patterns of ground-level concentrations. An atmospheric boundary layer that simulated the velocity and dispersion characteristics in a forested, hilly region was generated using spires and roughness blocks. A 1:480 scale model of the area surrounding the WTI facility was installed in the wind tunnel for two wind directions, 125° and 305°; these directions put the largest nearby hills directly upwind and downwind of the stack, with the wind blowing across the river valley. This scale is suitable for the terrain-downwash study, and uses distorted stack diameter modeling. Dispersion near the buildings, in particular *building-downwash* effects, are not strictly modeled. Building-downwash observations are therefore regarded as qualitatively indicative of problems at the full-scale site, but are not to be taken as strictly valid quantitatively.

For each wind direction, three stack heights were used; the existing stack (45.7m), the good-engineering-practice stack (72.7m) and a higher stack (120m). For each stack and wind direction, ground-level concentrations (glcs) of the tracer released from the stack were measured at distances from 240 to 2400m downwind for a range of wind speeds. The terrain model was replaced with a suitably-roughened flat surface and the glcs for conditions equivalent to those with the terrain were measured. For several cases, vertical profiles of concentration were obtained at six downwind distances. In addition, for the 125° wind direction, all three components of the wind vector were measured in the centerplane of the valley with a pulsed-wire anemometer.

Based upon the velocity measurements and observations using a smoke tracer, a small recirculation region was found at the base of the upwind hill. The stack, located farther downwind, was in an area of downward-directed mean flow. The equivalent approach flow for flat-terrain comparisons was based on matching the freestream speeds. At a given freestream speed, the wind speeds at stack-top elevation were considerably lower with the complex terrain present.

For each combination of wind direction (or flat terrain), stack height, and wind speed, a map of the measured glcs was drawn. By plotting the maximum concentration at each distance against the distance from the source and hand-fitting a smooth curve, the maximum expected concentration and its distance from the source was determined for each case. Comparison of these maxima for the actual site with those in flat terrain enabled evaluation of the influence of the nearby terrain on dispersion from the stack.

Many interacting factors contribute to the differences in the glc patterns observed as a result of emissions from the WTI site and those observed from the same source in flat terrain. For the two wind directions studied, large hills reach their peak elevations approximately 1000m upwind and 1000m downwind of the stack. An upwind hill tends to reduce the wind speed at stack top, which should increase the plume rise and reduce the maximum ground-level concentrations. On the other hand, the upwind hill tends to produce a downward component of wind velocity at stack top and to increase the intensity of the ambient turbulence; both these effects tend to bring the plume to ground level more rapidly and to increase the ground-level concentrations. A downwind hill will also tend to increase glcs, the degree of which depends upon the hill shape; maximum glcs on three-dimensional hills tend to be larger than those on two-dimensional hills when the sources are upstream. In the present case, one of the hills might be classified as ridge (very roughly two-dimensional), whereas the other is more of a knob (fully three-dimensional). Further complicating our understanding is the presence of building influences for the shorter stacks and higher wind speeds. The concentrations as measured and presented herein are influenced by all these factors; to quantify the influences of each factor would require many additional measurements.

In spite of our inability to isolate and describe in detail the specific causes of the results, the broad picture is understood and the concentration patterns and values should be eminently usable for the intended purpose. Given emission rates of passive containments from the WTI stack, the user may simply and easily apply the surface maps contained herein to calculate concentration levels and areas of exposure for each of the wind speeds, directions, and stack heights tested. With some interpolation, he may use the results for wide ranges of wind speeds and stack heights under what we believe to be the most serious terrain-downwash conditions.

This data set should be complemented by a meteorological analysis that assesses the relative frequencies of occurrence of those conditions which result in the maximum glcs. A further risk assessment must be made by health specialists as to whether those values of concentration and frequencies of occurrence are acceptable. These results will assist EPA's Regional Office in assessing the impacts of the surrounding topography as it relates to the overall risks associated with operation of the WTI hazardous waste incinerator.

ACKNOWLEDGEMENTS

The authors express their appreciation to Ms. Donna Schwede, Atmospheric Sciences Modeling Division (ASMD), National Oceanic and Atmospheric Administration (NOAA), for her help in processing the wind records from the Beaver Valley Power Station, to Messrs. G. Leonard Marsh, Mantech Environmental Technology (MET), and GuWei Zhu, North Carolina State University, for their help in collecting the wind-tunnel data, to the latter two plus Messrs. Paul

Bookman, MET, Van Hursey, MET, and Lewis A. Knight, ASMD, NOAA, for help in preparing the wind tunnel and constructing and installing the terrain model, to Mr. Michael S. Shipman, MET, for developing specialized software, to Mr. Robert E. Lawson, Jr., ASMD, NOAA for help with the pulsed-wire measurements, and to Ms. Pamela Bagley, ASMD, NOAA, for typing this report. We also wish to thank Mr. Virgil Reynolds, East Liverpool, OH, for supplying numerous aerial photographs and videotapes of the site and surrounding areas; these were especially useful in construction of the model. Finally we thank Ms. Pamela Blakley, Region 5, EPA, who supplied many maps, facts, and figures useful to the study.

DISCLAIMER

This document is intended for internal Agency use only. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

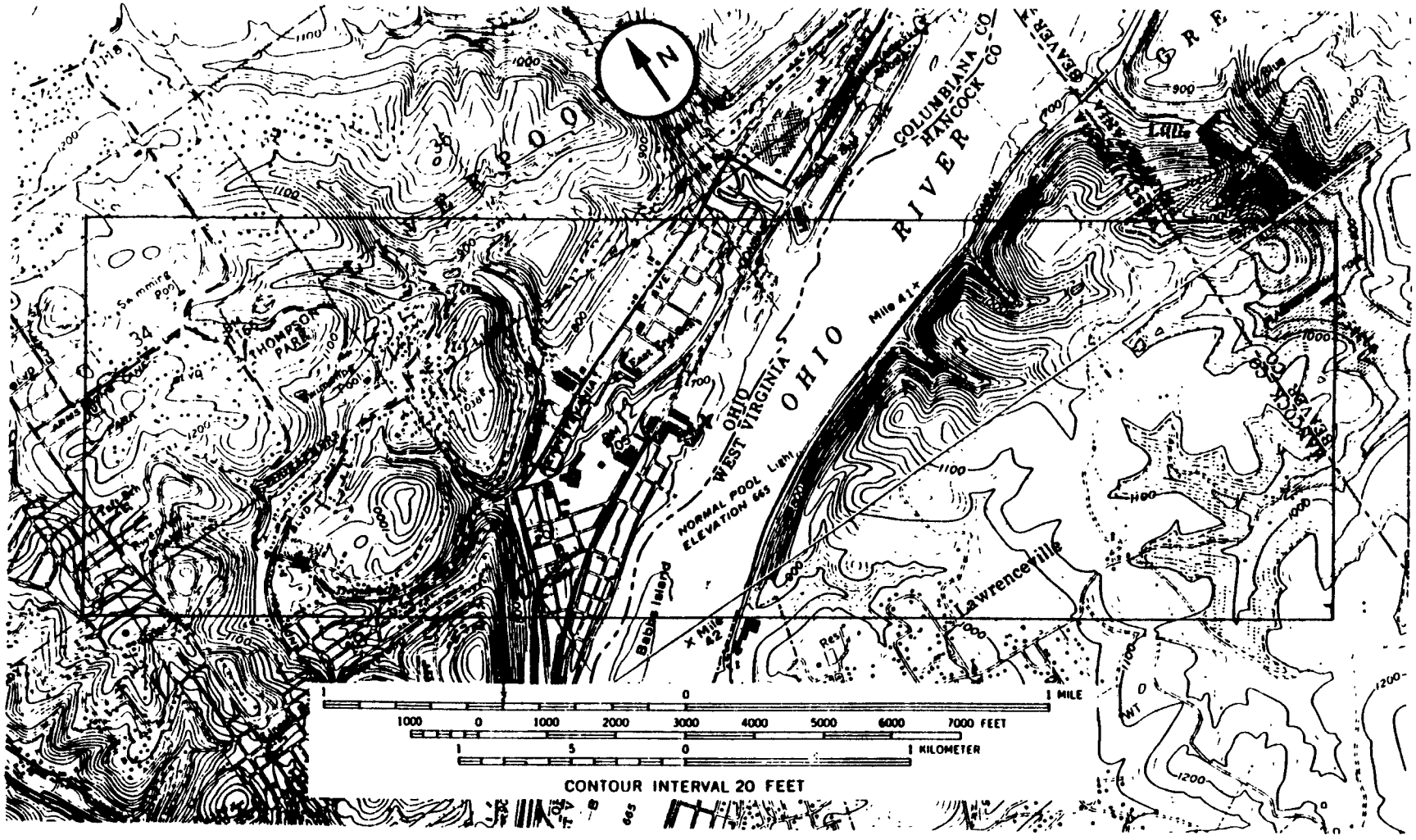

Figure 1. Topographical map showing terrain surrounding WTI site. Rectangle shows boundaries of wind-tunnel model. x is location of stack. WTI buildings not shown.

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FIG2.DRW

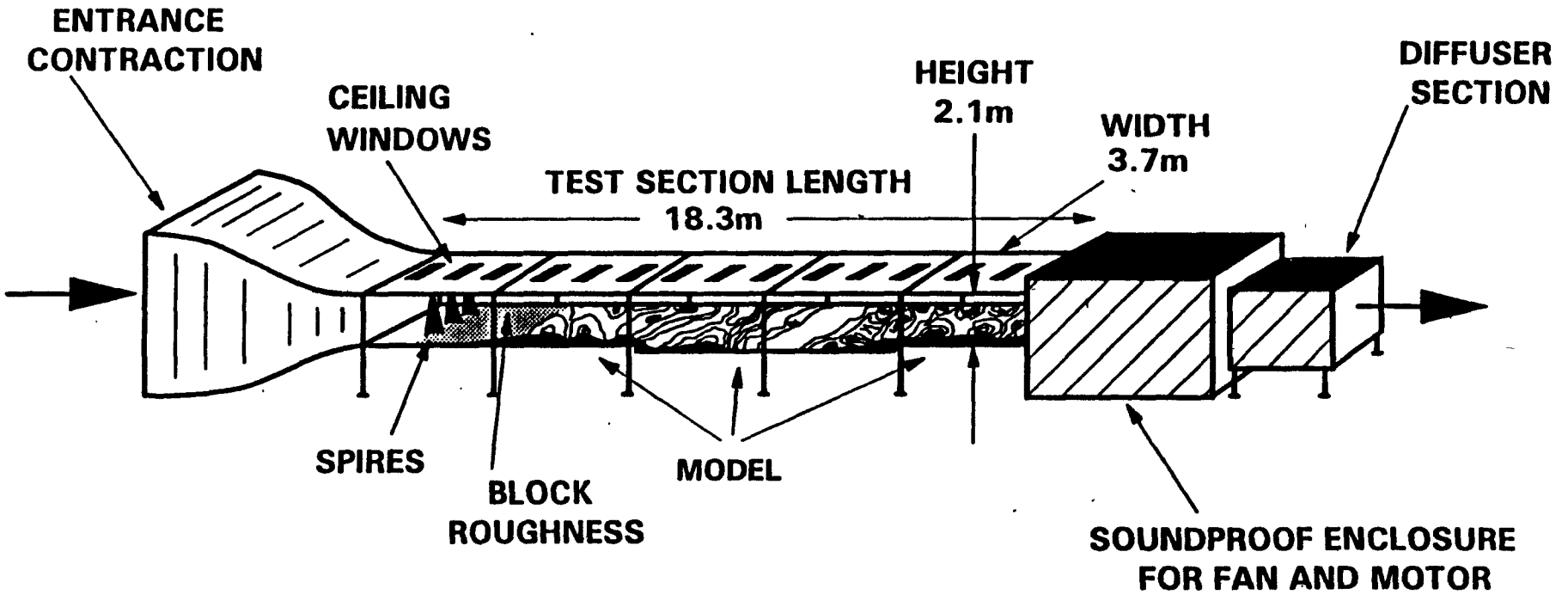

Figure 2. Schematic diagram of the EPA Meteorological Wind Tunnel

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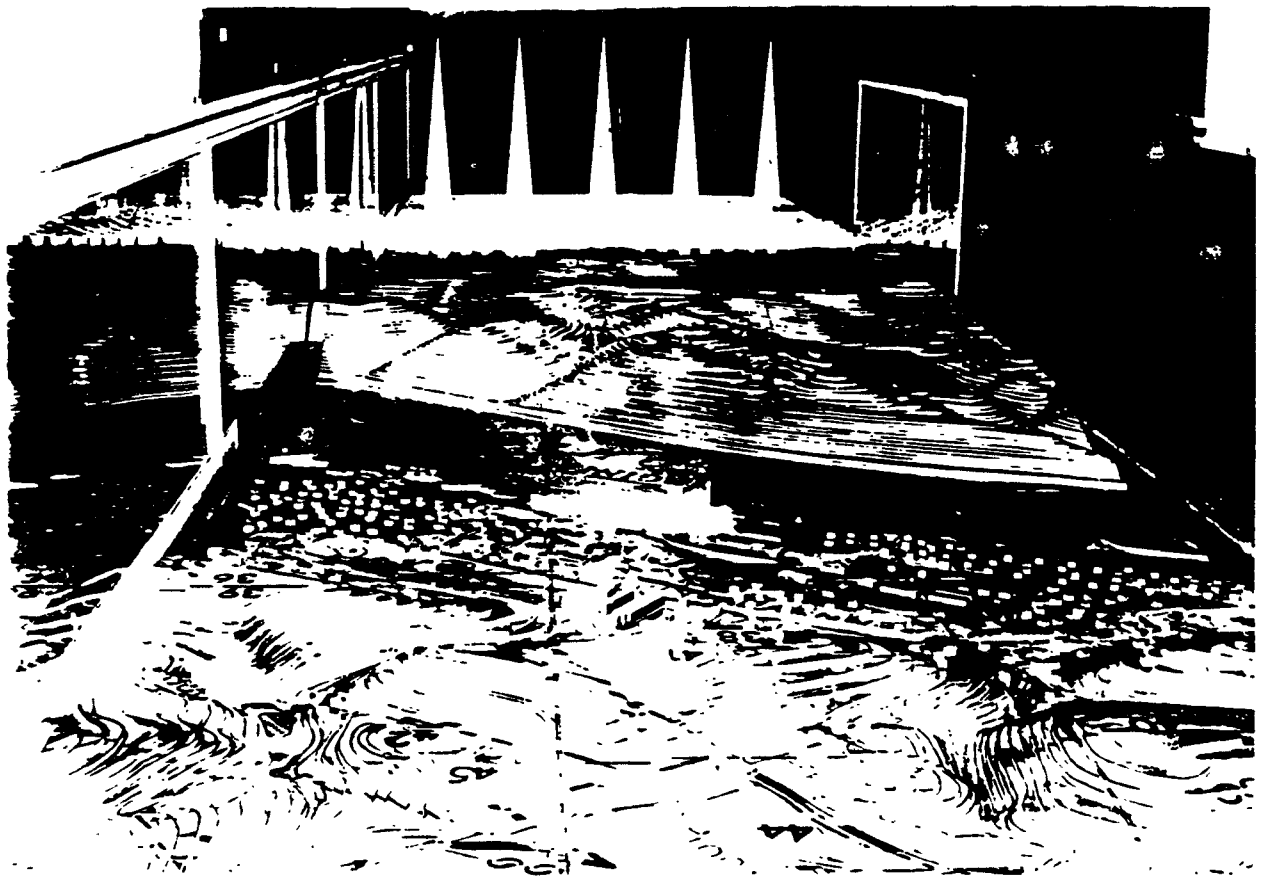

Figure 3. View of WTI terrain model in meteorological wind tunnel -- looking upstream.

