ATMOSPHERIC TRANSPORT OF HYDROGEN SULFIDE

FROM PROPOSED GEOTHERMAL POWER PLANT (UNIT 20)

Predictions by Physical Modeling in a Wind Tunnel

by

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ABSTRACT

The transport and dispersion of hydrogen sulfide plumes emanating from cooling towers located at three separate positions in the Geysers Geothermal Area were studied in the Colorado State University drainage flow and environmental wind tunnel facilities. The tests were performed utilizing 1:1920 scale models of the cooling towers and the terrain surrounding the Geysers Power Plant complex.

Ground-level concentrations were measured along Big Sulphur Creek to study interaction of the cooling tower plumes with the natural drainage flow. Concentrations were also sampled at ground-level and vertically between the cooling towers and Anderson Springs at five different wind speeds and a predominantly west wind, under neutral conditions.

Data obtained include velocity and temperature profiles, isopleths of ground-level concentration, vertical concentration distributions, and plume visualization photographs.

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LIST OF SYMBOLS

Symbol		Units
B_o	Buoyancy ratio $\left[\frac{R^3}{Fr^2}\ \frac{D}{H_s}\right]$	(-)
CF	Calibration factor	(-)
D	Cell/Stack diameter	(m)
E	Hot-wire voltage	(V)
E_c	Eckert number $\left[\frac{u_o^2}{C_{p_o}\ (\Delta t)_o}\right]$	(-)
F_L	Lagrangian spectral function	(s)
F_{r_Γ}	Froude number $\left[\frac{u_s}{\sqrt{g\Gamma d}}\right]$	(-)
Fr_γ	Modified Froude number $\left[\frac{u_s}{\sqrt{g\gamma D}}\right]$	(-)
g	Acceleration due to gravity	(ms^{-2})
H	Hydrogen	(-)
H_s	Height of cooling towers	(m)
$i_{x,y,z}$	Turbulence intensity in x, y or z direction	(1)
i	Tracer gas	(-)
I_s	Integrated value of tracer gas	(μv-s)
k	Thermal conductivity	($Wm^{-1}\ K^{-1}$)
k_s	Uniform sand grain height	
K	Dimensionless concentration $\left[\frac{\chi u_\infty \delta^2}{\chi_o V}\right]$	(-)
L	Length scale or Monin Obukhov length scale	(m)
M_o	Momentum ratio $\left[(1-\gamma)\ R^2\ (D/H_s)^2\right]$	(-)

Symbol		Units
n	Frequency, power law exponent or King's law exponent	(varies)
Pr	Prandtl number $\left[\frac{\nu_o \rho_o C_{p_o}}{k_o}\right]$	(-)
Q	Emission Rate	(gm/s)
R	Velocity ratio (u_s/u_a)	(-)
Re	Reynolds number $\left[\frac{L_o u_o}{\nu_o}\right]$	(-)
Ri	Richardson number $\left[\frac{\Delta T_o\, g_o\, L_o}{T_o u_o^2} = \frac{g\, \Delta T\, z_o}{T_o u_o^2}\right]$	(-)
Ro	Rossby number $\left[\frac{u_o}{L_o\, \Omega_o}\right]$	(-)
$R(\tau)$	Autocorrelation	(-)
t, τ, ζ	Time or time scale	(s)
S	Sulphur	(-)
T, θ	Temperature or potential temperature	(K)
$\bar{T}$	Mean temperature	(K)
t_1	Center of gravity of autocorrelation curve	(s)
t_o	Integral time scale	(s)
u	Ambient velocity	(m/s)
$\bar{u}$	Mean velocity	(m/s)
u_a	Ambient velocity at reference height	(m/s)
u_m	Maximum ambient velocity	(m/s)
u_r	Reference velocity	(m/s)
u_s	Cell/Stack exit velocity	(m/s)

Symbol		Units
u_∞	Velocity in the free stream	(m/s)
u_*	Friction velocity	(m/s)
V	Volume flow	(m^3s^{-1})
w'	Deviation from mean vertical velocity	(m/s)
x, y, z	Cartesian coordinates	(-)
z	Height above ground	(m)
z_o	Surface roughness factor	(-)

Greek Symbols

β	Plume rise	(-)
χ	Concentration	(ppm)
χ_o	Tracer gas strength	(ppm)
χ_s	Calibration gas strength	(ppm)
δ	Reference height	(m)
Δ	Change in parameter	(-)
Γ	Density ration $\left[\frac{\rho_a - \rho_s}{\rho_s}\right]$; adiabatic lapse rate	(-)
γ	Modified density ratio $\left[\frac{\rho_a - \rho_s}{\rho_a}\right]$	(-)
Λ	Length scale	(m)
ν	Kinematic viscosity	(m^2s^{-1})
Ω	Angular velocity	(s^{-1})
ρ	Density	(gm^{-3})
σ_z, σ_y	Vertical and horizontal standard deviation of concentration distribution	(m)

Subscripts	Definition
a	Pertaining to ambient condition
BG	Background
i, j, k	Tensor summation indices
m	Model
o	General reference quantity or initial condition
p	Prototype
s	Pertaining to cell/stack exit conditions
∞	Free stream

Superscripts	
'	Root-mean-square of quantity
*	Dimensionless parameter

1.0 INTRODUCTION

The Pacific Gas and Electric (PG&E) Company operates a geothermal steam-powered complex to generate electricity approximately 140 km north of San Francisco, California, known as the Geysers Power Plant.

PG&E contracted with Colorado State University to perform wind-tunnel modeling studies of the hydrogen sulfide dispersion from two possible site locations for Unit 20, presently under development. Further study of Unit 18 was simultaneously accomplished to supplement earlier reports.

Plume dispersion characteristics were studied under both stable and neutral stratification conditions using a 1:1920 scale model of the cooling towers and their surrounding topography. Ground-level and vertical H_2S concentrations were determined by sampling tracer gases (ethane and propane) released from the model cooling towers. Plume geometry was determined by photographing the plumes made visible by adding smoke (titanium tetrachloride) to the gases released from the model cooling towers.

The stable tests were conducted in a specially constructed room which permitted cooling of the aluminum shell model with dry ice to induce a drainage flow. The plumes released from Units 18, 20A and 20B all flowed downslope into Big Sulphur Creek and followed the creek bottom, thereafter. Isopleths of the ground-level concentrations along the creek for an approximate 20 percent plant load are contained elsewhere in this report.

The neutral stratification tests were conducted in the wind tunnel at prototype free stream wind speeds of 7.5, 10, 15, 20 and 28 m/s for a simulated westerly wind. Ground-level concentrations were measured at numerous locations between the cooling tower sites and Anderson Springs. Additionally, vertical concentration distributions were obtained at three locations between the sites and Anderson Springs. The isopleth patterns were similar from each of the release sites, and varied little with wind speed. The evidence obtained in this portion of the study suggests that Unit 20B will have the least overall H_2S impact.

Included in this report are a discussion of wind-tunnel similarity requirements, description of experimental methods, detailed results of the drainage and neutral flow studies and appendices containing all concentration measurements. The report is supplemented by motion pictures and photographs to illustrate plume behavior for the wind speeds studied.

2.0 WIND-TUNNEL SIMILARITY REQUIREMENTS

2.1 Basic Equations

The Basic equations governing atmospheric and plume motion (conservation of mass, momentum and energy) may be expressed in the following dimensionless form (Cermak, 1974):

$$\frac{\partial \rho^*}{\partial t} + \frac{\partial(\rho^* u_i^*)}{\partial x_i^*} = 0 \tag{2.1}$$

$$\frac{\partial u_i^*}{\partial t^*} + u_j^* \frac{\partial u_i^*}{\partial u_j^*} - \left[\frac{L_o \Omega_o}{u_o}\right] 2\varepsilon_{ijk}\Omega_j^* u_k^* = - \frac{\partial P^*}{\partial x_i^*}$$

$$- \left[\frac{\Delta T_o L_o g_o}{T_o u_o^{2}}\right] \Delta T^* g \delta_{i3} + \left[\frac{\nu_o}{u_o L_o}\right] \frac{\partial^2 u_i^*}{\partial x_k^* \partial x_k^*} + \frac{\partial}{\partial x_j^*} (\overline{- u'^*_j u'^*_j}) \tag{2.2}$$

and

$$\frac{\partial T^*}{\partial t^*} + u_i^* \frac{\partial T^*}{\partial x_i^*} = \left[\frac{k_o}{\rho_o C_{p_o} \nu_o}\right]\left[\frac{\nu_o}{L_o u_o}\right] \frac{\partial^2 T^*}{\partial x_k^* \partial x_k^*} + \frac{\partial}{\partial x_i^*} (- \theta'^* u_i'^*)$$

$$+ \left[\frac{\nu_o}{u_o L_o}\right]\left[\frac{u_o^{2}}{C_{p_o} (\Delta T)_o}\right] \phi^* \tag{2.3}$$

The dependent and independent variables have been made dimensionless (indicated by an asterisk) by choosing appropriate reference values.

For exact similarity, the bracketed quantities and boundary conditions must be the same in the wind tunnel and in the plume as they are in the corresponding full-scale case. The complete set of requirements for similarity is:

1) undistorted geometry
2) equal Rossby number: $Ro = \frac{u_o}{L_o \Omega_o}$
3) equal gross Richardson number: $Ri = \frac{\Delta T_o g_o L_o}{T_o u_o^{2}}$

4) equal Reynolds number: $Re = \frac{u_o L_o}{\nu_o}$

5) equal Prandtl number: $Pr = \frac{(\nu_o \rho_o C_{p_o})}{k_o}$

6) equal Eckert number: $Ec = \frac{u_o^2}{[C_{p_o} (\Delta T)_o]}$

7) similar surface-boundary conditions

8) similar approach-flow characteristics.