Figure 4. Flow vectors in centerplane of river valley

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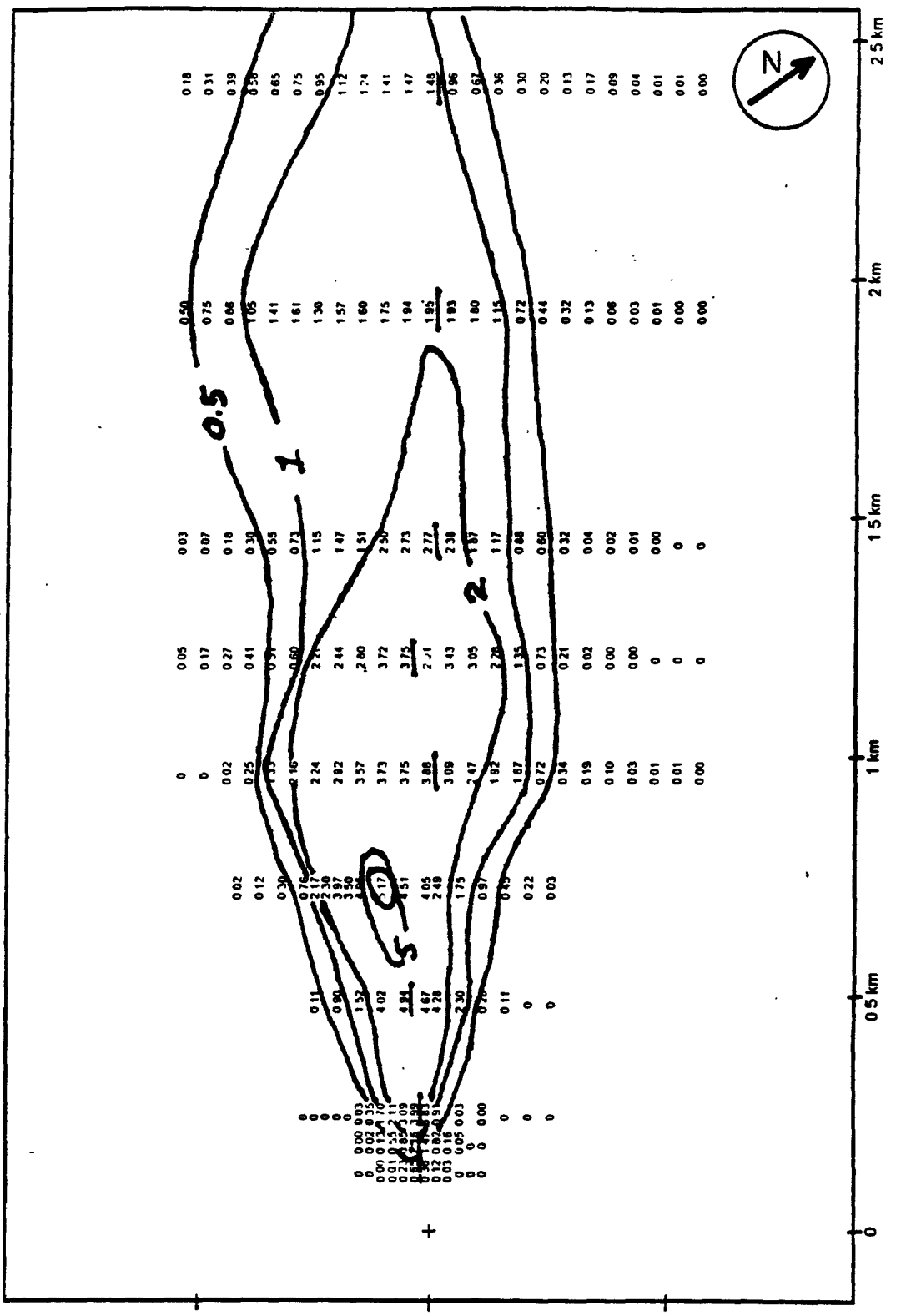

Figure 5. Surface concentration map for case SE6.8. H_s = 45.7m, wind direction = 125°, U_{500} = 6.8m/s.

SE6-8MX 001 (1 2) Max gic vs downwind distance WD=125deg. U=6 8m/s Hs=45 7m
06-25-94

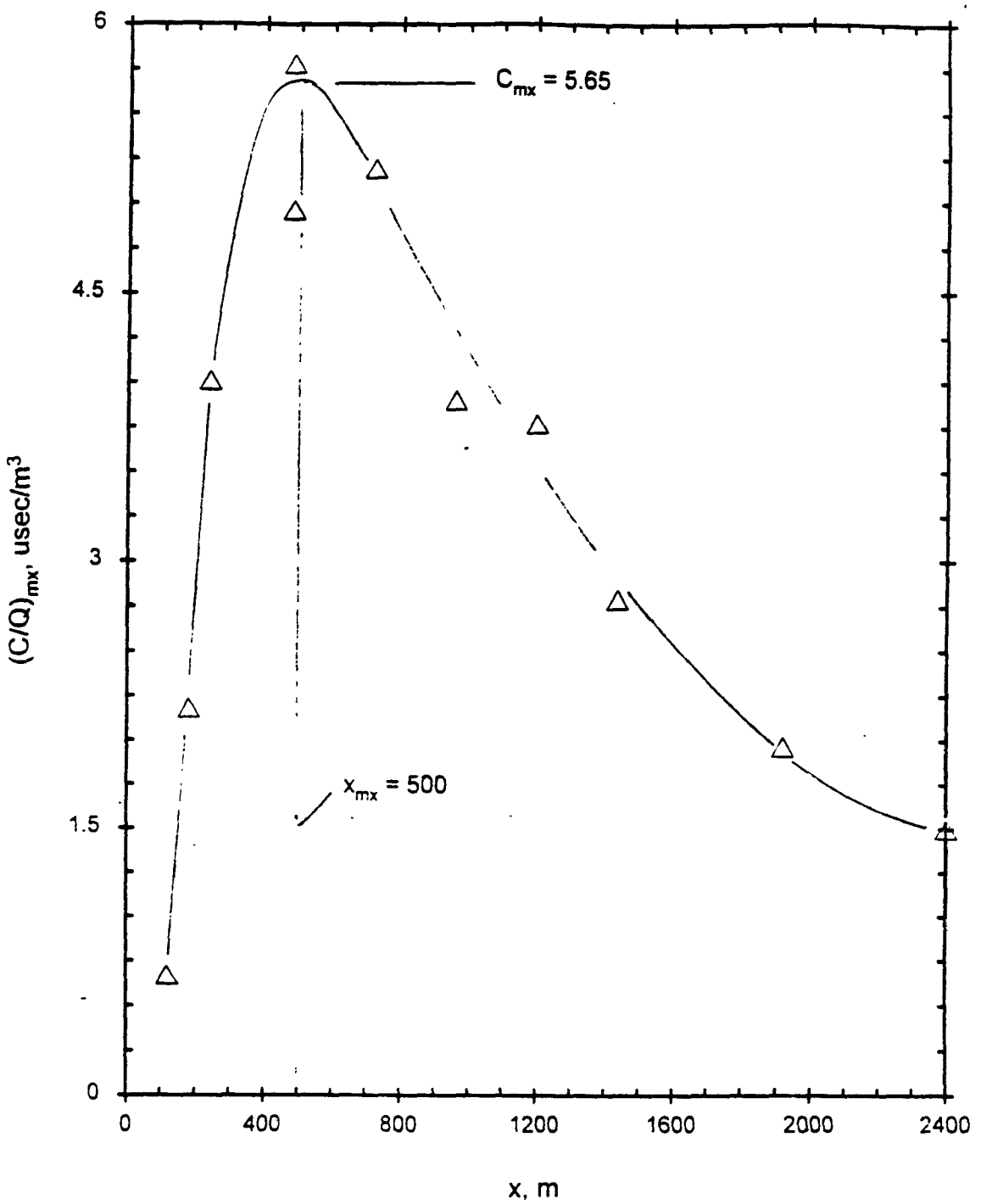

Figure 6. Maximum concentration versus downwind distance for case SE6.8. H_s = 45.7m, wind direction = 125°, U_{500} = 6.8m/s.

△ WTISEMX.001 (1,2) Max concentration and distance vs wind speed, WD=125deg, Hs=45.7m
06-15-94

□ WTISGMX.001 (1,2) Max concentration and distance vs wind speed, WD=125deg, Hs=72.7m
06-16-94

○ WTISHMX.001 (1,2) Max concentration and distance vs wind speed, WD=125deg, Hs=120m
06-20-94

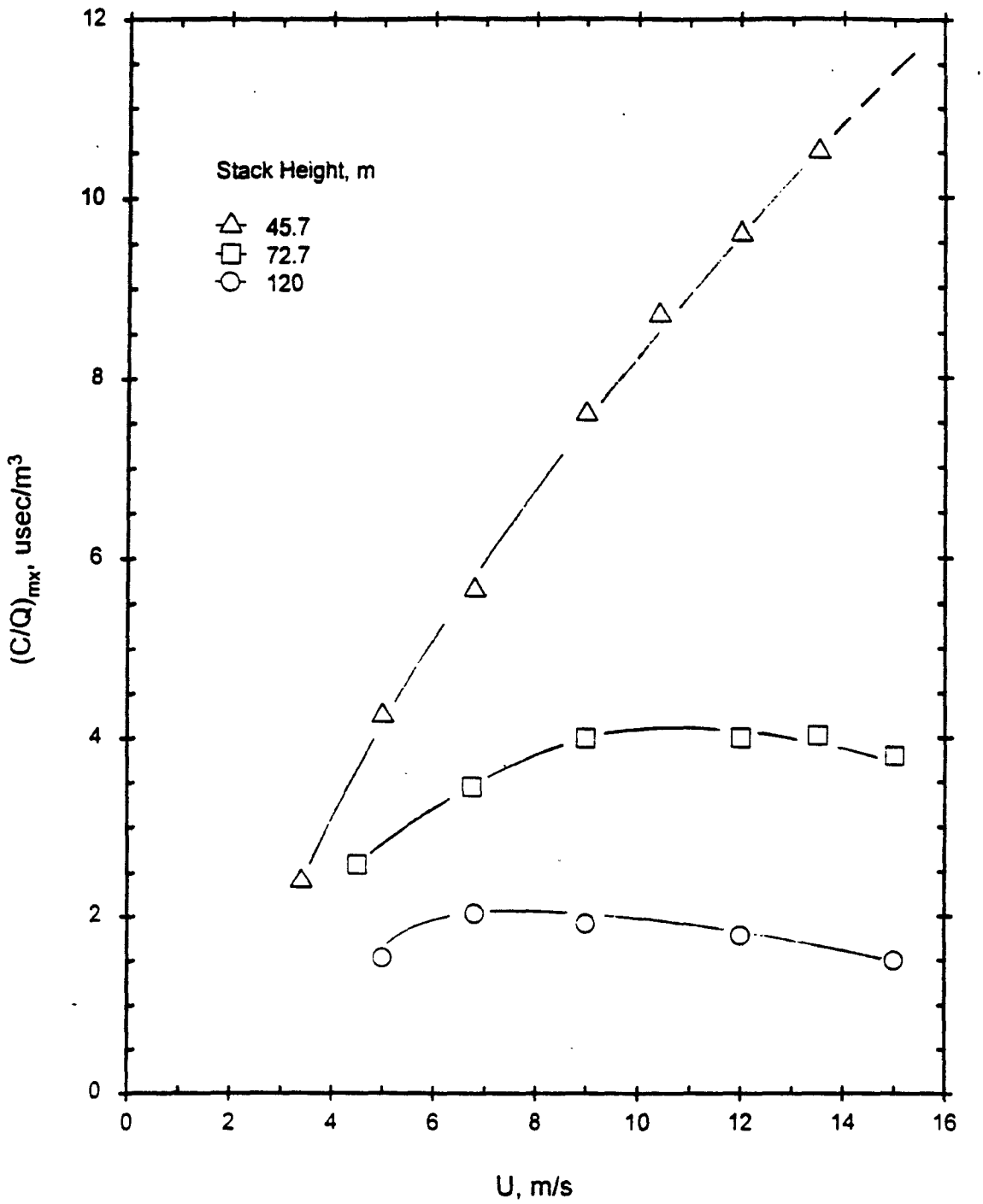

Figure 7. Maximum glc versus wind speed for SE wind direction.