For exact similarity, each of the above parameters must be matched in model and prototype for the stack gas flow and ambient flow separately. Naturally, the reference quantities will change depending on which flow is being considered. To insure that the stack gas rise and dispersion are similar relative to the air motion, three additional similarity parameters are required (Snyder, 1979; Petersen et al., 1977):

9) velocity ratio: $R = \frac{u_s}{u_a}$

10) Froude number: $Fr_\Gamma = \frac{u_s}{\sqrt{g\Gamma D}}$

11) density ratio: $\Gamma = \frac{\rho_a - \rho_s}{\rho_s}$

All of the above requirements cannot be simultaneously satisfied in the model and prototype. However, some of the quantities are not important for the simulation of many flow conditions. The parameters which can be neglected and those which are important will be discussed in the following subsections.

2.2 Nonequal Scaling Parameters

For plume rise and dispersion studies equal Reynolds number for model and prototype is not possible since the length scaling is 1:1920 and unreasonably high model velocities would result. However, this inequality is not a serious limitation.

The Reynolds number related to the stack exit is defined by

$$Re_s = \frac{u_s D}{\nu_s} .$$

Hoult and Weil (1972) reported that plumes appear to be fully turbulent for exit Reynolds numbers greater than 300. Their experimental data show that the plume trajectories are similar for Reynolds numbers above this critical value. In fact the trajectories appear similar down to $Re_s = 28$ if only the buoyancy dominated portion of the plume trajectory is considered. Hoult and Weil's study was in a laminar cross flow (water tank) with low ambient turbulence levels, and hence the rise and dispersion of the plume would be predominantly dominated by the plume's own self-generated turbulence. For the neutral stratification tests a minimum u_s is 1.71 m/s, D = 0.00443m and $\nu = 0.15 \times 10^{-4}$ m^2/s giving $(Re_s)_{min} = 505$, well above the recommended minimum value. These arguments for Reynolds number independence only apply to plumes in low ambient turbulence or to the initial stage of plume rise where the plume's self-generated turbulence dominates. For drainage flow the minimum u_s was 0.13 m/s giving a $(Re_s)_{min} = 38$. Even though the value is below 300 the results are not seriously affected since the drainage flow tests were run at ambient conditions such that the plume would bend over quickly. In this case the dispersion would be dominated quickly by the atmospheric generated turbulence characteristics.

The ambient flow field also affects the plume trajectories and consequently similarity between model and prototype is required. The mean flow field will become Reynolds number independent if the flow is fully turbulent (Schlichting, 1968; Sutton, 1953). The critical Reynolds number for this criteria to be met is based on the work of Nikuradse as summarized by Schlichting (1968) and is given by:

$$(Re)_{k_s} = \frac{k_s u_*}{\nu} > 70 \; . \qquad (2.4)$$

In this relation k_s is a uniform sand grain height. If the scaled down roughness gives a $(Re)_{k_s}$ less than 70, then exaggerated roughness would be required. In the tunnel a lower estimate of k_s may be taken as the average terrain step height of 0.64 cm, or assuming $u_*/u_\infty \sim 0.05$, u_∞ must be greater than 3.28 m/s. All tests were run in the range $0.5 < u_\infty < 2.1$ m/s giving a range for $(Re)_{k_s}$ of 11 to 45. Since the effective roughness of the terrain is much greater than 0.64 cm (say a factor of at least 3), the range is acceptable.

The Rossby number, R_o, is a quantity which indicates the effect of the earth's rotation on the flow field. In the wind tunnel, equal Rossby numbers between model and prototype cannot be achieved. The effect of the earth's rotation becomes significant if the distance scale is large. Snyder (1979) puts a conservative cutoff point at 5 km for diffusion studies. For this particular study, the maximum range over which the plume is transported is less than 6 km in the horizontal and 200 m in the vertical, hence equality of Rossby number is not required.

When equal Richardson numbers are achieved, equality of the Eckert number between model and prototype cannot be attained. This is not a serious compromise since the Eckert number is equivalent to a Mach number squared. Consequently, the Eckert number is small compared to unity for laboratory and atmospheric flows.

2.3 Equal Scaling Parameters in Model

Since air is the transport medium in the wind tunnel and the atmosphere, equality of the Prandtl number is assured.

The remaining relevant parameters are the velocity ratio,

$$R = \frac{u_s}{u_a} \tag{2.5}$$

Froude number

$$Fr = \frac{u_s}{\sqrt{g\gamma D}} \quad , \tag{2.6}$$

density ratio

$$\gamma = \frac{\rho_a - \rho_s}{\rho_a} \quad , \tag{2.7}$$

and Richardson number

$$Ri = \frac{g\Delta T_o z_o}{\bar{T}_o u_o^2} \quad . \tag{2.8}$$

Since the model scale was chosen to be 1:1920 for this study, matching of all of the above parameters would result in low tunnel operating speeds (hence low Reynolds number). For example, if a 15 m/s wind were to be simulated with equality of Froude number, a corresponding speed in the wind tunnel would be 0.34 m/s*.

In order to obtain higher tunnel operating speeds an alternate set of similarity critieria was used as recommended by Snyder (1979). The two parameters set equal in model and prototype are a momentum ratio, M_o defined by,

*The following scaling relation was applied: $u_m = u_p\sqrt{\frac{L_m}{L_p}}$.

$$M_o = \left(\frac{\rho_s}{\rho_a}\right)\left(\frac{u_s D}{u_a H_s}\right)^2 = (1-\gamma)\left(\frac{RD}{H_s}\right)^2 \qquad (2.9)$$

and a buoyancy ratio, B_o, defined as follows,

$$B_o = \frac{gD^2 \gamma u_s}{u_a^3 H_s} = \frac{R^3}{Fr^2}\frac{D}{H_s} \qquad (2.10)$$

where

$$\gamma = \frac{\rho_a - \rho_s}{\rho_a} \qquad (2.7)$$

$$Fr = \frac{u_s}{\sqrt{g\gamma D}} \qquad (2.6)$$

Use of these two parameters as similarity variables allows the relaxation of the density ratio, stack diameter, Froude number and velocity ratio. Hisato and Cermak (1980) utilized the momentum and buoyancy equality parameters and Froude and velocity ratio equality criteria for plume dispersion in complex terrain. The experimental results show no more than 10 percent variation in the concentration measurements.

Briggs (1969, 1975) developed an analytical expression for plume rise given by:

$$\left(\frac{\Delta h}{H_s}\right)^3 = \frac{3}{4\beta_1^2} M_o \frac{x}{H_s} + \frac{3}{8\beta_2^2} B_o \left(\frac{x}{H_s}\right)^2 \qquad (2.11)$$

where,

$$\beta_1 = 0.5 \quad \text{and} \quad \beta_2 = 1/3 + \frac{1}{R} \ .$$

His development used the equations of motion and energy with various simplifying assumptions. The above equation has been tested against field and laboratory observations and has shown acceptable agreement in many cases (Briggs, 1975). The same plume rise will be predicted for a source if M_o and B_o are equal for the two cases; that is, if we assume β_1 and β_2 are also equal. The entrainment parameters will be equal if the flow is fully turbulent both in the plume and surrounding ambient fluid. Thus, for the plume rise in the model and full-scale to be equal, only the parameters M_o and B_o need be equated.

In past studies for PG&E (Petersen and Cermak, 1977, 1978) the following set of scaling parameters was used for modeling effluent rise.

$$Fr = \frac{u_a^2}{g\gamma D} \; ; \quad (Fr)_m = (Fr)_p \tag{2.12}$$

$$R = \frac{u_s}{u_a} \; ; \quad (R)_m = (R)_p \tag{2.13}$$

These relations were derived based on dimensional analysis arguments.

In order to determine the effects of using the earlier scaling criteria on the present study results, tests were run using 2.9 and 2.10 as compared to 2.12 and 2.13, as discussed in Section 5.5. Table 2-1 gives the model and full-scale parameters using the scaling criteria for this study, and Table 2-2 the model parameters using the scaling parameters for past studies (Equations 2.12 and 2.13). Also in Table 2-2 are the model parameters using only velocity ratio and momentum ratio as scaling parameters.

The remaining similarity parameter is the <u>Richardson</u> <u>number</u> Ri. For the atmosphere Ri is defined

$$(Ri)_p = \frac{g}{\bar{T}} \frac{\Delta\theta z}{u(z)^2} = \frac{g}{\bar{T}} \frac{(\Delta T + \Gamma z)\, z}{u(z)^2} \tag{2.14}$$

where

ΔT = temperature difference between z and surface $(T(z) - T_o)$

Γ = adiabatic lapse rate (~ 1°C/100 m)

$u(z)$ = wind speed at height z

z = height above ground--taken to be height (z_m) of maximum velocity u_m

$\bar{T}$ = mean temperature between surface and z

For the wind tunnel Γz is typically less than 0.002°C whereas ΔT is much greater than 1°C. Hence, for the wind tunnel the Richardson number is defined

$$(Ri)_m = \frac{g}{\bar{T}} \frac{(\Delta T)z}{u(z)^2}$$

Before comparing the laboratory to a full-scale case, near equality of Ri for model (Ri_m) and full-scale (Ri_p) should first be checked. For the neutral flow tests $\Delta T \doteq 0$ in model and $\Delta T + \Gamma z = 0$ in prototype; hence, $(Ri)_m = (Ri)_p = 0$.