△ WTISEMX 001 (1.3) Max concentration and distance vs wind speed WD=125deg Hs=45 7m
06-15-94

□ WTISGMX 001 (1 3) Max concentration and distance vs wind speed, WD=125deg, Hs=72 7m
06-16-94

○ WTISHMX.001 (1.3) Max concentration and distance vs wind speed, WD=125deg, Hs=120m
06-20-94

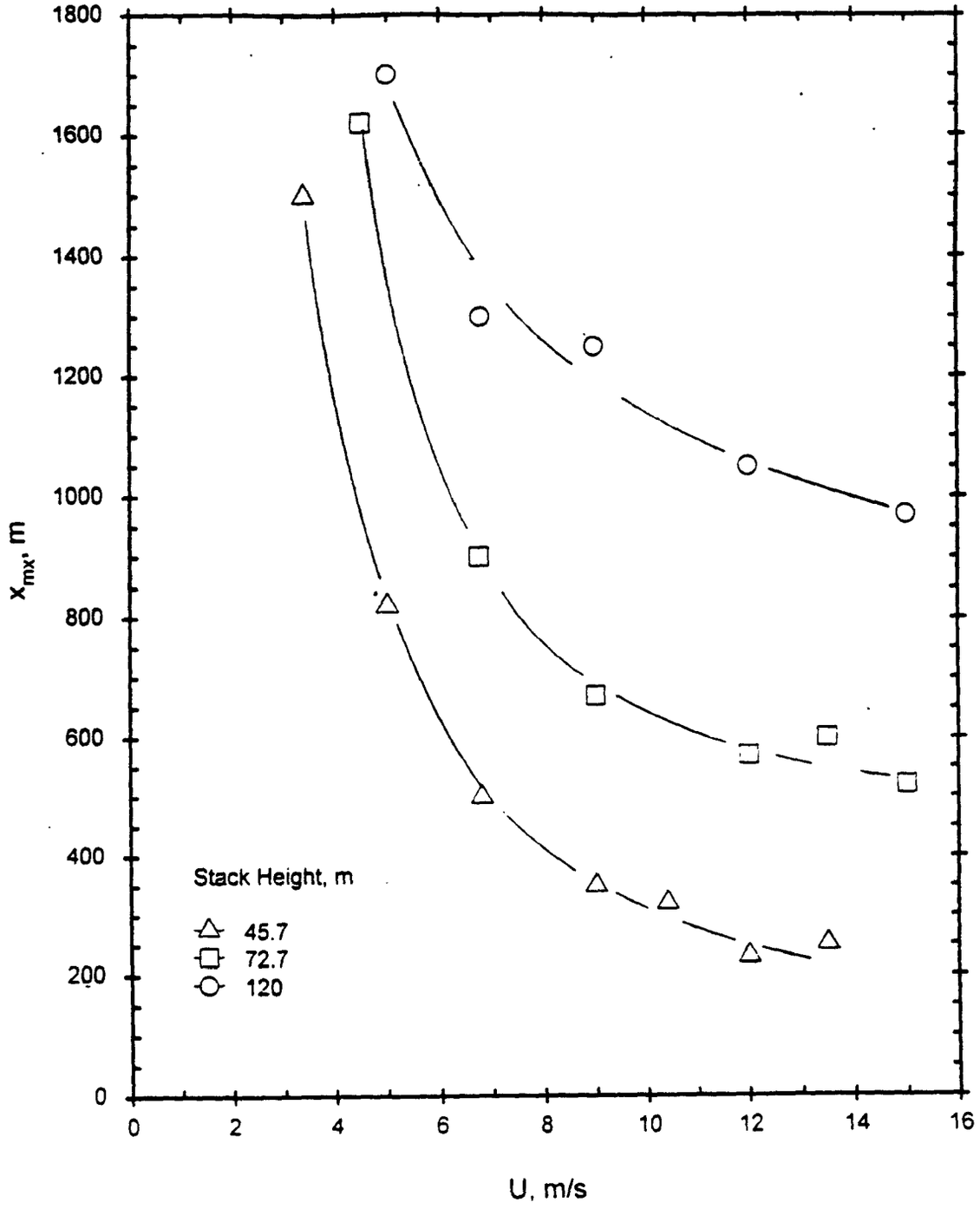

Figure 8. Distance to maximum glc versus wind speed for SE wind direction.

△ WTINEMX.001 (1,2) 07-13-94 Max concentration and distance vs wind speed, WD=305deg, Hs=45.7m

□ WTINGMX.001 (1,2) 07-13-94 Max concentration and distance vs wind speed, WD=305deg, Hs=72.7m

○ WTINHMX.001 (1,2) 07-13-94 Max concentration and distance vs wind speed, WD=305deg, Hs=120m

▲ WTINENM.001 (1,2) 07-13-94 Max concentration and distance vs wind speed, WD=305deg, Hs=45.7m w/o bldgs

■ WTINGNM.001 (1,2) 07-13-94 Max concentration and distance vs wind speed, WD=305deg, Hs=72.7m w/o bldgs

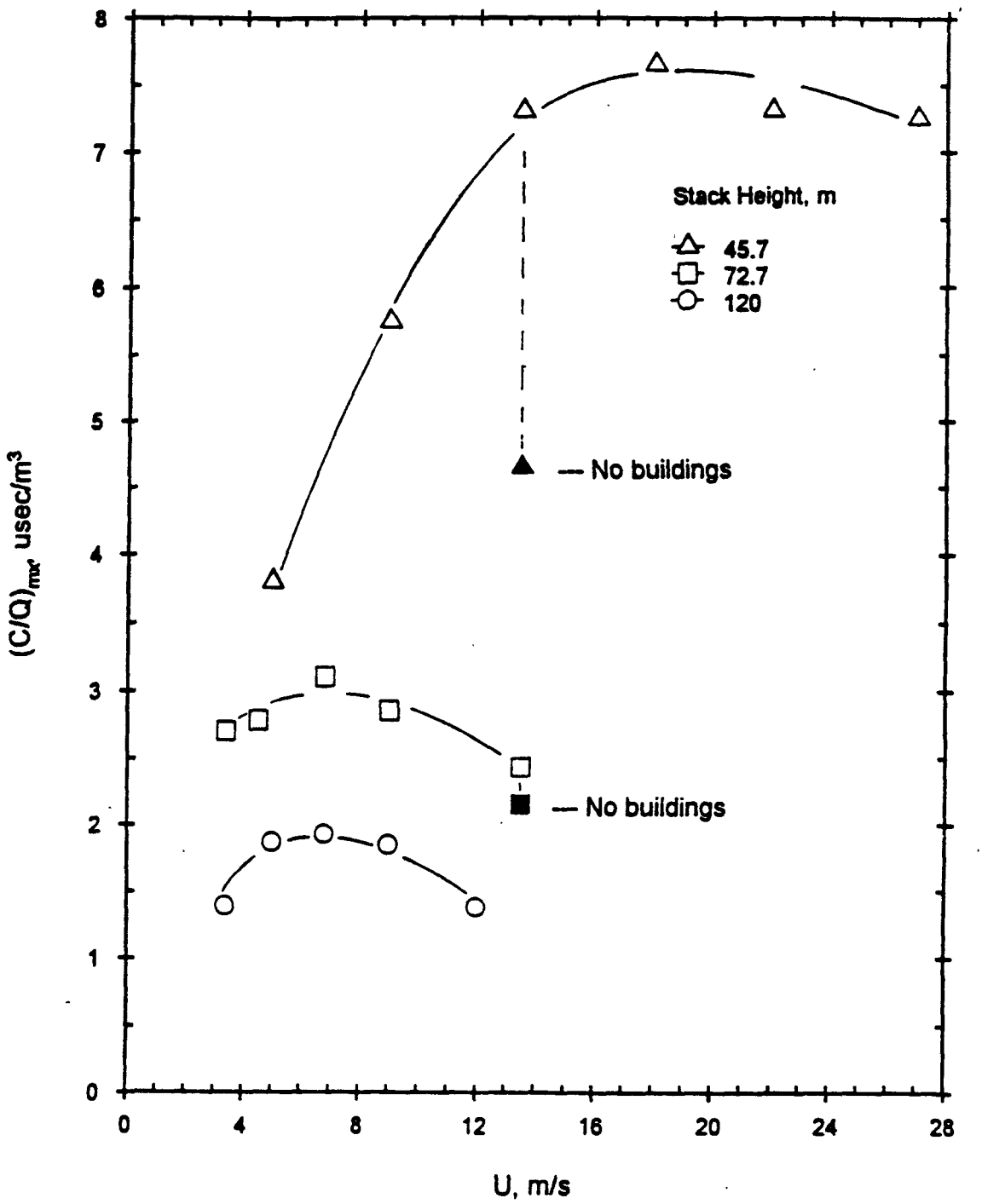

Figure 9. Maximum glc versus wind speed for NW wind direction.

△ WTIFEMX.001 (1,2) Max concentration and distance vs wind speed for flat terrain, w/ bldg
07-26-94 Hs=45.7m

□ WTIFGMX.001 (1,2) Max concentration and distance vs wind speed for flat terrain, w/ bldg
07-26-94 Hs=72.7m

○ WTIFHMX.001 (1,2) Max concentration and distance vs wind speed for flat terrain, w/ bldg
07-27-94 Hs=120m

▲ WTIFENMX.001 (1,2) Max concentration and distance vs wind speed for flat terrain, w/o bldg
07-27-94 Hs=45.7m

■ WTIFGNMX.001 (1,2) Max concentration and distance vs wind speed for flat terrain, w/o bldg
07-27-94 Hs=72.7m

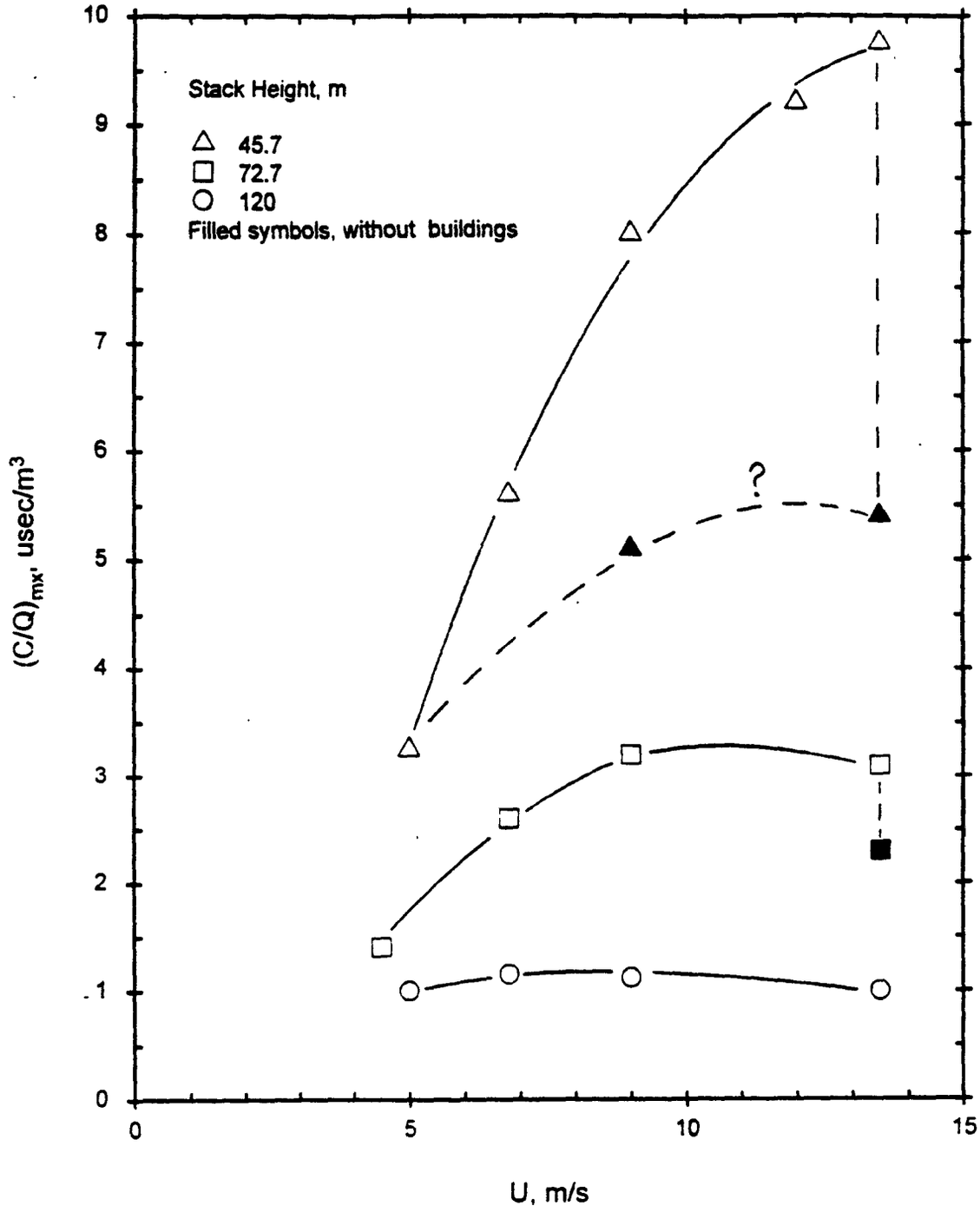

Figure 10. Maximum glc versus wind speed in flat terrain.

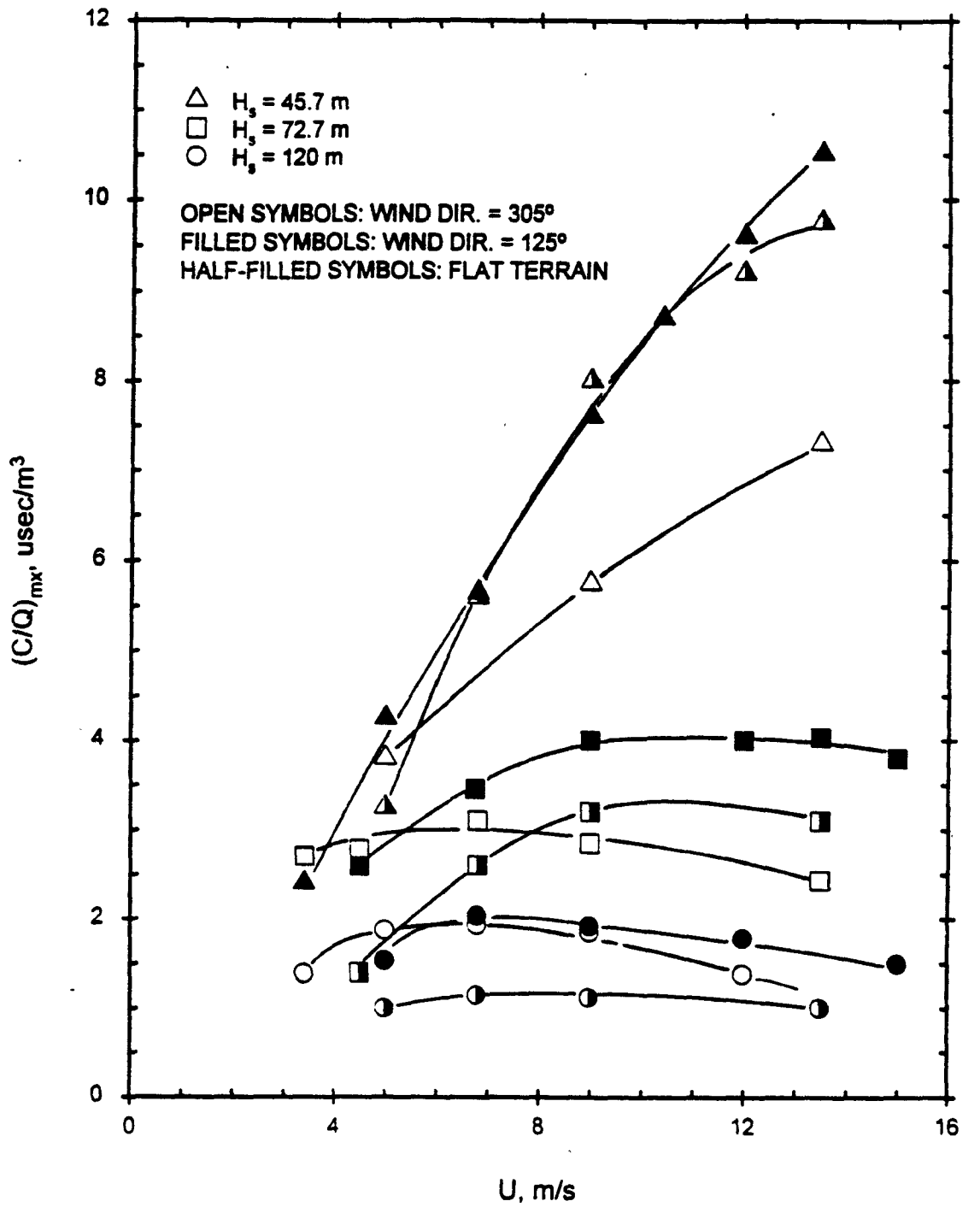

Figure 11. Maximum glc versus wind speed for all configurations with buildings.

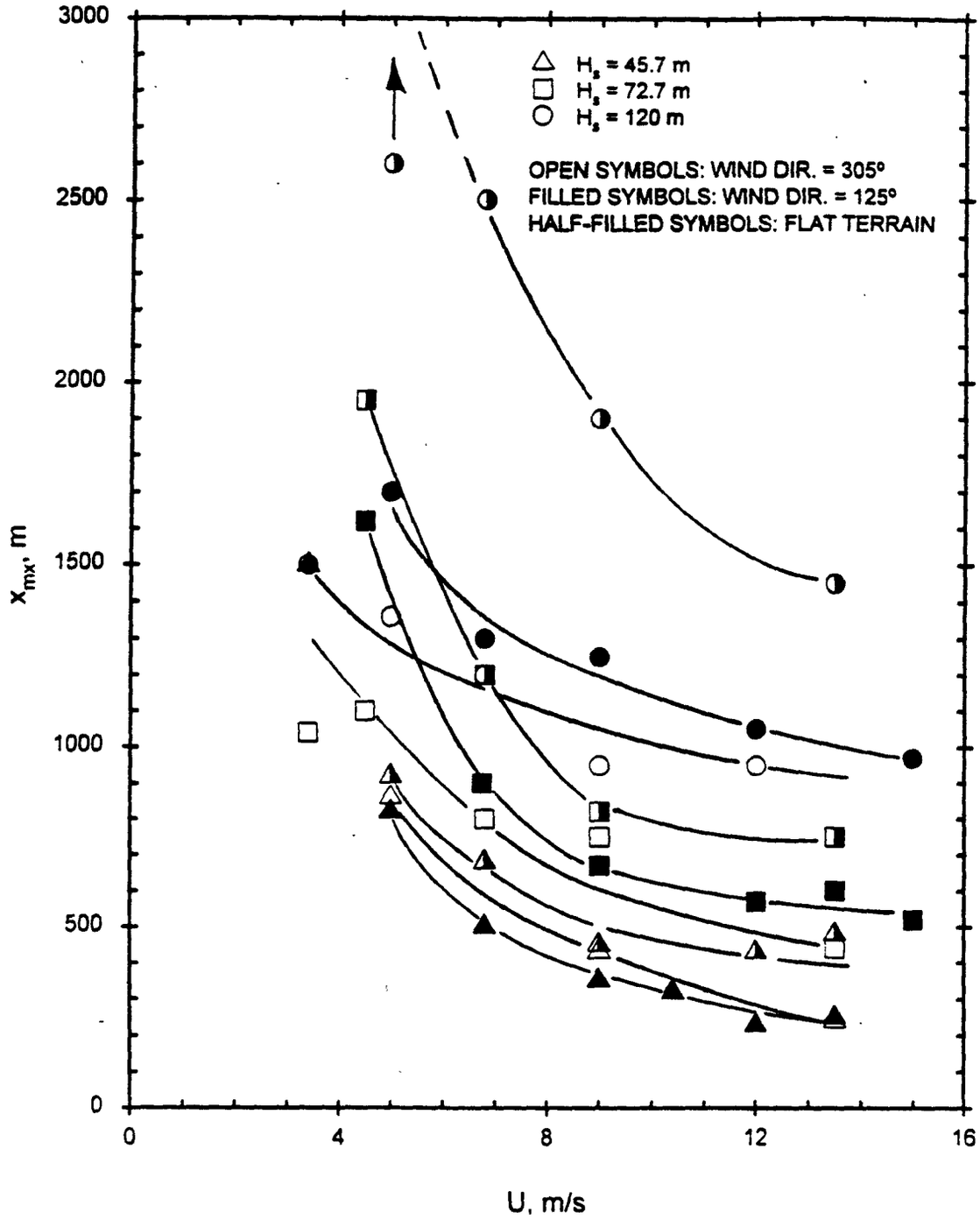

Figure 12. Distance to maximum glc versus wind speed for all configurations with buildings.

APPENDIX IV-7
PEER REVIEW COMMENTS

COMMENTS

D. Bruce Turner, C.C.M.

From the desk of D. Bruce Turner, C. C. M.
P O Box 2099, Chapel Hill, NC 27515-2099

June 27, 1995

Review of the ISC-COMPDEP Model

Background

A review of the ISC-COMPDEP Model was made based upon the following materials:

In hard copy:

"Development of the ISC-COMPDEP and User Instructions" Submitted by: A. T. Kearney, Inc.; Submitted to: Bernie Orenstein, US EPA, Region V. In response to : EPA Contract No. 68-W9-0040, Work Assignment No. R05-32-01. December 1993.

"Summary of ISC-COMPDEP Model" Submitted by: A. T. Kearney, Inc.; Submitted to Pam Blakley, EPA Region V. EPA Work Assignment No. R05001, Contract No. 68-W4-0006. August 16, 1994.

"User Instructions for a New Area Source Algorithm" U. S. EPA, August 1993.

"Appendix A, Integration Approach" (no further identification)

In electronic form:

ISC2 Users Guide (Vol. 1, Vol. 2, and Appendices)

ISCOMDEP executable code and test data.

Action Taken

The furnished materials were reviewed. (Some pages that were missing from one of the documents were sent to me by fax.) The tests included with the materials furnished were run and verified to produce proper results. A number of additional tests were devised and run to examine specific features of the model. These are described and discussed in the last section of this review.

Comments on the Appropriateness of the Methods Used to Develop the Model

The EPA undertook a multi-million dollar effort to develop a refined model for use in complex terrain. The CTDMPLUS is a result of that effort and is designated by EPA as a refined model for use in complex terrain.

The CTDMPLUS, however, does not include effects of building downwash, the calculation of wet/dry deposition, or the ability to calculate concentration or deposition from an area source.

Therefore if a given source configuration includes both considerations of complex terrain, as well as some of the features mentioned in the above paragraph, to analyze impacts for this source it must be determined if there are dominant features to be considered that make selection of an existing model possible in spite of limitations or if it necessary to create a new model that will have the necessary features combined that will allow the proper analysis of the situation.

Apparently, the decision was made to create a new model with the desired features.

It would seem that if complex terrain were of significant importance that the CTDMPLUS would be the base model with which to start and to add necessary features to that model. In this case this was not done. There is no information in the material furnished as to whether this was considered or not. Also there is no information furnished to determine the importance of complex terrain in relation to other desired modeling features.

The screening procedure for complex terrain situations that includes use of both ISCST2 and COMPLEXI that was in common use as a screening technique prior to the adoption of CTDMPLUS as a refined model for complex terrain has formed the basis of handling complex terrain for the model being reviewed. The way in which the results from these two models are combined is as follows: ISCST2 is used for receptors below stack top elevation; COMPLEXI is used for receptors above plume centerline; both models are evaluated for receptors whose elevations are between stack top and plume centerline and the larger value chosen as the appropriate concentration.

Appropriateness of Dispersion Modeling Algorithms and Techniques to Regulatory Modeling

1) Treatment of Terrain

The treatment of terrain for receptor elevations that are between stack-top elevation and plume centerline elevation by using the largest value from the two techniques COMPLEXI or ISCST2 with chopped terrain are following regulatory guidance issued by EPA. Each of these techniques have little technical basis and are not compatible with each other. The COMPLEX-I is a 22.5° sector averaged technique which may be quite reasonable for long-term (monthly to annual or longer) concentration but has little relevance to one-hour plumes to which it is being applied here. One-hour plumes are much more likely to have higher concentrations near the centerline of the plume and drop to lower concentrations to the side. They may not have an exact Gaussian or normal distribution crosswind but are more likely to have a distribution not greatly differing from Gaussian than they are to have a uniform distribution crosswind across a 22.5° width.

The chopped ISCST2 calculations although assuming a normal distribution crosswind (and thus not very compatible with the COMPLEX-I technique) drops the elevation of the receptor regardless of its actual elevation to that of the stack top. This procedure is likely to underestimate the concentration at the receptor due to removing the receptor vertically away from the plume centerline. This underestimation of concentrations is probably compensated for by the dispersion parameters (σ_y and σ_z, the spreading parameters in the horizontal and the vertical) that are used. The parameters used as functions of the Pasquill stability class and downwind distance from the source are those commonly used over flat or rolling terrain. These are likely to be smaller than the dispersion that actually takes place in a terrain situation primarily due to the additional roughness of the terrain situation and the consequent generation of additional mechanical turbulence which increases the spreading. The effects of this additional spreading in the horizontal are easily understood as the additional spreading will reduce concentrations at all downwind locations. The effect of additional vertical spreading is not as easily explained as it will cause additional parts of the plume to be spread to a receptor beneath the plume centerline position and will increase concentrations. At greater distances the additional vertical spreading

will decrease concentrations just as is done in the horizontal. In summary, the chopped ISCST2 treatment likely causes the underestimation by the treatment of the vertical receptor position to be compensated, at least partially, by the overestimation resulting from using dispersion parameter values that are likely to be too small.

Since the larger value from the two techniques is chosen, this value frequently comes from the ISCST2 because of its narrower plume.

The preceding paragraphs are just commenting on the technical aspects of the two techniques adopted by guidance of EPA. It is expedient to include in ISC-COMPDEP those techniques which previously have been approved. Deviation from these techniques would need to be accompanied by considerable volumes of evaluation data; data which is not readily available.

2) Use of Wind and Temperature Data for Multiple Levels

The use of available onsite data is to encouraged. In fact, the use of multiple-level meteorological data is required by EPA in order to use the CTDMPLUS, the only refined complex terrain model approved (by Supplement B to the Guidelines) for regulatory use. The approximation of the direction of flow of the plume by the wind direction for the height of the leveled-off plume is much more likely to result in the plume being oriented toward the proper direction.

The calculation of the rise of the plume (and its resulting final height) is also likely to be more correct by considering the wind speed and temperature structure of the air through which the plume rises.

However, the model uses the wind speed at final plume height for dilution. This is *incorrect* since the dilution by the wind or stretching of the plume in the downwind direction is something that takes place by the horizontal wind as the effluent exits the stack. Therefore, the wind speed estimated to occur at stack top is the correct wind speed to use as a dilution wind.