For the drainage flow tests $(Ri)_m = (Ri)_p$. The Ri value varied at each profile measurement location for these tests. To find corresponding full-scale values for the drainage flow tests, first consider only those days having almost zero (calm) free-stream velocity, and second, the Richardson number in the model should nearly equal that in the field. Since no field data are available, typical field conditions corresponding to those set in the drainage flow test may be computed using the following relation: $(Ri)_m = (Ri)_p$ or,

$$\left(\frac{\Delta\theta}{\bar{T}\, u_{max}^2}\right)_p = \frac{(Ri)_m}{g\, z_{max}}$$

Table 2-3 gives the model and typical full-scale conditions used during the simulation. During testing it was observed that the plumes would not penetrate the low-level drainage flow when actual plant operating conditions were simulated as given in Table 2-1. So that measurable concentrations could be obtained buoyancy effects were neglected and the flow rate from the cooling towers was lowered until the plume became caught in the low-level drainage wind. The plant conditions simulated represent about 22 percent of the full load, and are tabulated in Table 2-3. However, this condition for the drainage flow study may not exist for the field condition. Hence, it should be noted that the measured concentrations are conservative. Since the meteorological conditions simulated are not unique, typical full-scale values for the wind velocity were assumed and a corresponding temperature difference calculated using the equation

$$\Delta T = (Ri)_m \left(\frac{u_{max}^2 \ \bar{T}}{g \ z_{max}} \right)_p .$$

In summary, the following similarity relations were applied for the neutral boundary layer simulation:

1) $M_o = (1-\gamma) \ R \left(\frac{D}{H_s} \right)^2$; $(M_o)_m = (M_o)_p$

2) $B_o = \frac{R^3}{Fr^2} \frac{D}{H_s}$; $(B_o)_m = (B_o)_p$

3) $Ri = \frac{g}{\bar{T}_o} \frac{\Delta T_o}{u_o^2} z_o$; $(Ri)_m = (Ri)_p = 0$

4) $Re_s = \frac{u_s D}{\nu}$; $(Re)_s > 300$

5) $Re_{k_s} = \frac{u_* k_s}{\nu}$; $11 < Re_{k_s} < 45$

6) Similar geometric dimensions, i.e., $\left(\frac{D}{H_s}\right)_m = \left(\frac{D}{H_s}\right)_p$

7) Equality of dimensionless boundary conditions.

For the drainage flow simulation the following criteria replaced items 1 and 2 above:

$$R = \frac{u_s}{u_{max}} \; ; \qquad R_m = R_p \; .$$

In addition criteria 4 and 5 could not be matched.

3.0 EXPERIMENTAL METHODS

3.1 General

A 1:1920 scale model of the topography for a west-southwest (262°) wind direction near Anderson Springs, California was constructed to study the transport and dispersion of effluent from Unit 20 (locations A and B) and Unit 18, under drainage and neutral flow conditions. Figure 3-1 shows the terrain areas modeled for the various atmospheric conditions and the unit locations.

Each test was conducted in a similar manner. Measurements of wind speed, temperature (for the drainage and stable tests only), and tracer gas concentration were obtained at various locations to document the flow pattern and for use in assessing maximum ground-level concentration. Concentration measurements were obtained at ground level and in vertical arrays. The model and full-scale conditions for each run are given in Table 3-1.

Prior to testing the appropriate free stream velocity (zero for drainage flow) and surface temperature (room temperature for neutral stratification) were set in the wind tunnel or drainage flow test facility. For the drainage flow tests velocity or concentration measurements did not begin until the surface temperatures reached equilibrium, which was usually less than 15 minutes. Thereafter, all velocity measurements (and if permitted, concentration measurements) were obtained before shutting the system down. The conditions were set again in the same manner if additional measurements were required. A complete discussion on every facet of the study follows.

3.2 Scale Model and Test Facilities

- Scale Models

Construction of the topographic model entailed a two-step process. The first involved constructing a Styrofoam model from 0.64 cm thick Styrofoam sheets (corresponds to a 40-ft contour interval). United States Geological Survey maps were photographed and the projected image used as patterns from which the Styrofoam was cut. The second phase of construction entailed fabricating a wood-ribbed frame as shown in Figure 3-2. The frame used wooden supports approximately every 30 cm which were cut to conform with the terrain elevation. Next, thin aluminum foil was placed on the Styrofoam model and molded in 30-cm wide strips to fit the terrain contours. Once a strip was molded it was placed onto the wood frame and fastened. This procedure was repeated until one model section (normally 1.22 x 3.66 m) was complete. At this stage the model section was ready for installing either thermistors or concentration sampling lines. Ground-level sampling taps were installed at the locations indicated in Figure 3-3 and thermistors at the locations indicated in Figure 3-4.

The complete model sections were then placed in either the Environmental Wind Tunnel or the Drainage Flow Facility for testing of neutral and drainage flows.

- Wind Tunnel

The Environmental Wind Tunnel, shown in Figure 3-5, was used for testing the neutral (stable) transport and diffusion. The terrain area placed in the tunnel is shown in Figure 3-1. Upwind of the modeled topography, a set of spires was used to stimulate the boundary layer. Tunnel configuration for the neutral tests is shown in Figure 3-6.

• Drainage Flow Facility

To study the natural mountain-valley or slope winds an enclosed room was specially constructed. A platform was built inside the room for supporting the aluminum shell topographic model. Figure 3-7 shows the platform in the final stages of construction. Holes were drilled through the top of the frame for mounting fans. Figure 3-8 shows a technician mounting these fans inside the frame.

The aluminum shell sections were placed atop the frame and the insulated area under the model used as a cold sink. The cold sink consisted of several short tons of dry ice at approximately -80°C, loaded on carts. Figure 3-9 shows a technician loading the ice on one of these carts prior to sliding the cart under the frame. The loaded test bed with model in place is shown in Figure 3-10. After installing the ice, the side of the frame and model were sealed with insulating materials.

The forced-air circulation system for the cold sink consisted of 120 instrument fans connected to a motor-speed controller. The rate of air circulation, as determined by the speed controller, made it possible to adjust the surface temperature conditions or shut the cooling system down entirely between experiments to conserve dry ice.

3.3 Gas Tracer Technique

• Test Procedure

The test procedure consisted of: 1) setting the proper tunnel wind speed and/or surface temperatures, 2) releasing a metered mixture of source gas of the required density (that of air) from the appropriate unit, 3) withdrawing samples of air into a series of syringes from designated locations, and 4) analyzing the samples with a flame ionization gas chromatograph.

The procedure for analyzing air samples from the tunnel was as follows: 1) a 2 cc sample volume drawn from the wind tunnel is introduced into the flame ionization detector (FID), 2) the output from the electrometer (in microvolts) is sent to the Hewlett-Packard 3380 Integrator (HP 3380), 3) the output signal is analyzed by the HP 3380 to obtain the proportional amount of hydrocarbons present in the sample, 4) the record is integrated and the ethane or propane concentration, as appropriate, is determined by multiplying the integrated signal (μv-s) times a calibration factor (ppm/μv-s), 5) a summary of the integrator analysis (gas retention time and integrated area) is printed out on the integrator at the wind tunnel, 6) the integrated values and associated run information are tabulated on a form, 7) the integrated values for each tracer are keypunched into a computer along with pertinent run parameters, and 8) the computer program converts the raw data to a dimensionless concentration $K = \chi_m u_r D^2/Q$ and the results are printed out in report format as shown in Appendices A and B where

$$(\chi)_m = (I - I_{BG})(CF)_i = \text{model concentration in ppm} \tag{3.1}$$

I = integrated value of sample for tracer i (μv-sec)

I_{BG} = integrated value of background for tracer i (μv-sec)

CF_i = calibration factor for tracer i (ppm/μv-sec)

u_r = model (m) reference wind speed (m/s)--equals u_∞ for neutral tests and u_{max} for drainage flow tests

D = diameter of individual model cell stack (m)

Q = $\chi_s \forall_s$

χ_s = source strength for tracer gas i (ppm)

$\forall_s$ = model volume flow (m^3/sec).

The calibration factor was obtained by introducting a known quantity, χ_s, of tracer i in the HPGC and recording the integrated value, I_s, in μv-s.

The CF_i value is then

$$CF_i = \left[\frac{\chi_s(\text{ppm})}{I_s(\mu\text{v-s})}\right]_i \quad . \tag{3.2}$$

Calibrations were obtained at the beginning and end of each measurement period. Tracer gas mixtures were supplied by Scientific Gas Products. The resultant full-scale H_2S concentration can be obtained using equality of nondimensional concentration coefficient, K.

- Gas Chromatograph

The FID operates on the principle that the electrical conductivity of a gas is directly proportional to the concentration of charged particles within the gas. The ions in this case are formed by the effluent gas being mixed in the FID with hydrogen and then burned in air. The ions and electrons formed enter an electrode gap and decrease the gap resistance. The resulting voltage drop is amplified by an electrometer and fed to the HP 3380 integrator. When no effluent gas is flowing, a carrier gas (nitrogen) flows through the FID. Due to certain impurities in the carrier, some ions and electrons are formed creating a background voltage or zero shift. When the effluent gas enters the FID, the voltage increases above this zero shift in proportion to the degree of ionization or correspondingly the amount of tracer gas present. Since the chromatograph[1] used in this study features a temperature control on the flame and electrometer, there is very low zero drift. In case of

[1]A Hewlett Packard 5700 gas chromatograph was used in this study (shown in Figure 3-11).

any zero drift, the HP 3380 which integrates the effluent peak also subtracts out the zero drift.

The lower limit of measurement is imposed by the instrument sensitivity and the background concentration of tracer within the air in the wind tunnel. Background concentrations were measured and subtracted from all data quoted herein.

- Sampling System

The tracer gas sampling system shown in Figure 3-11 consists of a series of fifty 30 cc syringes mounted between two circular aluminum plates. A variable-speed motor raises a third plate which in turn raises all 50 syringes simultaneously. A set of check valves and tubing are connected such that airflow from each tunnel sampling point passes over the top of each designated syringe. When the syringe plunger is raised, a sample from the tunnel is drawn into the syringe container. The sampling procedure consists of flushing (taking and expending a sample) the syringe three times after which the test sample is taken. The draw rate is variable and generally set to be approximately 6 cc/min.

The sampler was periodically calibrated to insure proper function of each of the check valve and tubing assemblies. The sampler intake was connected to short sections of tygon tubing which led to a sampling manifold. The manifold, in turn, was connected to a gas cylinder having a known concentration of tracer (100 ppm ethane). The gas was turned on and a valve on the manifold opened to release the pressure produced in the manifold. The manifold was allowed to flush for ~ 1 minute. Normal sampling procedures were carried out to insure exactly the same procedure as when taking a sample from the tunnel. Each sample was then analyzed for ethane or propane. Percent error was calculated, and any "bad" samples (error > 2 percent) indicated a failure in the check valve assembly, and the check valve was replaced or the bad syringe was not used for sampling from the tunnel. A typical sampler calibration is shown in Figure 3-12.