3) The Building Downwash Techniques

Here as in the treatment of terrain the standard treatment in guidance is adopted in the model. This is appropriate since without substantiating data there is little basis to propose alternate techniques.

However, it needs to be pointed out that the current techniques make the assumptions that the size of the zone and the effects of downwash are not altered by either wind speed or stability. This results in the highest concentrations occurring downwind of buildings occurring with light winds and stable conditions. One expects the maximum sized zone of building generated turbulence to occur with moderate to strong wind speeds when the maximum degree of mechanically turbulence is generated. Under such wind speeds the atmosphere is driven to neutral. The actual effects that would be expected under light-wind stable conditions would be the drift of winds around buildings without the generation of much additional turbulence, thus having considerably less distortion of the flow and effect upon emissions from roof-top and higher heights. The use of the current downwash techniques endorsed by guidelines will tend to greatly overestimate the close-to-the-source concentrations that are calculated under light-wind stable conditions for sources that are calculated to be affected by building downwash.

4) The Area Source Algorithm

Although not particularly important for assessing effects from a hazardous waste incinerator, the inclusion of an improved area source algorithm is a welcome substitution to the base model. The problems of the simulation of an area source by a single finite line source that is located too close to the upwind side of the source (the technique used by ISC2) has been known for some time. Some calculations using the area source algorithm have been included in the examination of the model for this review (see 8) and 9) below). On the plus side the addition of the substitute algorithm not only allows much better calculation of concentrations at receptor distances at downwind locations near the source, but also allows more appropriate calculation of concentrations for receptors within the area source. The capabilities of this algorithm to properly estimate concentrations are especially important for the use of these concentrations to calculate deposition such as from an area source with particulate emissions raised by the movement of vehicles and the loading, unloading, and redistributing of particulate material throughout the area.

On the negative side, the proper calculation of effects from area sources using this technique is very consuming of computer time and will lengthen the time significantly for simulations involving area sources. This could be reduced by using the exacting procedures of this area-source algorithm only for receptor positions near or within the area, and using more approximate techniques as the source-receptor downwind distance increases.

5) Dry Deposition, Depletion of Particles, Wet Scavanging

Specific runs of the model (see 15) through 18) below) were made to examine deposition and depletion. The directions of change for both concentrations and deposition were as expected for the modifications made to the input for each run.

It is not possible with the limited time allowed for this review to do as complete an analysis as is desired of the features of the deposition and depletion that is now included in the model. From the description in the text, there is a good attempt to meld the features of treatment of terrain and deposition and depletion. A comparison that would be useful would be to examine deposition and depletion with this model and the FDM (Fugitive Dust Model) for both point and area sources.

Comments on Use of Model for Evaluation of Impact of a Hazardous Waste Incinerator in a Valley

It is my opinion that the use of this model for the evaluation of the impact of a hazardous waste incinerator in a valley is likely to result in estimates of concentration and deposition that more closely simulate what occurs in the atmosphere than the use of a model such as ISCST2.

The use of onsite data should result in improved results. If data from a nearby location but not onsite are used, it is likely that the topographic influences may be slightly altered resulting in increased simulation of cross-valley flow which will result in high calculated impacts. The use of onsite data will be expected to more properly simulate the frequencies of wind direction that actually occur which will probably include high frequencies of along-valley flow but not very high frequencies of cross-valley flow.

If sufficient data are available to apply the CTDMPLUS model, that model may better simulate the resulting concentrations. Of course, since deposition and depletion are not addressed by the CTDMPLUS, it could not do any of the simulation of the behaviour of particulate matter that would be different from assumptions that the particles are transported and dispersed similar to a gas.

Modeling Runs to Examine Features of Model and Results

The following modeling runs were accomplished with the indicated results.

1) The test input for both concentration and deposition runs were executed with results as expected.

2) Abbreviated data for MET, WND, and TMP were created consisting of only two days and a runstream TEMP.INC to execute for just one day was formulated and executed. Results given in the plot file appeared to be OK.

3) Remove access to the special terrain file WTI100K.OUT creating input runstream TEM1.INC and run again. Output in the plot file appears reasonable.

4) Create new .met, .wnd, and .tmp files called area.xxx with same hourly data repeated for each of 48 hours. Create new receptor array, access new files TEM2.INC. and run for flat terrain. Output in the plot file appears reasonable.

5) Remove building dimensions TEM3.INC and run again. Concentrations are considerably less as they should be.

6) Change from ten particle size fractions to three particle size fractions TEM4.INC and run again. Concentrations given in the plot file are very slightly greater.

7) Lower stack height, decrease diameter, exit velocity, and exit temperature TEM5.INC and run. Concentrations are greatly increased.

8) Create 100 meter by 100 meter area source of height 0.5 meters TEM6.INC and run. Concentrations increase with downwind distance to downwind edge of area source. Behaviour appears to be reasonable.

9) Create a runstream TEM6.IND for the area source for deposition and run. Output appears reasonable.

10) Create new vertical wind data AREA2.WND with no change of wind speed with height. Run TEM7.INC and examine output. Expected concentrations to change because of different plume rise and dilution. Output is same as for TEM5.INC. It is questionable as to whether the calculation of plume rise considering the wind with height is working!!

11) Create runstream TEM8.INC with higher source. Run with same met files as TEM7.INC (step above). Output is same as running TEM4.INC. Would have expected plume rise to change.

12) Create a new temperature with height data set AREA2.TMP with temperature increasing with height. Create a runstream TEM9.INC to use this data and run. With use of this data there is no change in concentrations from the previous run. This may be due to the temperatures not being used since the stability is 4.

13) Create a new temperature with height data set AREA3.TMP with the temperatures the same as in AREA2.TMP except that they are in units of Kelvin. Create runstream TEM10.INC and run. Concentration output is unchanged.

14) A new met set AREA2.met with stability 5 substituted for stability 4 for all hours was created. A new runstream TEM11.INC which is a duplicate of TEM9.INC with the exception that AREA2.MET is accessed. The expectation was that the concentrations would change due to a variation in the plume rise and due to changed dispersion parameters. The concentrations

decreased greatly, probably due to the decreased σ_z values that do not allow very much influence of the plume upon the ground.

Eight additional runs of the model were made to see how changes in inputs related to the deposition affect concentration and deposition. Description of these runs follow:

15) Using the stack that was part of the TEM5. run (a shorter stack) particles of just one size, 2 μm, were assumed. The runstream for concentration is TEM12.INC; the runstream for deposition is TEM12.IND.

16) A change in particle density from 1 to 2 was made. Runstreams are TEM13.INC and TEM13.IND. Results for concentrations are barely perceptible. Maximum deposition is about 1.8 times as high as previously. Deposition at the farthest downwind distance, 5000 m, is also higher (the exact fraction can not be determined as there is only one significant digit given in the results).

17) The particle size is increased from 2 to 20 μm. Runstreams are TEM14.INC and TEM14.IND. Peak concentration is decreased to 0.79 of that for 2 μm particle sizes. Concentration at 5000 m, the farthest distance calculated, is decreased to 0.23 of that for 2 μm particle sizes. Maximum deposition is 299 times that for 2 μm particle sizes. Deposition at 5000 m is 94 times that at this distance for 2 μm particle sizes.

18) Runs for 15) through 17) were over flat terrain. Terrain was added to the runstreams of 17) resulting in TEM15.INC and TEM15.IND. Both concentrations and deposition were increased close in and were less at 5000 m. This is the direction of change that would be expected.

D. Bruce Turner, CCM*
Senior Consultant

* Certified Consulting Meteorologist

Enclosures: Listings of: Computer Input Runstreams; Output Plot Files; Data Files
Diskette with Test Runstreams, Data, and List files.

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COMMENTS

Rayford P. Hosker, Jr., Ph.D.

U. S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
ENVIRONMENTAL RESEARCH LABORATORIES
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May 11, 1995

Mr. Daniel A. Vallero
Mr. Tom McCurdy
U. S. Environmental Protection Agency
Atmospheric Research and Exposure Assessment Laboratory
Human Exposure and Field Research Division (MD-56)
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Dear Sirs:

The following summarizes my review of two documents by W. H. Snyder and R. S. Thompson. "Wind-Tunnel Simulation to Assess Terrain Downwash Effects at the WTI Hazardous Waste Incinerator: Project Summary", and "Data Report: Wind-Tunnel Simulation to Assess Terrain Downwash Effects at the WTI Hazardous Waste Incinerator". The first of these documents is just an abbreviated version of the second, and seems to include all the pertinent materials from the main (data) report. I believe it is a very clear and complete summary. I have therefore discussed the two reports together rather than separately; the comments below apply to both reports unless stated otherwise.

You asked me to address the following scientific issues (paraphrased for brevity):

(a) *Are the project goals clearly stated and met? Could the project have been modified to meet any unmet goals?* The primary goal, to simulate worst-case terrain-induced downwash effects, is clearly stated. The December 1993 peer-review panel convened to evaluate the draft EPA plan for assessing risk at the WTI facility is quoted as also being interested in "quantification of the near- and mid-field three-dimensional wind flow within and downwind of the river valley and the quantification of the combined effects of terrain and buildings on the near-field dispersion". The project mentions these secondary goals, and points out that the technical requirements for wind tunnel modeling of such a physically large area preclude a strict quantification of near-field phenomena because of necessary scaling distortions. However, the modeling effort is able to provide a qualitative picture of these secondary points of interest. Given the size of the present EPA wind tunnel (already a large facility), it would be impossible to improve this situation. The local scale flows presumably could be studied separately, using an appropriate building complex and stack model, although it would be difficult in my opinion to establish an approach flow that simulates the mean wind field distortions and turbulence effects of the upwind terrain obstacles.

(b) *Are state-of-the-art wind tunnel simulation practices used?* The authors are very well aware of the scaling requirements for successful wind tunnel simulations (Dr. Snyder has helped "write the book" in this area), and have spent considerable effort in meeting these requirements. Their procedures are well documented in the report, and I see no problems with their effort.

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(c) *Are the QA/QC practices described in the report? Were scientifically adequate QA/QC practices followed during the experimental work?* Equipment calibration procedures are described at length, and samples of typical calibration runs are included. The measurement procedures are documented in great detail. The computer files are described in detail, so that interested parties could utilize the files without difficulty. Overall, this is one of the best documented wind tunnel studies I have ever read; the level of detail provided inspires a good deal of confidence in the results. The procedures followed are pretty much standard (or should be) in the field. The only possible improvement would be for the authors to demonstrate NIST or similar traceability in their laboratory standards.

(d) *Do the data meet adequate precision and accuracy requirements?* Yes. Accuracy and precision of the measurements are described, along with the methods used to evaluate them. The accuracy and precision achieved are adequate, in my opinion, to determine the flow and concentration fields of interest.

(e) *Do the summary and conclusion follow logically from the data, and are they scientifically valid?* Yes. In fact, the authors seem to be making an effort to avoid "overselling" the significance of their results. They clearly state the limitations of their work, identify continued areas of uncertainty, and describe the additional work needed to turn this wind tunnel study into a risk assessment.

(f) *Are the documents clear and concise, complete, and logically organized?* Yes. Condensation of the text would be possible, but at the expense of the detailed description of the calibrations and experimental procedures that provide extra credibility for the work. This is a judgement call. I'd leave it alone.

You also asked me to address the following points (paraphrased for brevity) relating to the wind tunnel simulation of the WTI facility:

(a) *Are the limitations of the project clearly stated? Are the limitations of sufficient magnitude that they severely reduce the usefulness of the simulations? If so, what mitigative measures should be taken to improve the situation?* The authors clearly and explicitly state the limitations of the experimental work. I think the most important limitations are: scaling distortions leading to improper scaling in the near field, the restriction to only two wind directions, and -- possibly -- the restriction to windy neutral conditions. As noted above, the scaling distortions are driven by the size of the existing EPA wind tunnel, the extent of the terrain to be modeled, and the need to model buoyant discharges. This distortion prevents quantitative interpretation of the near field. If this near field flow and dispersion behavior is important (e.g., for questions related to employee exposures), then a separate study should be done at a lesser scale reduction. But, as stated earlier, this study will be difficult because of the need to somehow simulate the terrain-influenced approach flow and turbulence. I think the restriction to only two wind directions is probably the main shortcoming of the work. Given the complexity of the terrain to the west of the site (multiple hills), I would have liked to see additional wind directions with a westerly component, in case streamline curvatures around these hills lead to unexpected regions of deflection and downwash. But this is perhaps more of a completeness issue than a practical one; I think it is likely that the authors have captured the main downwash effects with their choice of the 125° and 305° wind directions because these cover the largest and closest terrain obstacles. Given the width of the EPA tunnel and the extent of the terrain to be modeled, additional wind directions would probably require the construction and testing of additional site models, at

considerable additional expense. The restriction to the windy neutral stability case is addressed below.

(b) *Do the simulations capture the important factors that are expected to generate maximum ground-level concentrations near WTI? The simulations were performed for the windy neutral case; are there other meteorological conditions or wind directions which could lead to higher ground-level concentrations?* I think the windy neutral terrain downwash case has been covered reasonably well by the present study, although I mention again that additional westerly wind directions would probably have been beneficial. But there are other atmospheric stability conditions that are known to occasionally generate very high ground-level concentrations, and these are not explored in the present study. First, light wind unstable conditions can generate very large scale eddies that can transport even very buoyant elevated plumes down to ground level quite close to the source; this results in very high concentrations. This case is very difficult to simulate in the laboratory. Also, the high concentrations are of short duration because of the nature of convective turbulence, so the actual dose to humans or vegetation is generally small. This highly convective case is probably important only if the stack effluent concentrations are very large and the toxicity of the material is high, so that significant dosage can be accumulated over very short time scales. Second, stable nocturnal conditions in complex terrain can give rise to some very interesting and complicated flow and dispersion phenomena. Terrain-induced flow disturbances (lee waves; hydraulic jumps) can result in significant downward motions in valleys behind obstacles; these could transport a normally elevated plume down close to the surface. Because the nocturnal turbulence levels will usually be rather low, the plume concentrations can be high. Another possibility might be the transport of an elevated plume in the cold air drainage within a deep valley at night; the minimally diluted plume may travel long distances before contacting terrain. If the nocturnal winds are very light and the airshed is not well drained (not clear from the terrain map given) then the effluent may collect within a kind of cold air pool, and produce high ground-level concentrations whenever the pool is mixed by a nocturnal turbulence outbreak, or during the morning fumigation and breakup of the valley inversion. These nighttime cases may or may not produce ground-level concentrations greater than the direct downwash case; the only thing I am sure of is that the surface concentration patterns will be different than for the windy neutral case. The nocturnal cases can be studied to some extent in a stratified tow tank, but the cases involving cold air drainages and pooling will be very difficult to simulate. This is one of the main reasons why people continue to perform field studies in complex terrain, rather than always resorting to laboratory simulations. In fact, it may take a field study (both meteorological fields and tracers) to fully evaluate the nocturnal case at WTI.

Finally, you asked me to:

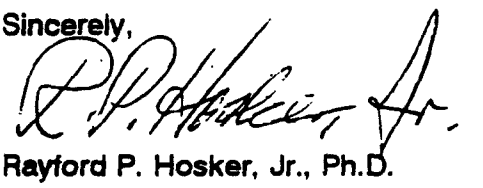
(a) *Evaluate the appropriateness of the approach.* If attention is confined just to the terrain-induced downwash case, then the approach and methods used by the authors are appropriate. If strongly convective light wind conditions occur frequently at WTI, and/or if the nocturnal flow patterns can lead to plume impaction, or to plume trapping in the river valley with subsequent fumigation, then additional studies are needed. There is not enough information provided to determine if any of these cases warrant attention.

(b) *Evaluate the technical and scientific quality of the work and data.* This is high quality work, suitable for publication in the scientific literature. What has been done is done well. What has not been done can only be the subject of speculation; the authors' opinions as to the benefits and necessary breadth of additional studies would be a useful addition to the report.

(c) *Evaluate the clarity of the presentation.* First rate. Few journal articles are as clear and well-written as these reports. I found only one minor discrepancy: in the main (data) report, on p. 49, the fifth line from the bottom refers to case SG9.0 in Appendix E; I could only find case NG9.0. Actually, this sentence would be clearer if the actual Figure numbers were cited instead.

If you have any questions about my comments and opinions, please contact me.

Sincerely,



Rayford P. Hosker, Jr., Ph.D.
Director
Atmospheric Turbulence and Diffusion Division

COMMENTS

Michael Schatzmann

Review on

W. H. Snyder an R. S. Thomson (1994) 'Wind Tunnel Simulation to Assess Terrain Downwash Effects at the WTI Hazardous Waste Incinerator'

by
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June 1995

Work content:

The objective of the study was to examine terrain-downwash effects on the ground level concentration field caused by releases from the WTI hazardous waste incinerator in East Liverpool, Ohio.

To achieve the objective, a wind tunnel study was carried out at scale 1:480, under neutral atmospheric stability conditions, for moderate to high wind speeds, for two wind directions and for three stack hights. The experiments have been carried out with and without terrain in order to isolate terrain effects and to better understand the effects of the topography on plume dispersion.

In modeling the small scale plume, methane was used to produce the buoyancy. The momentum and buoyancy length scales of the exhaust gas were matched.

Comments:

To study plume dispersion in complex terrain, physical modeling (i. e. the simulation in a wind tunnel or water tank) is presently the most appropriate way to understand the processes involved and to achieve reliable data.

The practices used in the study are common and are applied in fluid modeling facilities all over the world.

Similarity concept:

For exact similarity the densimetric Froude number, the velocity ratio, the density ratio, several Reynolds numbers and some non-dimensional boundary layer parameters must be matched (see Data Report, chapter 2.3). Since not all of the similarity requirements can be achieved simultaneously in a small scale simulation, certain compromises have to be made.

The compromise the authors of the study chose was to distort the densimetric Froude number, the density ratio and the velocity ratio and to match instead of them two bulk parameters, i. e. the momentum length scale and the buoyancy length scale. Although the referee follows in his own work alternative lines of approximate scaling, the authors approach is certainly a possible solution to the similarity problem. The authors themselves discuss their choice critically and in detail. They are aware of the fact that they will have discrepancies between model and prototype in the near field of the plume but get the benefit of obtaining larger Reynolds numbers and manageable tunnel speeds.

Wind tunnel boundary layer:

The wind tunnel boundary layer was generated using a combination of vortex generators and roughness elements. This is a common and recognized procedure. The boundary layer parameters were measured and compared with field data. The efforts described to adjust the ceiling above the terrain model give evidence on the care and thoughtfulness with which the authors prepared their experiments.

Data collection:

The authors used state of the art equipment to measure velocities, turbulence intensities and mean concentrations. The methods applied have proven to be reliable and accurate.

Quality control:

The authors made intercomparisons with field data whereever it appeared to be possible (vertical velocity and turbulence intensity profiles, dispersion parameters downwind from a point source etc.) Much more care has been taken to assure the quality of the work as is usually commen in contract work.

Data processing:

The collection and processing of data has been automated to a high degree. Under such conditions, errors in data handling are unlikely to occur. The documentation of the data is very clear and sets standards for other wind tunnel laboratories

Experimental program:

The number of experiments had to be limited by the authors to a reasonable amount. The decision by the authors, to concentrate on two wind directions seems to be justified. Although not proven through further experiments, the assumption of the authors that the wind directions 125° and 305° would lead to the largest increase in ground level concentration maxima due to terrain effects is quite convincing and in line with the referees experience. The maximum mean concentration increase due to building effects (likely to be important for the smallest stack) might be found at another wind direction, but building effects were not the main objective of the study.

The variation of wind speed (in order to find the worst case wind velocity) leads to plausible results.

The flat terrain experiments carried out to isolate the terrain effects were done in an adequate manner. Although not all of the results from these experiments allowed a clear interpretation of the findings, the broad features of the results were plausible.

Stability effects:

The study was carried out under neutral ambient stability conditions only. In view of the fact that the ground level concentration maxima were found in the velocity range (500 feet level) between 7 m/s (tallest stack) and more than 13.5 m/s (smallest stack), this seems to be justified. A stability statistic of the WTI site would most likely show that these large wind speeds occur only in combination with neutral or near-neutral stability classes.

Summary of statements and conclusions:

The conclusions drawn in the summary statement are convincing and a logical interpretation of the experimental observations.

Written document:

The document is well organised and written in a clear and concise manner.

Limitations:

There are only minor limitations of the study and these are discussed by the authors themselves. They result mainly from the fact that the whole study was focussed on the quantification of terrain effects. The investigation of building effects was given only second priority when the experimental program was designed. This is in line with the objective of the project but leads to some difficulties in interpreting the results. This does, however, not significantly limit the usefulness of the study.

Conclusion:

The goal of the study was to assess the terrain effects on plume dispersion under the specific conditions of the WTI-site in East Liverpool, Ohio. The objective of the study has been met.

M. Schatzmann

COMMENTS

Dr. R.E. Britter

Scientific Peer Review of Two Documents which report the results of AREAL's Wind Tunnel Simulation Study of Terrain Downwash Effects at the WTI Harardous Waste Incinerator

Review by

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For

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June 12, 1995

1. Introduction

The Purpose. Background and Statement of Work of this review are reprinted below.

1.1 Purpose

The purpose of this statement of work is to provide assistance to the U.S. Environmental Protection Agency (EPA) in requesting the services of two experts to review two reports describing wind-tunnel simulation experiments (the Study) conducted at the Atmospheric Research and Exposure Assessment Laboratory (AREAL). These reports are entitled: 1) *Wind-Tunnel Simulation to Assess Terrain Downwash Effects at the WTI Hazardous Waste Incinerator: Project Summary* (William H. Snyder and Roger S. Thompson. December 1994), and 2) *Data Report: Wind-Tunnel Simulation to Assess Terrain Downwash Effects at the WTI Hazardous Waste Incinerator* (William H. Snyder and Roger S. Thompson. December 1994).

1.2 Background

In a December 1993 workshop, a panel of experts reviewed a project plan for conducting an assessment of the potential risks associated with an incinerator operated by Waste Technologies Industries (WTI) Inc. The panel stated that terrain-induced downwash effects are likely to be a serious problem at the WTI site and recommended that a wind-tunnel study should be conducted to investigate these effects.

The goal of the Study was to address this recommendation by simulating worst-case terrain-downwash effects at the WTI incinerator and determining what meteorological conditions lead to high ground-level pollutant concentrations.

The Study's design is principally defined by the following experimental conditions:

a. The Study focused on examining *terrain effects* at the WTI site under moderate and high-wind conditions. The Study did not examine building downwash effects.

b. Due to the physical and mechanical configuration of the wind-tunnel, only two wind directions were simulated, rather than all-possible wind directions.

c. The Study applied scale-reduction parameters, such as exaggerating the stack diameter and increasing the difference in density between exhaust gas and ambient air.

d. Methane was used as a tracer gas in the simulations.

1.3 Statement of Work

In accordance with guidance provided by the project manager, the contractor, hereafter called the reviewer, shall review the reports listed above. The reviewer shall specifically address the following scientific issues in his or her review.

a. The goals of the Study were to examine possible terrain-induced downwash effects and to assess the resulting values and patterns of ground-level concentration. Please discuss to what extent these objectives have been met.

b. The experimental conditions used are intended to simulate those that occur in the vicinity of the WTI incinerator site. Provide comments on whether the condition

used in the wind-tunnel experiments are appropriate to simulate conditions at the site. These comments should address the following points:

* The appropriateness of the wind-tunnel simulation practices that are used in the study.
* The adequacy of the quality assurance/quality control practices that are described in the report.
* The precision and accuracy of data collected during the study, and
* The extent to which the simulations capture important factors that are expected to lead to maximum ground-level concentrations in the vicinity of the WTI plant due to terrain downwash.

c. The wind-tunnel simulations were performed for neutral atmospheric stability conditions. Please comment on the appropriateness of these conditions.

d. Evaluate whether the summary statements and conclusions flow logically from the data obtained and observations made during the Study. Also, provide suggestions as to how they might be improved to better represent the experimental results.

e. Provide an evaluation of the written documents. Please address whether they are complete, logically organized, and written in a clear and concise manner.

f. Describe any significant and relevant limitations of the Study that are not adequately described in the documents. Please comment on whether any of the Study's limitations (whether described in the document or not) significantly limit its usefulness in simulating upwind terrain-induced downwash from the WTI incinerator.

Each of the points within the Statement of Work is addressed in the following sections.

2. The goals of the Study were to examine possible terrain-induced downwash effects and to assess the resulting values and patterns of ground-level concentration. Please discuss to what extent these objectives have been met.

In general the objectives of the study have been met but, as in most scientific investigations of complex problems, the final conclusions are not completely unqualified.

The logical development of the study was

(i) To recognize the possible importance of terrain-induced downwash at the WTI Hazardous Waste site.

(ii) To note that the importance will be most evident at higher wind speeds when the plume rise due to momentum and buoyancy effects is reduced, and that these wind speeds are likely to be met under neutral or near-neutral atmospheric stability conditions.

(iii) To note that the importance will be most evident with two specific wind directions for which the local terrain is most influential.

(iv) To recognize that a neutrally stratified wind tunnel was an appropriate tool with which to undertake an investigation.

(v) The investigation was undertaken and the resulting patterns of ground-level concentration presented. These were broadly consistent (qualitatively) with expectations and

with additional experiments taken to determine the velocity and turbulence fields of the flow in the complex terrain.

(vi) Two summary graphs (reproduced here as Figures 1 and 2) were presented to show the magnitude and position of the maximum ground-level concentration as a function of wind speed, chimney stack height and wind direction. Figure 1 shows the expected effects of wind speed and chimney stack height.

The results also show a substantial effect of the complex terrain, producing changes up to a factor of two in the maximum ground-level concentration compared with flat terrain.

An alternative view of the same data might be that

(a) if the stack height of 45.7m is considered the maximum, ground-level concentrations were uninfluenced or reduced by the complex terrain;

(b) if the stack height of 72.7m is considered the maximum, ground-level concentration at the critical wind speed of about 10m/s is increased by about 20% for complex terrain with the worst wind direction over the flat terrain. This may (with hindsight) not be considered significant.

More detailed analysis of the data is difficult. The authors have correctly noted that there are several competing physical phenomena involved and it is not obvious which phenomenon, if any, is most important in which scenario. The authors' interpretations are plausible but further work would be required to provide definitive interpretation of the observations.

(vii) A specific difficulty was encountered and discussed in the reports.

Large buildings close to the chimney stack are able to deflect the plume towards the ground and thereby produce increases in the maximum ground-level concentrations. This effect was shown to be present for the stack heights of 45.7m where it was significant, and 72.7m where it was slight (particularly in the complex terrain scenario). It is unlikely to be of significance for stacks of height 120m. This further physical phenomenon need not of itself be a difficulty.

However a difficulty does arise because the modelling of the flow around the building leading to the building downwash may not be adequately modelled. The possibly inadequate modelling, acknowledged by the authors, arises because of a building Reynolds number limitation and because of the distortion of geometrical scaling in the near field and the interaction of this distortion with the velocity field near the building.

3. The experimental conditions used are intended to simulate those that occur in the vicinity of the WTI incinerator site. Provide comments on whether the conditions used in the wind-tunnel experiments are appropriate to simulate conditions at the site. These comments should address the following points:

3.1 The appropriateness of the wind-tunnel simulation practices that are used in the study.

The wind-tunnel simulation practices used in the Fluid Modeling Branch for this study are, in general, appropriate to the study.