- Averaging Time

To determine the averaging time for the predicted concentrations from wind-tunnel experiments, the dispersion parameters--σ_y and σ_z--for undisturbed flows in the wind tunnel have been compared to those used for numerical modeling studies (Petersen et al., 1979) in the atmosphere. The dispersion rates used in the atmosphere are referred to as the Pasquill-Gifford curves and are given in Turner (1970) and modified values are given in Pasquill (1974, 1976). The results of this comparison showed that the σ_y and σ_z values in the wind tunnel compare (when multiplied by the length scaling factor) with those expected for the atmosphere. Hence, the method used for converting numerical model predictions to different averaging times should also be used for converting the wind-tunnel tests.

Specification of an effective atmospheric averaging time for the steady-state average concentrations measured in the wind tunnel can be generally made only in terms of the joint probability of wind speed, wind direction and thermal stability during a particular time interval. Kothari, Meroney and Bouwmeester (1981) have shown through comparison with full-scale data that one-hour average concentrations can be predicted with good accuracy by superposition of wind-tunnel concentration data for each 2-minute average of measured meteorological data during the interval. Unfortunately, the statistics of meteorological data used to make this time-weighted calculation for a specific site are not available. In lieu of full-scale averages calculated from wind-tunnel concentration data, physical fluid model results are related to full-scale averages by specifying a single equivalent averaging time. As indicated by the work of Kothari, Meroney and Bouwmeester (1981) the equivalent averaging time, even for neutral stratification, is dependent upon the spectrum of turbulence during the averaging interval. A spectrum for longitudinal velocity fluctuations (not universal!) developed by van der Hoven--see Lumley and Panofsky (1964), p. 43--has been used by Ludwig (1974) to justify an equivalent averaging time of 10-15 minutes. However, for meteorological condition during which disturbances with frequencies lower than at the spectral gap (0.1-1.0 cycles/hr), such as shown by meteorological record b of Fig. 2.31 in Meteorology and Atomic Energy (1968), the equivalent averaging time can be several hours.

A rather recent consensus for a reasonable equivalent averaging time that will be applicable for most meteorological conditions is 10-15 minutes (Snyder, 1979). Complex terrain of the Geysers Power Plant site will usually result in substantial energy at low-frequencies above the spectral gap frequencies; therefore, we recommend that the equivalent averaging time for this study be taken as approximately 10 minutes.

3.4 Velocity Profiles

- General

Vertical profiles of mean velocity were obtained for the various tests at the locations indicated in Figure 3-4. The measurements were performed to 1) monitor and set flow conditions, 2) document flow conditions, and 3) for use in calculating surface roughness, power-law exponent and Reynolds stress.

The velocity measurements for the drainage test were made using a Gould/Datametrics Model 800-LV temperature compensated linear velocimeter without a probe shroud. The probe shroud was removed to minimize the disturbance to the flow field by the bulk of the probe as it was lowered near the model surface. The velocity measurements for the neutral test were made with a Thermosystems hot-film anemometer system.

• Velocity Measurements

Measurements of mean velocity and turbulence intensity were accomplished with a single hot-film anemometer with film axis horizontal. The instrumentation used was a Thermo-Systems constant temperature anemometer model 1050 connected to a 2.54×10^{-3} cm diameter platinum film sensing element 0.0508 cm long. The output of the constant temperature anemometer was directed to an on-line data acquisition system consisting of a Hewlett-Packard 21 MX Computer, disc unit, card reader, printer, Digi-Data digital tape drive and a Preston Scientific Analog-digital converter. The data was processed immediately into mean velocity and turbulence intensity at each corresponding height and stored on the computer disc for printout or further analysis.

Calibration of the hot-wire anemometer was performed using a calibrator suitable for low velocity and developed by CSU staff. The calibration data were fit to a variable exponent King's law relationship

$$E^2 = A + BU^n \qquad (3.3)$$

where E is the hot-wire output voltage, U is the velocity and A, B and n are coefficients selected to fit the calibration data. All measurements were performed with a sample rate of 250 samples per second for 20 seconds, and the above calibration relationship was used to determine the mean velocity. The King's Law relationship is not normally used for very low velocities where the heat transfer from the sensor is governed by mixed forced/free convection; hence, the low velocity measurements obtained by the hot-film are somewhat questionable. Absolute accuracy is probably no better than ±20 percent at such low velocities; however relative magnitudes are consistent. The fluctuating velocity may be characterized by the statistic U_{rms} (root-mean-square velocity). It was calculated from

$$U_{rms} = \frac{2E\ E_{rms}}{Bn\ U^{n-1}} \tag{3.4}$$

where E_{rms} is the root-mean-square of the voltage output from the anemometer. The local turbulence intensity, U_{rms}/U, was then calculated.

The Datametrics Model 800-LV temperature compensated linear velocity meter was used for the drainage flow tests. The principle of operation of this probe is the same as the hot film discussed above with the addition of an unheated element, the resistance of which corresponds to ambient temperature and controls the overheat ratio of the velocity sensing element. In this manner the probe is made insensitive to temperature variations. The probe is normally configured with a shield over the wire with a hole allowing airflow for measurement. Since the shield restricted the closeness with which one could approach the model surface, it was removed. Figure 3-13 shows the two sensing elements, the top one being the velocity sensor and the bottom one the temperature sensor.

- Anemometer Calibration

For both the drainage flow and neutral flow tests a system providing a source of reference air speed was used to calibrate the velocity measurement apparatus. This system consists of a discharge nozzle (shown in Figure 3-14), a linear mass flowmeter and controller, and a source of regulated air. The nozzle was supplied with regulated air the quality of which was monitored on the linear mass flowmeter. Regression analysis was used to fit the calibration data to Equation (3.3) for the hot film or to a linear equation for the Datametrics probe. Figures 3-15 and 3-16 show respective calibration curves for the hot film and Datametric probe.

- Data Collection and Analysis

The manner of collecting the data was as follows:

1) The hot-film or Datametric probe was attached to a carriage.

2) The bottom height of the profile was set to the desired initial height.

3) A vertical distribution of velocity was obtained using a vertically traversing mechanism which gave a voltage output corresponding to the height of the wire above the ground.

4) The signals from the anemometer and potentiometer device indicating height were fed directly to a Hewlett-Packard Series 1000 Real Time Executive Data Acquisition System.

5) Samples were stored digitally in the computer.

6) The computer program converted each voltage into a velocity (m/s) using the equations:

$$u = \left[\frac{E^2 - A}{B}\right]^{1/n} \qquad \text{for hot film}$$

$$u = \text{constant } (E) \qquad \text{for Datametrics.}$$

3.5 Temperature Measurement

Temperature measurements at the model surface and local air temperature for the drainage flow test were made using Yellow Springs Instruments Model 44004 thermistors. The model surface temperature measurement was made by mounting the thermistor on the model terrain so that the lead wires passed beneath the model and the body of the thermistor element was exposed to the air immediately above and adjacent to the model surface material. The location of these probes is seen in Figure 3-4. Resistance measurements of the thermistors were routed through a switch panel to a Keithley Instruments Model 177 digital multimeter. The resistances were then converted to temperature with a table supplied by Yellow Springs. The air speed probe thermistor was mounted on a hot-wire probe fixture so that the body of the thermistor was positioned lateral to the velocity probe but near it in the flow field and at the same height.

4.0 DRAINAGE FLOW RESULTS

4.1 Velocity and Temperature Measurements

A series of six velocity and temperature profiles were obtained at locations T6, T5, T12, T11, T3 and T1, which are annotated in Figure 3-4. Prior to testing, the surface of the aluminum model was cooled and allowed to stabilize (required approximately 15 minutes). Surface temperature measurements at thermistors 1 through 12 (noted in Figure 3-4) were then obtained during all velocity profile measurements to document the consistency of the test condition. Table 4-1 shows the surface temperatures and Tables 4-2 through 4-7 shows the measured vertical distributions of $\bar{u}$, i and $\bar{T}$.

Figures 4-1 through 4-6 show the respective temperature and velocity profiles for locations T1, T3, T5, T6, T11 and T12. Locations T5, T6 and T12 correspond to respective unit locations 20A, 20B and 18. Locations T1, T3 and T11 are along Big Sulphur Creek. The profile taken at T1 (Figure 4-1) shows the deepest stable layer and strongest velocity. The depth of the stable layer is approximately 20 cm (384 m full-scale) and maximum velocity is 49.5 cm/s at 3 cm (58 m full-scale) above the ground. This location is farther down Big Sulphur Creek and consequently a deeper and stronger stable flow is expected.

The profiles at T3 (shown in Figure 4-2), which is up Big Sulphur Creek toward Unit 18, shows a stable layer depth of 15 cm (288 m) and a maximum velocity of 30.4 cm/s at 1 cm (19 m) above the ground.

Figures 4-3 and 4-4 show the temperature and velocity profiles at T5 and T6. Since these locations are near the top of a hill the stable layer is very shallow and the maximum velocity low. The stable layer is about 4 cm (77 m) deep with a maximum velocity of 8.0 cm/s. Location

T11 is down the slope from Unit 18 toward Big Sulphur Creek. The profiles in Figure 4-5 show a stable layer about 10 cm (192 m) thick with a maximum velocity of 14.3 cm/s at 2 cm (38 m) above the ground.

At T12 (the location of Unit 18) the depth of the stable layer is 10 cm (192 m) with a maximum velocity of 15.2 cm/s at 1 cm (19 m) above ground level.

As is evident from these results the drainage flow is very shallow on hilltops or close to hilltops. In addition the velocity is low at these locations relative to locations further down the slope. Hence, a plume emitted from or near a hilltop should penetrate these slope flows if sufficient initial plume rise is present.