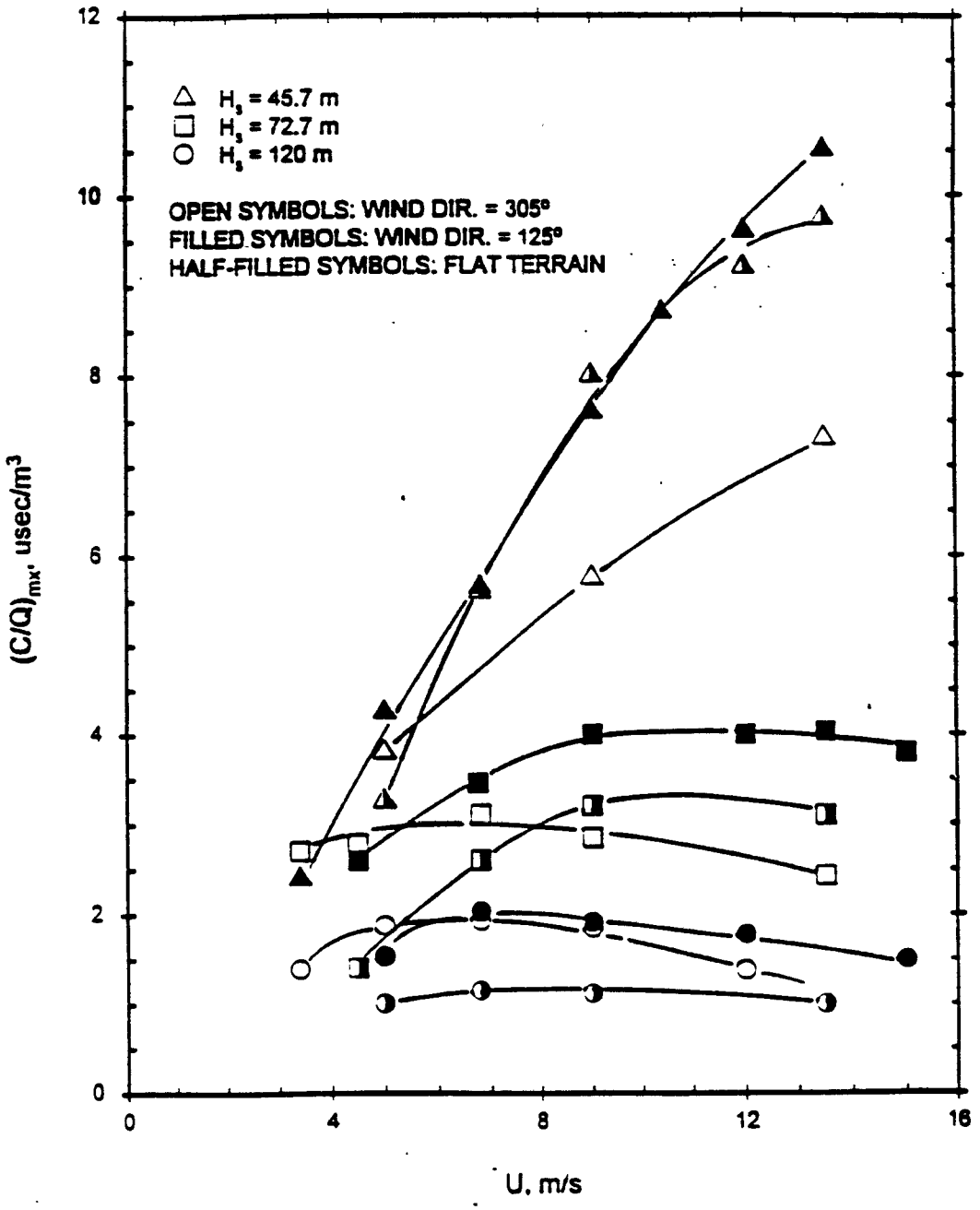

Figure 11. Maximum gic versus wind speed for all configurations with buildings.

Figure 1

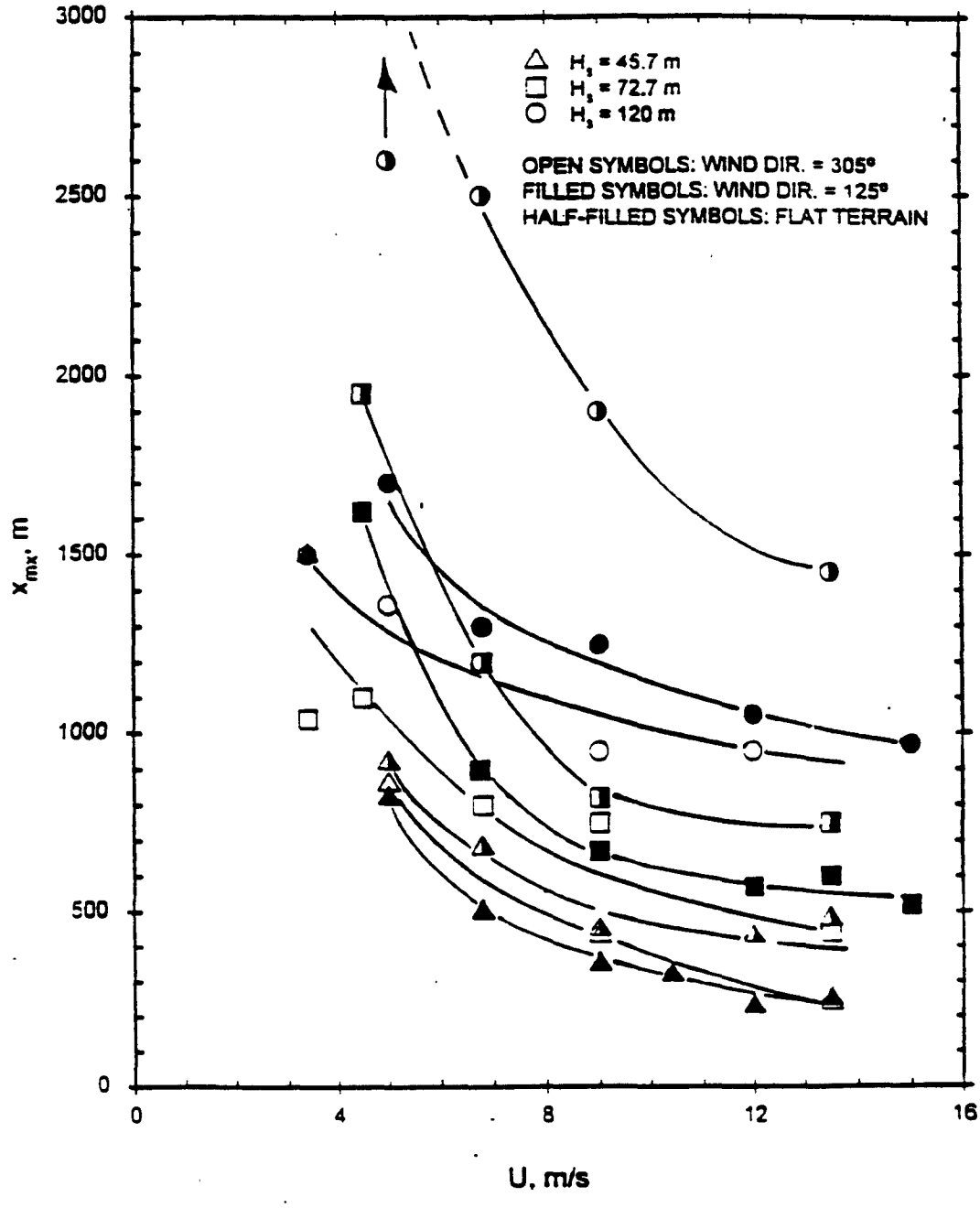

Figure 12. Distance to maximum glc versus wind speed for all configurations with buildings.

Figure 2

The relevant dimensionless parameters are noted and where possible these are modelled correctly. It is noted in the study that some dimensionless parameters cannot be modelled and when this is the case arguments are produced to allow relaxation of strict modelling conditions provided certain criteria are met. It is then shown that either those criteria are met or, if not, some further distortion of strict modelling is argued for, following accepted modelling procedures.

Points which require further explanation follow.

(i) I found the discussion on p. 20 of the Data Report concerning the approach boundary layers a little unclear.

I would prefer an explicit statement of what u_*/U_∞ or u_*/U_{10}, and z_0 is expected or measured at full scale (with ranges), then an explicit statement of what was obtained in the model and how it was obtained. This could be followed by a statement that the physical modelling was deemed to be satisfactory.

Two minor points on the same page are: On what basis was the 'somewhat arbitrary' choice of $d = -13$mm made? u_*/U is used rather than u_*/U_∞, and d is given as metres rather than mm.

(ii) I found a similar difficulty in the discussion on pp. 24 and 25 of the Data Report concerning the concentration measurements for flat terrain and a comparison of these results with atmospheric dispersion correlations. It is not clear what the goal is and whether it is attained. The difficulty is most apparent in the concluding two sentences of section 5.2.

These begin "Overall, if the roughness correction method of HGS is used...", but it is not explicitly stated that the authors believe this technique to be superior to the conventional PG technique. I believe what has been done is appropriate but it is incumbent on the authors to say explicitly why they have chosen a particular correlation for comparison rather than another more commonly used correlation.

(iii) The implications of the observed importance of building downwash and the significance of the inability to correctly model it requires further comment. As does any additional complication arising due to the near field geometrical distortion and density distortion. What, qualitatively, will be the effect of these matters? If no guidance can be offered due to the complexity of the problem, a specific statement should be made that no qualitative guidance can be offered.

(iv) The adequacy of the physical modelling in capturing the marginal separation in the valley near the upwind topography must be explicitly addressed. This may be of importance for the conclusions of the study.

3.2 The adequacy of the quality assurance/quality control practices that are described in the report.

I am uncertain what is meant by the quality assurance/quality control procedures that are described in the report. However, my observations that may be relevant are:

(i) The laboratory has obviously gone to considerable effort to provide an infrastructure to ensure that all the data are available, are documented and have been archived in a readily accessible way.

(ii) The laboratory undertaking the study is internationally recognised as one in which great care is taken in developing formalised procedures in order to ensure the quality of the work coming from the laboratory. Mention is made in the report of Snyder (1979) which describes the wind tunnel, and of Snyder (1981) which addresses the scientific basis and appropriate procedures for physical modelling. The latter reference is internationally recognised as the definitive document on this subject.

Mention is also made of Lawson (1984) which describes the Standard Operating Procedures for the EPA Fluid Modeling Facility and to Shipman (1990) which describes the Fluid Modeling Facility Computer User's Guide.

The existence of these documents reflects a serious concern by the laboratory for an assurance of quality and accountability in its activities. I know of no comparable laboratories that operate with this level of concern.

(iii) The instruments and the calibration procedures used are described and appear adequate and appropriate to the study.

3.3 The precision and accuracy of data collected during the study.

The instruments and calibration procedures used are adequate and appropriate to the study.

I am uncertain as what is the distinction being drawn between precision and accuracy in the measurement.

I was unable to find a concise, explicit statement of the accuracy of the observations made. Of course this is not a simple matter and discussions on accuracy require a careful statement of the goals.

The question of natural variability and the choice of averaging time is addressed. The discussion here and the conclusions are appropriate. For example, a roughly 10% 'error' (or expected variability) in the concentration measurements is accepted and this allows for an operational useful averaging time.

However, an explicit statement that this is the only 'error' and that such an error is of no consequence for the conclusions that are drawn from the study would have been helpful to this reviewer.

3.4 The extent to which the simulations capture important factors that are expected to lead to maximum ground-level concentrations in the vicinity of the WTI plant due to terrain downwash.

The simulations capture most of the important factors but this reviewer would welcome (justified) reassurance that

(i) the inadequacy (or not) of the physical modelling of the flow around the buildings would not influence the conclusions drawn from the study. Of course this is easier if the critical aspects of the real problem under study were more openly specified;

(ii) the simulation correctly captured the marginally separating flow in the valley near the upwind terrain or that the exact capture of this feature of the flow was not critical to the conclusions of the study.

4. The wind-tunnel simulations were performed for neutral atmospheric stability conditions. Please comment on the appropriateness of these conditions.

The wind-tunnel simulations were intended to model neutral atmospheric conditions.

The simulations have shown that the critical wind speeds (providing the maximum, with wind speed, of the maximum ground-level concentration) are above 6m/s. At these wind speeds the atmosphere will be neutrally or near-neutrally stratified. Thus the choice to simulate neutral atmospheric conditions was appropriate, particularly when considering the difficulties of modelling non-neutral atmospheric conditions.

These comments relate to the objectives of the study: to consider the influence of terrain downwash. They specifically do not relate to any alternate mechanisms of obtaining high ground-level concentrations. e.g. plume impingement under highly stable atmospheric conditions.

5. Evaluate whether the summary statements and conclusions flow logically from the data obtained and observations made during the Study. Also, provide suggestions as to how they might be improved to better represent the experimental results.

5.1 Data Report

The Summary and Conclusions section of the Data Report follow logically from the data obtained and observations made.

5.2 Project Summary

The Project Summary is an adequate summary of the Data Report. The Summary and Conclusions section of the Project Summary are the same as those in the Data Report. and logically follow from the data obtained and observations made.

6. Provide an evaluation of the written documents. Please address whether they are complete, logically organized, and written in a clear and concise manner.

The documents, in the main, are logically organized and written in a clear and concise manner.

There are, however, some specific points for which more explanation would be of assistance. These are listed below.

(i) Very little useful information is provided on the background of the specific problem being addressed. It may be intentional to decouple the scientific investigation from the decision-making process. This approach does present difficulties in that it is not clear to the reviewer what particular issues are critical. No scientific investigation of a complex problem is completely definitive and various pragmatic assumptions and approximations are introduced. When trying to assess the importance of these approximations/assumptions, some guidance is required as to what use is to be made of the results, e.g. is the downwind extent of certain concentrations the dominant issue or is the ground area/population exposed? what

accuracy is required of the data when applied to the real problem? and many similar questions which arise in this reviewer's mind.