4.2 Concentration Measurements

A neutrally buoyant plume was released from scale models of Units 18, 20A and 20B. The model and full-scale test conditions are given in Table 2-3. As discussed in Section 2, the actual operating conditions of the units were not simulated. Exploratory studies showed that the plumes penetrated the stable layer and zero ground-level impact resulted if the actual conditions were simulated. To see what diffusion patterns would result if the plumes became entrained in the drainage flow, a neutrally buoyant gas was released at a sufficiently low rate.

The drainage flow simulation was established in the same manner as for the velocity profiles. The surface temperatures that were recorded during each test are given in Table 4-8.

The resulting ground-level concentration measurements, presented in the form of nondimensional concentration coefficient, K, are given in Appendix A and ground-level isopleth patterns in Figures 4-7 through 4-9. The ground-level isopleth pattern in Figure 4-7 shows that the effluent released from Unit 18 is carried down the northeast side of Big Sulphur Creek with patches of effluent detected on the southwest side.

For Unit 20A (Figure 4-8) the effluent moves down the southwest side of Big Sulphur Creek and eventually follows the creek bottom. There appears to be an initial spreading of the plume due to the light and variable wind at the release location.

The isopleth pattern for Unit 20B in Figure 4-9 is similar to that observed for 20A. The center of the plume moves down slope toward the bottom of Big Sulphur Creek. Upon reaching the creek bottom the plume follows the creek. Near the release point increased initial spreading is observed. This is due to the light and variable winds at the release locations in the tunnel.

In summary the concentration results showed that the plumes released from Units 18, 20A and 20B will flow downslope into Big Sulphur Creek and follow the creek bottom thereafter. The case simulated represents about 20 percent of full load capacity. At full load the plumes from the cooling towers penetrated the drainage flow and rose into the cooler air above. Hence no ground-level impact was observed for the 100 percent load case.

5.0 NEUTRAL FLOW--WEST WIND RESULTS

5.1 Velocity Profiles

A series of mean velocity and longitudinal turbulence intensity profiles were taken at locations T6, Met Station and C-35 annotated in Figure 3-4. At the Met Station profiles were taken for free stream velocities of 5.7, 6.7, 10.5, 15.3, and 20.1 m/sec. The results are shown in Figure 5-1. The mean velocity profiles (nondimensionalized by u_∞) are similar over the range of speeds considered. The largest deviation from similarity is for the 5.7 and 6.7 m/s free stream velocity cases. The turbulence intensity profiles also show similarity except for the 5.7 m/s case.

At T6, profiles were taken at free stream velocities of 4.8, 8.6, and 16.3 m/s. The results are shown in Figure 5-2. The mean dimensionless velocity profiles are nearly identical for all speeds considered. The turbulence intensity profiles show more scatter from case to case.

The profiles taken at C-35 (near Anderson Springs) for free-stream velocities of 4.8, 7.7, and 17.2 m/s are shown in Figure 5-3. Both the mean velocity and turbulence intensity profiles exhibit a large degree of dissimilarity over the range of speeds studied. This could be due to a Reynolds number effect or to the fact that the measurement location is in the wake of a hill. The velocity measurement averaging time may have been insufficient to represent the mean of velocity and turbulence intensity.

To summarize the boundary-layer characteristics obtained with the hot-film sensor, Table 5-1 was prepared. This table gives the u_*, z_o, and n values obtained for each profile by fitting the data by least squares to the following formulae:

$$\frac{\bar{u}}{u_*} = \frac{1}{k} \ln \frac{z}{z_o} \tag{5.1}$$

$$\frac{\bar{u}}{u_\infty} = \left(\frac{z}{z_\infty}\right)^n \tag{5.2}$$

The average z_o values at respective locations T6, Met Station, and C-35 are 0.04 (0.76 m full-scale), 0.0022 (0.04 m full-scale) and 0.21 cm (3.95 m full-scale). The corresponding average n values are 0.18, 0.11 and 0.22 and the average ratio $\frac{u_*}{u_\infty}$ at each respective station is 0.061, 0.04 and 0.08.

To check whether the n and $\frac{u_*}{u_\infty}$ values are consistent with atmospheric observations consider the following two equations from Counihan (1975):

$$\left(\frac{u_*}{u_\infty}\right)^2 = 2.75 \times 10^{-1} + 6 \times 10^{-4} \log_{10} z_o \tag{5.3}$$

$$n = 0.096 \log_{10} z_o + 0.016 (\log_{10} z_o)^2 + 0.24 \tag{5.4}$$

For the respective full-scale z_o values of 0.76, 0.04 and 3.95 m the expected $\frac{u_*}{u_\infty}$ values as computed from Equation (5.3) are 0.05, 0.04 and 0.06--good agreement with wind-tunnel observation. The respective n values are 0.23, 0.14 and 0.30 using Equation (5.4) and the z_o values obtained from Equation (5.1). The n values as determined using Equation (5.2) and the measured velocity show fair agreement in absolute value but show a similar trend as predicted using Equation (5.4).

5.2 Vertical Concentration Distributions

Vertical concentration distributions at three locations downwind of Units 18, 20A and 20B were measured and the results are given in Figures 5-4 through 5-7. Figures 5-4 shows the distribution downwind of

Unit 20B for a simulated 15 m/s free stream velocity. At the hillcrest the plume center of mass is 161 m above the ground with little ground-level impact. In the lee of the hill the concentration becomes nearly uniform below the hill top elevation (msl) while the height of the plume center of mass relative to local ground level continues to increase.

Figure 5-5 shows the vertical concentration distributions downwind of Unit 18 for a 15 m/s free-stream wind velocity. The distribution 1 km downwind of Unit 18 on the hill top has lower concentrations than those farther downwind. This apparent inconsistency is due to the fact that the distribution was not taken close enough to the exact center of the plume. The shape of the distribution, the $\bar{z}$ and σ_z values should be representative. It is apparent that the plume passes closer to the ground at the hilltop than for Unit 20B at the 15 m/s free-stream wind speed. This is due to the fact that Unit 18 is at a more exposed location and consequently higher speeds at cooling tower height would give lower plume rise. The concentration profiles downwind of the hill show almost uniform mixing below the hilltop elevation with a rapid decrease to zero concentration above that elevation. Since the plume is closer to the release than for Unit 20B, the σ_z values are less at all three locations as expected.

Figures 5-6 and 5-7 show the vertical concentration distributions downwind of Units 18 and 20A for a 20 m/s full-scale free stream wind velocity. Again the plume from Unit 18 passes closer to the ground as it passes over the hill and the σ_z and $\bar{z}$ values are less at all similar downwind locations. The plumes from Unit 18 and 20A both become uniformly mixed below the hilltop elevation at distances downwind from the hill. Higher ground-level concentrations are evident from Unit 18 at locations in the lee of the hill.

5.3 Maximum Ground-Level Concentrations

Ground-level tracer gas concentrations were measured downwind of Units 18, 20A and 20B for full-scale free stream wind velocities of 7.5, 10, 15, 20 and 28 m/s. The results are contained in Appendix A and summarized in Tables 5-2, 5-3 and 5-4. Table 3-1 gives the model and full-scale parameters for each run and Figure 3-3 the sampling location key.

The maximum observed nondimensional concentration coefficient, K, is plotted versus distance downwind from the release for each wind velocity and unit studied in Figures 5-8 through 5-12. For the 7.5 m/s free-stream velocity case (Figure 5-9), Unit 18 appears to have the highest normalized concentrations near the source whereas Unit 20B has the highest concentrations beyond 4 km. At a 10 m/s free-stream velocity (Figure 5-10) the nondimensional concentration values beyond 4 km appear nearly equal for all units. Close to the source Unit 18 again appears to have the highest impact with Unit 20A having the second highest. This same pattern is observed for the 15, 20 and 28 m/s free-stream wind velocity cases.

The overall pattern of maximum concentration is to increase with increasing wind speed for each unit. At 15 m/s and above the increase with wind speed diminishes and the maximum concentration becomes nearly constant with increasing wind speed. Below 15 m/s the maximum nondimensional concentration drops sharply with decreasing wind speed. This suggests that below 15 m/s plume rise is still an important phenomena in the diffusion process. At 15 m/s and above the plume rise must become nearly constant which gives a constant normalized maximum concentration as a function of wind speed. The maximum ground-level H_2S concentration would occur at approximately the speed where the normalized concentration changes very little with increasing wind speed. This critical wind speed appears to be between 15 and 20 m/s.

The following method should be utilized to calculate prototype concentrations from nondimensional concentration coefficient, k. The basic equation is:

$$k = \frac{\chi\, u_r\, D^2}{\chi_s\, \forall_s}$$

where

k = nondimensional concentration coefficient from wind tunnel study,

χ = H_2S concentration (ppm),

u_r = prototype reference wind speed (m/sec) and equals to u_∞ for neutral flow tests and u_{max} for drainage flow tests,

D = prototype individual cell diameter (8.45 m),

$\forall_s$ = prototype total volume flow rate through all cells (4312.6 m^3/sec),

χ_s = prototype source strength of gas (ppm).

Solving for the prototype concentration,

$$\chi = \frac{K\, \chi_s\, \forall_s}{u_r\, D^2} = 60.4\, \frac{k\, \chi_s}{u_r} \quad .$$

Thus, for $k = 0.128 \times 10^{-3}$, χ_s = 10 ppm and u_r = 10 m/sec,

$$\chi = 60.4\, \frac{0.128 \times 10^{-3} \times 10}{10} = 0.008 \text{ ppm}$$

will be the equivalent prototype concentration.

5.4 Ground-Level Isopleth Patterns

To assess the ground-level distribution of concentration, isopleths of nondimensional concentration, K, were plotted for each unit and wind speed studied. Figure 5-13 shows the isopleths downwind of Unit 18 for free-stream velocities of 7.5, 10, 15, 20 and 28 m/s. When viewing Figures 5-13a through 5-13e the general similarity of the isopleth pattern regardless of wind speed is evident. The isopleths show the steady increase in the maximum K value with increasing wind speed. Also evident is the steady progression of the 40×10^{-5} isopleth toward Anderson Springs as wind speed increases.

The ground-level isopleths downwind of Unit 20A are shown in Figures 5-14a through 5-14e for the five wind speeds studied. In this case the 40×10^{-5} isopleth line does not reach Anderson Springs. Hence the concentration levels are less than for Unit 18. For Unit 20B the isopleths are shown in Figure 5-15a through 5-15e for each wind speed studied. The concentration levels for this unit are less than either Unit 18 or 20A.

In general all the isopleths showed a similar pattern. The maximum K gradually increased with increasing wind speed but to a lesser extent at the higher speeds. The shape of the isopleth pattern appeared similar for a given unit as wind speed varied. The results also suggest that Unit 20B will give the least overall H_2S impact in Anderson Springs.

5.5 Similarity Criteria Test

As discussed in Section 2.3, five tests were run simulating a same full-scale case with different similarity criteria. The full-scale and model conditions for each test are given in Table 2-2. The full-scale case simulated was a 15 m/s free stream velocity with Unit 18 operating. Figure 5-16 shows the maximum observed K versus downwind distance for each different simulation of the full-scale case. The simularity method used in this report has been identified by Δ in this figure. For this case plume rise scaling was $(M_o)_m = (M_o)_p$ and $(B_o)_m = (B_o)_p$.[1] All past PG&E studies were run using the results marked with a ⬡. The plume scaling criteria for those studies was $(Fr)_m = (Fr)_p$ and $(R)_m = (R)_p$. As can be seen, the two simulations give the same trend but the old method provides slightly lower estimates. The main reason for the difference in concentration between "past" and "present" simulation methods is attributed to current use of the free-stream velocity for a reference speed. Comparing the nondimensional velocity profiles PGE04 ("present" simulation) and PG05 ("past" simulation) in Figure 5-1, it can be concluded that the velocity profile PGE04 would result in the lower plume rise and correspondingly higher concentration. However, due to the complex terrain and low stack height (1.07 cm), it is difficult to monitor the reference velocity at stack height during wind-tunnel experiments.

Two simulations were performed by equating the R in model and full-scale and letting $Fr = \infty$. The two cases were for two different free-stream velocities. If Reynolds number effects are important a change should be observed between the two runs; otherwise, the results should be identical. As is evident in the figure the two runs give nearly identical results but higher values than the "true" simulation. Since a neutrally buoyant plume would have less rise than a buoyant plume for the same R, the increase in concentration is expected.

The last simulation presented is for $(M_o)_m = (M_o)_p$ and $Fr = \infty$. This case agreed well with the equal velocity ratio cases and gives higher concentrations than the "present" simulation.

[1]See Section 2.3 for a discussion of terms.

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TABLES

Table 2-1. Model and Prototype Parameters for the PGE Evaluation at Geysers

Parameters	Test Series Prototype	Model	Prototype	Model	Prototype	Model	Prototype	Model	Prototype	Model
1) Cooling Tower Height - $H(m)$	20.0	0.0107	20.0	0.0107	20.0	0.107	20.0	0.0107	20.0	0.0107
2) Cell Diameter - $D(m)$	8.5	0.00443	8.5	0.00443	8.5	0.00443	8.5	0.00443	8.5	0.00443
3) Free Stream Velocity - $u_\infty(m/s)$	28.0	2.93	7.5	0.785	10.0	1.047	15.0	1.570	20.0	2.093
4) Exit Velocity - $u_s(m/s)$	7.6	1.705	7.6	1.705	7.6	1.705	7.6	1.705	7.6	1.705
5) Volume Flow - $V(m^3/s)$	4312.6	2.628×10^{-4}	4312.6	2.628×10^{-4}	4312.6	2.628×10^{-4}	4312.6	2.628×10^{-4}	4312.6	2.628×10^{-4}
6) Ambient Temperature - $T_a(°K)$	293.0	293.0	293.0	293.0	293.0	293.0	293.0	293.0	293.0	293.0
7) Exit Temperature - T_s	319.0	293.0	319.0	293.0	319.0	293.0	319.0	293.0	319.0	293.0
8) Density Ratio - γ $\left(\frac{T_s - T_a}{T_s}\right)$ or $\left(\frac{\rho_a - \rho_s}{\rho_a}\right)$	0.0815	0.80	0.0815	0.80	0.0815	0.80	0.0815	0.80	0.0815	0.80
9) Froude Number - F_r $\left(\frac{u_s}{\sqrt{g\gamma D}}\right)$	2.914	9.139	2.914	9.139	2.914	9.139	2.914	9.139	2.914	9.139
10) Velocity Ratio - R $\left(\frac{u_s}{u_\infty}\right)$	.2714	.582	1.013	2.172	0.760	1.620	0.507	1.086	0.380	0.315
11) Momentum Ratio - M_o $[(1-\gamma)\ R^2\ D^2/H^2]$	.012	.0116	.170	.162	.096	.090	.043	.040	.024	.023
12) Buoyancy Ratio - B_o $\frac{R^3}{Fr^2} \cdot \frac{D}{H}$	.001	.00098	.052	.051	.022	.021	.007	.006	.0027	.0026

Table 2-2. Model and Prototype Parameters for PGE Similarity Tests

		MODEL				
Parameter	Prototype	Present Simulation	Past Simulation	Velocity Ratio 1	Velocity Ratio 2	Momentum Ratio
1) Cooling Tower Height - $H(m)$	20.0	0.0107	0.0107	0.0107	0.0107	0.0107
2) Cell Diameter - $D(m)$	8.5	0.00443	0.00443	0.00443	0.00443	0.00443
3) Free Stream Velocity - $u_\infty(m/s)$	15.0	1.57	1.07	1.07	2.093	2.093
4) Exit Velocity - $u_s(m/s)$	7.6	1.705	0.543	0.543	1.062	1.023
5) Volume Flow - $V(m^3/s)$	4312.6	2.628E-4	8.369E-5	8.369E-5	1.679E-4	1.578E-4
6) Ambient Temperature - $T_a(°K)$	293	293	293	293	293	293
7) Exit Temperature - $T_s(°K)$	319	293	293	293	293	293
8) Density Ratio - γ $\left[\frac{T_s - T_a}{T_s}\right]$ or $\left(\frac{\rho_a - \rho_s}{\rho_a}\right)$	.0815	0.80	0.80	0	0	0
9) Froude Number - Fr $\left(\frac{u_s}{\sqrt{g\gamma D}}\right)$	2.914	9.139	2.914	∞	∞	∞
10) Velocity Ratio - R $\left(\frac{u_s}{u_\infty}\right)$	.51	1.086	0.51	0.51	0.51	0.489
11) Momentum Ratio - M_o $[(1-\gamma)R^2(D/H_s)^2]$	0.043	0.040	0.009			
12) Buoyancy Ratio - B_o (R^3/Fr^2)	0.007	0.006	0.016			

Table 2-3. Model and Prototype Parameters for the PGE Drainage Flow Tests

Unit	20A		20B		18	
Parameter	Prototype	Model	Prototype	Model	Prototype	Model
1) Cooling Tower Height - H(m)	20.0	0.0107	20.0	0.0107	20.0	0.0107
2) Cell Diameter - D(m)	8.5	0.00443	8.5	0.00443	8.5	0.00443
3) Load - (%)	22.5	22.5	22.5	22.5	22.5	22.5
4) Maximum Velocity - u_{max}(m/s)	1.09	0.081	1.05	0.078	2.04	0.152
5) Exit Velocity - u_s(m/s)	1.709	0.127	1.709	0.127	1.709	0.127
6) Volume Flow - V(m^3/s)	969.8	1.95 E-5	969.8	1.95 E-5	969.8	1.95 E-5
7) Ambient Temperature - T_a(°K)	293.0	253.0	293.0	253.0	293.0	253.0
8) Exit Temperature - T_s(°K)	319.0	253.0	319.0	253.0	319.0	253.0
9) Density Ratio - γ $\left(\frac{T_s - T_a}{T_s}\right)$	0.0815	0	0.0815	0	0.0815	0
10) Froude Number - Fr $\left(\frac{u_s}{\sqrt{g\gamma D}}\right)$	2.914	∞	2.914	∞	2.914	∞
11) Velocity Ratio - R $\left(\frac{u_s}{u_{max}}\right)$	1.568	1.568	1.628	1.628	0.836	0.836
12) Surface Temperature - T_o(°K)	291.7	246.0	291.3	239.4	292.0	234.2
13) T(Z_{max})	294.3	269.4	294.7	270.3	294.0	252.5
14) Z_{max}(m)	9.6	0.005	9.6	0.005	19.2	0.010
15) Ri	0.68	0.68	0.98	0.98	0.32	0.32

Table 3-1. Model and Prototype Conditions for each Test Studied

Drainage Flow

				Model			Prototype		
Run	Type Samples	Unit NRS.	Tracer	Vol. Flow (m^3/s)	S. Strength (ppm)	Vel. (m/s)	Vol. Flow (m^3/s)	S. Strength (ppm)	Vel. (m/s)
1	GND	20A	E	1.95E-5	10E4	8.123E-2	1	1	1
1A	"	20A	E	1.95E-5	10E4	8.123E-2	1	1	1
1B	"	20A	E	1.95E-5	10E4	8.123E-2	1	1	1
2	"	20B	E	1.95E-5	10E4	7.846E-2	1	1	1
2A	"	20B	E	1.95E-5	10E4	7.846E-2	1	1	1
2B	"	20B	E	1.95E-5	10E4	7.846E-2	1	1	1
3	"	18	E	1.95E-5	10E4	15.183E-2	1	1	1
3A	"	18	E	1.95E-5	10E4	15.183E-2	1	1	1
3B	"	18	E	1.95E-5	10E4	15.183E-2	1	1	1

Table 3-1. Model and Prototype Conditions for each Test Studied (continued)