There is little point in addressing in great detail issues that are irrelevant for the problem under study. Similarly, if certain issues are critical then they warrant detailed scrutiny.

(ii) On p. 5 of the Data Report the geometrical and density distortion issue is raised. Appeal to 'previous experience' is made. A more specific reference or argument is required on this important issue.

(iii) On p. 9 of the Data Report it is stated that "These steps...we believe, provided an adequate simulation of the full-scale roughness". Some additional support for this statement is appropriate.

(iv) On p. 8 of the Data Report it is stated that "However this adjustment appeared to result in an unnaturally large dip in the ceiling over the river valley. After considerable debate, this dip in the ceiling was removed..." This action should be supported by explicit argument.

Points (ii), (iii) and (iv) are not intended to question the correctness of what has been stated but are requests for explicit information.

(v) Sometimes the wind direction is given as 305° and sometimes as NW. Only one form of description is necessary.

(vi) The units of C/Q are given as μsec/m^3 in the text, and as $u$sec/m^3 in several graphs. Both seem clumsy.

(vii) An important issue that needs to be raised in the documents is the adequacy or otherwise of the physical modelling of the 'marginally separating' flow that occurs in the valley near the upwind topography.

It would appear that the ground-level concentrations could be quite dependent on the precise nature of this flow: steady/unsteady, mean streamline pattern, turbulence changes etc. If this is the case then the ground-level concentrations could be sensitive to the nature of the marginal flow separation. It is not obvious that the non-dimensional parameters selected for physical modelling have captured those that may be relevant for marginally separating flow over 'gently sloping' topography. If my point is not correct then explicitly addressing this point will limit further argument.

7. Describe any significant and relevant limitations of the Study that are not adequately described in the documents. Please comment on whether any of the Study's limitations (whether described in the document or not) significantly limit its usefulness in simulating upwind terrain-induced downwash from the WTI incinerator.

The principal limitation of the study that was not adequately described in the documen concerns the adequacy or not of the physical modelling of the marginally separating flow in the valley near the upstream terrain. This aspect of the flow should be explicitly addressed.

This aspect. and the implications of the inadequacy of the modelling of building downwash. *may* limit the usefulness of the study in simulating upwind terrain-induced downwash from the WTI incinerator.

The authors of the study are in a position to address both these points.

COMMENTS

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June 15, 1995

Tom McCurdy
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Dear Tom:

My peer review of the reports sent to me related to dispersion under low wind speed and calm conditions is enclosed. I found that both models are technically adequate to evaluate dispersion under low wind speed and calm conditions. However, I do have some reservations about the manner in which the models were applied and conclusions drawn from the model results. These concerns are listed in the enclosed review.

If you have any questions, please call.

Sincerely,

J. V. Ramsdell, Jr.

JVR:pp

Enc

Scientific Peer Review of Studies to Simulate Air Concentrations and Deposition in the Vicinity of a Hazardous Waste Incinerator under Calm Wind Conditions

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June 15, 1995

I have examined the material related to diffusion in low wind speed and calm conditions provided by the EPA Project Manager. This material included:

1) pages 40-43 of a draft document *Air Dispersion Modeling Waste Technologies Industries* dated February 9, 1995

2) *A User's Guide for the CALPUFF Dispersion Model* dated February 1995

3) *INPUFF 2.0 - A Multiple Source Gaussian Puff Dispersion Algorithm User's Guide* dated July 1986

4) "Effects of Near Calms on Air Concentration and Deposition" dated February 24, 1995.

Conclusions

1) Both computer models are technically adequate for and capable of evaluating the effects of calm and low wind speed diffusion on 1-hr, 24-hr, and annual average concentrations.

2) Both models are capable of treating fumigation.

3) The comparisons of the 1-hr and 24-hr concentrations presented in pages 40-43 of *Air Dispersion Modeling* are inconclusive because no information is presented to permit isolation of the effects of calm and low wind speed diffusion from differences in concentrations due to differences in model parameterizations.

4) The ratios between the highest 1-hr and highest 24-hr concentrations presented in this document are larger than expected.

5) The use of a Pasquill-Gifford (P-G), distance-based diffusion parameterization with the INPUFF code is inconsistent with the purpose of the study.

6) The results of the INPUFF model are probably correct qualitatively, but the increases in the lower 1-yr average concentrations associated with low wind speed diffusion may be overestimated due to the use of the P-G diffusion coefficient parameterization rather than a time-based parameterization.

7) Similarly, the increased deposition may be overestimated due to the combination of overestimated concentrations and overestimated deposition velocities.

General Comments

1) Gaussian puff models are one appropriate means of addressing atmospheric dispersion under low wind speed conditions. However, the models must be used with appropriate diffusion coefficient parameterizations. Use of diffusion coefficient parameterizations that are based on distance travelled is not appropriate for examination of dispersion under low wind speed conditions; the diffusion coefficients must be based on time since release.

2) If Gaussian puff models are used to evaluate dispersion under low wind speed conditions and Gaussian plume models are used to evaluate dispersion under windy conditions, a great deal of care must be exercised to ensure that the models produce consistent results. Given a common diffusion coefficient parameterization and steady-state, horizontally homogeneous meteorological conditions, puff and plume models should give the nearly identical concentration estimates. If different parameterizations are used for puff and plume models, the diffusion parameterization for the puff model should be adjusted to give results that are the same as the plume model under some standard set of conditions, for example neutral stability and 8 m/s wind.

Specific Comments on CALPUFF model

1) The CALPUFF model treats diffusion in manner that is suitable for evaluation of potential concentrations during low wind speed conditions.

2) Concentrations during fumigation are calculated realistically in the CALPUFF model because of the Lagrangian nature of the model.

3) The use of the usual PG curves to estimate σ_y and σ_z is inconsistent with the intent of the study, i.e. calculation of diffusion under low wind speed conditions.

4) The use of time-based diffusion coefficients is appropriate. However, it is not clear from the draft report whether the time-based diffusion coefficients were corrected for initial buoyancy-enhanced diffusion... they should have been according to the CALPUFF User's Guide. It is also not clear whether the combination of puff movement, puff dimensions and diffusion coefficients during low wind speed conditions are sufficiently large to ensure that the concentration in the air at any location (summation over all puffs) is always less than the concentration in the stack.

5) What is the purpose of the model? Is it to estimate an ensemble average estimate of the concentrations under specific sets of meteorological conditions and find the highest of those averages, or is it to estimate the upper bound for concentrations under specific sets of meteorological conditions and find the highest upper bound? Most models seek the highest of the ensemble averages rather than the highest upper bound. If the purpose of the model is to seek the highest ensemble average, the minimum values used for σ_v and σ_w are too small. I suspect that the Beaver Valley meteorological data underestimate σ_v for low wind speeds due to lack of instrument responsiveness.

Hanna (1990) suggests σ_v of 0.5 m/s for hourly diffusion estimates. Data in Figure 3 of Hanna et al (1985) indicate that the value of 0.5 m/s is a typical lower bound, and that the actual lower bound may be of the order of 0.17 m/s. In looking at diffusion data from Hanford, Idaho Falls, and Oak Ridge, we have found (unpublished analysis) that σ_v between 0.1 and 0.2 m/s and σ_w between 0.05 and 0.1 m/s provide better estimates of concentrations than the values given by Hanna. The differences in values may be associated with the differences between the ideal conditions of the controlled experiments and the those of the real world associated with the data of Hanna et al. (1985).

6) There appears to be something wrong with the table at the top of page 43 in the report extract that I was give. Why should the concentrations for the PG sigmas be lower than those for the time-based sigmas? Were the time-base diffusion algorithms ever calibrated so that the models gave consistent results under standard conditions? Was there any attempt to calibrate the CALPUFF model with either diffusion coefficient parameterization with the ISC-COMPDEP model for standard conditions? If not, the comparison in the table is meaningless in a regulatory sense because there is no way of separating differences resulting from model parameterizations (diffusion coefficients) from differences associated with the meteorological parameter of interest (wind speed).

7) The ratio between the largest 1-hr average and the largest 24 hr average are considerably larger than I expected based on published ratios from other models and observed data. The factor of about 10 difference for ISC-COMPDEP and CALPUFF (time-base diffusion) is closer to the expected value than the factor of about 20 difference for CALPUFF (PG sigmas).

8) The comment related to the ISC-COMPDEP model doesn't make sense unless the concentration during periods of calm is assumed to be zero, and that assumption is inconsistent with the basic Gaussian plume formulation.

9) The comments related to fumigation need to be rethought. What is the time-scale of those concentrations? To get a maximum concentration that is 15 times the maximum 1-hr average, the averaging time would have to be 4 min or less. The maximum ratio of concentration for an n minute period to the concentration for a 60 min period is 60/n. To get this ratio, the entire exposure would have to occur in n minutes and the concentration in the remaining 60-n minutes would have to be zero. What is the minimum period of interest? If the periods of interest are 1 hr, 24 hr and 1 yr, then the CALPUFF model will adequately treat all relevant processes including fumigation if reasonable sequences of meteorological data are used as input to the model calculations.

In the long run deposition flux during transient periods such as fumigation is a minor factor in total deposition over period longer than a few hours. I am not sure what the relevance of a short-duration high deposition flux is.

Comments on the INPUFF model

1) The INPUFF model is an appropriate tool for investigating effects of calm and low wind speeds on concentrations.

2) Concentrations during periods that include fumigation are calculated naturally in the INPUFF model if realistic meteorological data sets are used as model input.

3) The generation of random wind components for hours with wind speeds of 1 m/s or less appears to be a more reasonable treatment of low wind speed conditions than neglecting those periods or assuming wind direction persistence during low wind speed conditions. I'm not convinced that the procedure used for the randomization is better than or more justifiable than any other procedure, but the differences are probably more of academic interest than of practical interest.

4) The treatment of receptors and wind fields in INPUFF is appropriate for the intended application.

5) The use of PG diffusion coefficient parameterization seems inconsistent with the intended model application. This choice would appear to bias the outcome of the analysis toward high concentrations during low wind speed conditions. There is sufficient information in the literature, including experimental data, that would indicate that calms and low winds might not be associated with high concentrations that it would be important not to bias the outcome of the analysis by selecting the P-G parameterization. The onsite scheme or some other scheme based on time would appear to have been more appropriate.

6) The model comparison statistic called percent difference is misleading. If A is 100% less than B then A = 0.

7) Figure 4 is much more informative than Figure 3. Figure 4 indicates that the effects of including calms are greater where the annual average concentrations are low than where the concentrations are high. It also shows that the highest annual average concentrations with calms included are no higher than those without calms included. I suspect that had a time-based diffusion coefficient parameterization been used there would have been less increase in the low concentrations than shown in Figure 4.

8) I am not comfortable with the conclusions drawn with respect to deposition. My first concern is related to the estimates of air concentrations and the choice of diffusion coefficient parameterizations. If, in fact, the choice of diffusion coefficient parameterizations causes the concentrations to be biased to the high side, then much of the increase in area may be associated with the concentration bias. The second concern is related to the unspecified relationship between air concentration and deposition assumed in generating Figures 5 and 6. It appears that a constant deposition velocity has been used to estimate deposition from air concentration. More current models of deposition velocity indicate that deposition velocity

should be directly related to wind speed. In other words, the low speed conditions that are supposed to be associated with the increase in air concentrations should also be associated with reduced deposition velocities. If this is the case, the 500% increase in deposition is probably overestimated, even if the air concentrations are correct.

9) A slightly modified version of the INPUFF model could be used to evaluate the effect of calms on the maximum 1-hr and 24 hr concentrations using the two meteorological data sets. Comparisons of concentrations computed with the two data sets would be more enlightening than comparison of the results of two different models with the same data set.

NOTE ON MODELING DIFFUSION IN LOW WIND SPEED CONDITIONS

Gaussian puff models are not the only approach to evaluation of dispersion under low wind speed and calm conditions. The assumptions made in the usual derivation of the Gaussian plume model eliminates the low wind speed/calm portion of the solution of the diffusion equation. Heat conduction, which is described by the diffusion equation, doesn't depend on advection. Thus, clearly there should be plume models that can estimate concentrations under all wind conditions, and there are.

Frenkiel (1953) derived a plume model that describes low wind speed dispersion as well as dispersion under windy conditions. Frenkiel's model is discussed Kao (1984) in Equations (6.259) and (6.260) et seq. This model is based on the assumption that the turbulence responsible for atmospheric dispersion doesn't become zero when the mean wind vector becomes zero.

Frenkiel's model has the following characteristics. Under calm conditions, the concentration is a function of the turbulence conditions and the distance between the source and receptor. The calm wind concentration is a local minimum relative to wind speed. As the wind speed increases; the concentration increases; for wind speeds of a few tenths of a meter per second, the concentration is directly proportional to wind speed. Finally, at high wind speeds, the concentration is proportional to 1/U as in the usual Gaussian plume model. In fact, with appropriate assumptions, Frenkiel's model for dispersion under windy conditions becomes identical to the usual Gaussian plume model. Thus, there is a wind speed, which we have found to be of the order of 1 m/s, that gives the maximum concentration. This maximum is significantly (factor of 2 to 10) lower than the concentration predicted by the usual Gaussian plume model for the same wind speed. In general, the concentrations predicted by Frenkiel's model are lower than those predicted by the Gaussian plume model until the wind speed approaches 7 or 8 m/s.

Similar behavior can be induced in the usual Gaussian plume model for wind speeds greater than about 0.1 m/s by using time-based diffusion coefficients provided that the turbulence statistics are not permitted to approach zero as the resultant wind speed approaches zero. One alternative along this line is to set a lower limit to σ_v, σ_{v0}, and combine the lower limit with formulations for σ_v proportional to wind speed in a in an interpolation scheme such as

$$\sigma_v = [\sigma_{v0}^2 + (b_v U)^2]^{1/2}$$

where b_v is related to surface roughness and stability. A similar relationship can be used for

σ_w.

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