Neutral Flow

Run	Conc. Samples	Unit NRS. Release Site	Tracer	Model: Vol. Flow (m^3/s)	Model: S. Strength (ppm)	Model: Wind Vel. (m/s)	Prototype: Vol. Flow (m^3/s)	Prototype: S. Strength (ppm)	Prototype: Wind Vel. (m/s)
1	GND	20A	E	262.8E-6	6.9E4	2.88	4312.6	1.0	27.56
		18	P	"	4.41E4	"	"	"	"
2	"	20A	E	262.8E-6	6.9E4	0.79	4312.6	1.0	7.5
		18	P	"	4.41E4	"	"	"	"
3	"	20A	E	262.8E-6	6.9E4	1.05	4312.6	1.0	10.0
		18	P	"	4.41E4	"	"	"	"
4	"	20A	E	262.8E-6	6.9E4	1.57	4312.6	1.0	15.0
		18	P	"	4.41E4	"	"	"	"
5	"	20A	E	262.8E-6	6.9E4	2.09	4312.6	1.0	20.0
		18	P	"	4.41E4	"	"	"	"
5A	"	20A	E	262.8E-6	6.9E4	2.09	4312.6	1.0	20.0
		18	P	"	4.41E4	"	"	"	"
5B	"	20A	E	262.8E-6	6.9E4	2.09	4312.6	1.0	20.0
		18	P	"	4.41E4	"	"	"	"
6	"	20B	P	262.8E-6	4.41E4	2.88	4312.6	1.0	27.56
		18	E	"	6.9E4	"	"	"	"
7	"	20B	P	262.8E-6	4.41E4	0.79	4312.6	1.0	7.5
		18	E	"	6.9E4	"	"	"	"
8	"	20B	P	262.8E-6	4.41E4	1.05	4312.6	1.0	10.0
		18	E	"	6.9E4	"	"	"	"
9	"	20B	P	262.8E-6	4.41E4	1.57	4312.6	1.0	15.0
		18	E	"	6.9E4	"	"	"	"
9A	"	20B	P	262.8E-6	4.41E4	1.57	4312.6	1.0	15.0
		18	E	"	6.9E4	"	"	"	"

Table 3-1. Model and Prototype Conditions for each Test Studied (continued)

Neutral Flow

Run	Conc. Samples	Unit NRS. Release Site	Tracer	Model Vol. Flow (m^3/s)	Model S. Strength (ppm)	Model Wind Vel. (m/s)	Prototype Vol. Flow (m^3/s)	Prototype S. Strength (ppm)	Prototype Wind Vel. (m/s)
9B	GND	20B	P	262.8E-6	4.41E4	1.57	4312.6	1.0	15.0
		18	E	"	6.9E4	"	"	"	"
10	"	20B	P	262.8E-6	4.41E4	2.09	4312.6	1.0	20.0
		18	E	"	6.9E4	"	"	"	"
11	VERT	20A	E	262.8E-6	6.9E4	2.09	4312.6	1.0	20.0
		18	P	"	4.41E4	"	"	"	"
12	VERT	20A	E	262.8E-6	6.9E4	2.09	4312.6	1.0	20.0
		18	P	"	4.41E4	"	"	"	"
13	VERT	20A	E	262.8E-6	6.9E4	2.09	4312.6	1.0	20.0
		18	P	"	4.41E4	"	"	"	"
14	VERT	20B	P	262.8E-6	4.41E4	1.57	4312.6	1.0	15.0
		18	E	"	6.9E4	"	"	"	"
15	VERT	20B	P	262.8E-6	4.41E4	1.57	4312.6	1.0	15.0
		18	E	"	6.9E4	"	"	"	"
16	VERT	20B	P	262.8E-6	4.41E4	1.57	4312.6	1.0	15.0
		18	E	"	6.9E4	"	"	"	"
17	GND	18	E	83.69E-6	6.9E4	1.07	4312.6	1.0	15.0
17A	"	18	E	83.69E-6	6.9E4	1.07	"	"	"
18	"	18	E	83.69E-6	10.0E4	1.07	4312.6	1.0	15.0
18A	"	18	E	83.69E-6	10.0E4	1.07	"	"	"
19	"	18	E	167.4E-6	10.0E4	2.09	4312.6	1.0	15.0
19A	"	18	E	167.4E-6	10.0E4		"	"	"
20	"	18	E	157.8E-6	10.0E4	2.09	4312.6	1.0	15.0
20A	"	18	E	157.8E-6	10.0E4	2.09	"	"	"

Table 4-1. Ground Temperatures (°C) Observed while Recording Velocity/Temperature Profile Data for Drainage Flow Conditions from 1601 to 2108 MST on 25 March 1980

Thermistor	Run Location					
	T6	T5	T12	T11	T3	T1
1	-29.6	-29.7	-29.5	-28.2	-27.8	-27.3
2	-34.5	-34.6	-34.3	-32.7	-32.2	-31.9
3	-33.0	-33.0	-33.0	-32.4	-31.4	-31.1
4	-32.7	-32.8	-32.9	-31.8	-30.7	-30.5
5	-27.8	-27.7	-27.8	-27.0	-25.8	-25.8
6	-34.6	-34.6	-34.6	-33.4	-32.3	-32.2
7	-23.1	-23.0	-23.3	-22.2	-21.6	-21.7
8	-37.3	-37.9	-37.8	-37.0	-36.0	-35.4
9	-40.8	-41.0	-41.1	-40.3	-39.4	-38.8
10	-34.1	-34.6	-36.2	-35.9	-35.1	-34.0
11	-39.4	-39.9	-41.3	-40.8	-40.0	-38.9
12	-38.8	-39.1	-39.7	-39.3	-38.4	-37.5
13	-41.0	-41.3	-41.8	-41.4	-40.7	-39.6
14	-40.7	-40.9	-41.1	-40.5	-40.5	-39.7
16	-38.0	-38.4	-38.8	-37.8	-37.8	-37.8
18	-26.9	-26.9	-26.7	-25.7	-24.8	-25.0

Table 4-2. Vertical Distribution of $\overline{u}$, i and $\overline{T}$ Measured at T1

z (cm)	$\overline{u}$ (cm/s)	i (%)	T (^{o}C)
0.2	25.265	17.5	-23.4
0.4	32.031	21.6	-23.1
0.6	39.003	16.8	-22.8
0.8	38.202	17.6	-23.1
1.0	38.187	17.5	-23.2
1.2	35.644	22.5	-23.2
1.5	42.476	17.5	-22.9
2.0	43.717	18.3	-22.0
2.5	44.236	13.7	-21.2
3.0	49.456	16.0	-19.5
4.0	42.180	13.3	-14.6
5.0	42.457	17.6	-12.6
6.0	38.737	17.1	-10.2
8.0	34.270	19.3	-6.8
10.0	21.287	28.3	-4.1
13.0	12.433	30.7	0.7
16.0	5.502	24.8	5.0
20.0	3.450	26.1	8.6
25.0	3.736	32.9	10.2
30.0	2.836	30.2	10.9
40.0	2.790	73.1	11.7
60.0	1.989	45.9	12.2

Table 4-3. Vertical Distribution of $\overline{u}$, i and $\overline{T}$ Measured at T3

z (cm)	$\bar{u}$ (cm/s)	i (%)	T (^oC)
0.2	17.664	6.8	-26.4
0.3	22.796	5.7	-26.7
0.4	26.870	4.8	-26.8
0.5	28.297	5.4	-26.9
0.6	28.866	5.0	-26.8
0.7	29.354	5.2	-26.6
0.8	30.248	4.9	-26.5
0.9	30.378	4.7	-26.2
1.0	29.856	4.7	-25.9
1.3	29.205	6.4	-25.5
1.7	29.580	5.2	-24.7
2.0	28.631	5.2	-24.0
3.0	26.205	5.6	-21.6
4.0	22.586	6.2	-18.6
5.0	19.156	8.1	-14.4
6.0	15.945	10.5	-11.1
8.0	9.721	16.1	-4.4
10.0	4.886	20.2	2.8
13.0	3.180	25.0	8.2
16.0	2.772	30.8	9.8
20.0	2.674	36.0	10.7
25.0	2.361	43.2	11.7
30.0	2.363	47.7	11.9
40.0	1.989	40.5	12.2
60.0	1.563	55.2	13.0

Table 4-4. Vertical Distribution of $\overline{u}$, i and $\overline{T}$ Measured at T5

z (cm)	$\overline{u}$ (cm/s)	i (%)	T (^{o}C)
0.5	8.123	15.6	-3.6
0.7	6.655	16.4	2.9
1.0	4.437	23.8	7.3
1.5	2.512	36.2	10.6
2.0	2.785	32.7	11.2
2.5	2.574	35.4	11.6
3.0	2.308	44.2	11.8
4.0	2.363	36.4	12.0
5.0	2.304	39.0	12.2
6.0	1.988	48.6	12.1
8.0	2.313	39.5	12.4
10.0	2.313	37.2	12.4
13.0	2.098	43.6	12.5
16.0	2.749	35.3	13.0
20.0	2.696	38.0	13.1
25.0	2.482	43.5	13.3
30.0	1.782	51.5	13.5
40.0	2.000	59.5	13.9
50.0	1.567	96.6	13.7

Table 4-5. Vertical Distribution of $\overline{u}$, i and $\overline{T}$ Measured at T6

z (cm)	$\overline{u}$ (cm/s)	i (%)	T (^{o}C)
0.5	7.846	14.3	-2.7
0.7	6.934	12.7	1.6
1.0	5.573	10.1	6.0
1.5	4.114	29.9	10.5
2.0	3.335	29.0	12.4
2.5	2.854	32.1	12.8
3.0	2.857	32.1	13.1
4.0	2.022	53.3	13.2
5.0	2.805	32.7	13.2
6.0	2.968	32.9	13.4
8.0	2.914	42.6	13.4
10.0	2.753	35.3	13.4
13.0	2.806	34.6	13.4
16.0	2.268	31.9	13.5
20.0	2.377	40.9	13.7
25.0	2.486	41.3	13.8
30.0	2.433	40.0	13.9
40.0	1.895	51.4	14.3
50.0	2.004	54.0	14.5
60.0	1.083	80.0	14.5

Table 4-6. Vertical Distribution of $\overline{u}$, i and $\overline{T}$ Measured at T11

z (cm)	$\overline{u}$ (cm/s)	i (%)	T (^{o}C)
0.4	12.951	7.5	-28.5
0.5	13.347	7.3	-28.0
0.6	13.464	7.2	-26.7
0.7	13.546	7.6	-25.2
0.8	13.517	8.3	-24.0
1.0	13.658	6.9	-21.4
1.2	13.729	7.6	-20.1
1.5	14.255	7.4	-17.5
2.0	13.135	7.8	-14.9
2.5	12.581	8.2	-13.3
3.0	12.570	7.8	-12.5
4.0	11.794	69.3	-10.1
5.0	9.072	9.4	-7.1
6.0	7.509	11.6	-2.0
8.0	3.707	24.3	8.0
10.0	2.393	33.3	9.1
13.0	2.507	31.9	10.0
16.0	2.403	33.3	10.3
20.0	2.517	38.9	11.1
25.0	1.984	43.2	11.5
30.0	1.663	48.4	11.7
40.0	1.505	57.1	12.1
60.0	1.185	68.2	12.8

Table 4-7. Vertical Distribution of $\bar{u}$, i and $\bar{T}$ Measured at T12

z (cm)	$\bar{u}$ (cm/s)	i (%)	T (^oC)
0.4	13.334	7.7	-24.8
0.5	14.257	7.6	-24.2
0.6	14.197	7.6	-23.6
0.7	14.714	7.7	-22.8
0.8	14.803	7.3	-22.1
1.0	15.183	7.5	-20.5
1.2	14.394	8.3	-19.3
1.5	14.851	7.5	-17.2
2.0	13.507	7.9	-14.3
2.5	12.311	8.8	-10.7
3.0	11.101	8.6	-7.7
4.0	6.817	13.6	1.0
5.0	4.425	19.0	6.5
6.0	3.390	25.0	8.0
8.0	2.663	30.0	9.6
10.0	2.354	34.1	10.9
13.0	2.195	39.0	11.1
16.0	2.146	40.0	11.6
20.0	1.664	51.6	11.8
25.0	1.772	51.5	11.9
30.0	1.558	51.7	12.1
40.0	1.237	65.2	12.3
60.0	1.185	68.2	12.7

Table 4-8. Ground Temperatures (^{o}C) Recorded during Concentration Sampling Runs (see Table 3-1) under Drainage Flow Conditions

	PG&E DRAINAGE FLOW								
THERM #	1	1A	1B	2	2A	2B	3	3A	3B
T1	-26.4	-26.3	-26.0	-26.5	-27.0	-23.6	-26.0	-22.9	-22.4
T2	-30.3	-28.9	-28.1	-30.9	-30.6	-26.6	-30.6	-25.7	-25.1
T3	-29.7	-27.3	-26.3	-29.8	-30.3	-23.7	-29.2	-22.8	-22.2
T4	-28.3	-25.6	-23.8	-28.8	-28.8	-22.6	-28.4	-20.9	-21.8
T5	-24.7	-23.4	-22.8	-24.7	-25.2	-19.2	-24.3	-18.8	-17.6
T6	-30.0	-28.1	-27.4	-30.1	-30.7	-24.7	-29.9	-23.8	-23.1
T7	-23.8	-21.9	-21.4	-21.7	-24.4	-18.9	-21.4	-18.4	-17.9
T8	-36.0	-33.2	-32.3	-33.8	-36.2	-29.3	-32.8	-28.3	-27.6
T9	-37.1	-34.6	-29.4	-35.6	-37.3	-30.6	-35.3	-29.6	-28.8
T10	-29.8	-28.3	-27.0	-29.3	-29.9	-24.0	-29.7	-23.0	-22.4
T11	-34.3	-30.9	-29.4	-34.2	-34.7	-26.2	-34.4	-25.1	-24.2
T12	-32.8	-29.5	-28.1	-32.9	-33.1	-25.0	-32.7	-23.7	-22.8
T13	-34.0	-30.8	-29.4	-34.2	-34.4	-26.2	-34.2	-25.0	-24.0
T14	-35.1	-26.1	-25.1	-35.2	-35.6	-22.4	-34.7	-21.4	-20.5
T15	-26.1	-22.7	-21.7	-26.1	-26.8	-19.1	-25.9	-18.1	-17.4
T16	-32.2	-28.8	-27.6	-33.9	-32.5	-24.6	-32.2	-23.5	-22.4
T17		-22.5	---	-24.8			---		
T18			-21.8				-24.5		
$T_{AMB.}$	12.2	14.0	13.6	11.9	11.9	13.5	12.5	13.2	13.5

Table 5-1. Summary of Velocity Profiles for the Neutral Westerly Wind Simulation

Test #	Location	z_o (cm)	u_* (cm/s)	n	u_∞ (cm/s)	u_*/u_∞	e_n	e_{z_o} (cm/s)
PGE 03	Met Sta	.00175	8.314	.1103	209.0	.0398	5.236	5.862
PGE 04	Met Sta	.00102	5.984	.1027	157.0	.0381	4.411	4.778
PGE 05	Met Sta	.00239	4.294	.1126	105.0	.0409	3.452	3.704
PGE 06	Met Sta	.00391	3.247	.1160	71.0	.0457	3.309	3.482
PGE 07	Met Sta	.00181	2.384	.1028	59.0	.0404	2.400	2.598
PGE 08	T 6	.05181	3.401	.1856	51.0	.0667	4.845	4.291
PGE 09	T 6	.03636	5.357	.1778	86.0	.0623	7.199	6.341
PGE 10	T 6	.03070	10.450	.1644	173.0	.0604	14.782	13.670
PGE 11	C #35	.12825	13.213	.1997	180.0	.0734	9.790	13.499
PGE 12	C #35	.41902	7.809	.2649	84.0	.0930	6.121	8.883
PGE 13	C #35	.07203	3.215	.1924	49.4	.0651	2.513	2.840

Table 5-2. Nondimensional Concentration Coefficients, K (x 10^5) for Unit 20A

Sample Number	Prototype Wind Speed (m/s)				
	7.5	10.0	15.0	20.0	28.0
1	0.027	---	0.286	0.576	0.864
2	0.496	0.933	3.32	8.36	12.0
3	1.35	2.90	10.7	24.1	32.1
4	1.67	3.20	12.2	29.9	40.0
5	2.66	5.27	17.9	33.4	35.5
6	8.63	16.9	46.9*	56.2*	58.4*
7	13.4*	17.6*	36.7	42.8	42.7
8	2.32	4.55	9.24	3.04	2.23
9	0.184	0.389	0.249	0.071	0.187
14	0.124	---	1.13	2.16	2.09
15	2.46	6.43	23.2	41.1	47.1
16	3.46	8.56	27.9	44.1	48.7
17	5.73	13.7	35.3	45.5	48.0
18	8.48	13.5	31.7	37.5	38.7
19	9.14	8.70	18.2	20.4	21.5
20	8.92	7.03	13.2	14.3	15.6
21	6.52	5.57	10.1	11.1	12.1
22	0.735	0.627	0.660	0.925	---
103	0.018	---	0.288	0.382	0.42
101	0.354	---	3.13	7.36	9.95
98	1.41	2.83	7.77	11.5	12.5
97	5.36	11.4	28.3	36.9	39.7
96	7.95	10.6	22.6	28.0	30.6
95	2.43	3.28	5.40	---	6.44
94	5.79	0.74	8.73	10.1	11.2
93	2.45	2.10	4.26	4.77	5.90
92	1.55	1.20	2.15	2.77	3.95
109	---	---	2.86	4.56	---
110	0.830	1.74	7.62	15.2	18.3
111	2.12	5.18	17.1	29.2	32.9
112	2.94	6.42	16.3	24.3	26.7
113	4.10	7.92	16.6	21.8	23.4
114	6.10	5.68	11.1	14.8	16.6
115	3.83	2.93	6.05	7.86	8.47
116	2.47	1.28	3.12	5.14	6.81
117	1.35	0.323	0.924	2.04	3.54
118	0.362	0.019	0.052	---	---
119	0.312	---	---	---	6.35
30	1.05	2.08	8.21	15.4	19.1
31	1.65	3.01	11.0	19.6	23.9
32	2.15	4.49	14.0	22.6	26.1
33	3.92	5.87	14.1	18.8	21.0
34	5.29	4.60	10.2	13.4	14.9
35	0.034	---	---	---	---
36	2.27	0.641	2.36	4.83	7.22
37	0.714	0.144	0.277	0.511	1.32
38	0.219	0.154	0.137	0.174	0.382
39	0.092	0	0.012	0.051	0.068

*Maximum value

Table 5-3. Nondimensional Concentration Coefficients, K (x 10^5) for Unit 20B

Sample Number	Prototype Wind Speed (m/s)				
	7.5	10.0	15.0	20.0	28.0
1	0.026	---	0.304	0.702	1.27
2	1.07	1.72	5.17	9.58	13.8
3	3.61	6.05	16.1	26.7	35.2
4	3.03	6.17	12.7	34.0	44.2*
5	4.27	8.08	20.2	28.4	30.4
6	3.68	9.71	16.0	18.3	20.1
7	0.443	1.69	4.18	4.27	5.53
8	0.222	0.155	0.539	0.697	1.52
9	---	---	0.185	---	---
14	0.408	0.557	1.64	2.21	2.74
15	6.13	10.4	27.7	38.4*	43.4
16	7.74*	13.3*	29.4*	38.4*	40.7
17	5.69	13.1	22.6	270.0	28.0
18	2.23	7.30	12.6	14.4	14.9
19	0.356	2.20	3.86	4.19	4.32
20	0.056	0.541	1.21	0.988	1.17
21	---	0.131	0.384	0.327	0.403
22	---	---	---	---	---
103	---	---	0.201	0.708	0.858
101	0.548	1.03	4.40	7.83	11.6
98	1.73	3.69	6.77	9.68	10.9
97	3.53	11.0	17.6	21.9	22.9
96	1.11	5.15	8.65	11.0	11.1
95	0.177	0.363	---	11.8	1.35
94	0.058	0.535	0.675	0.743	0.910
93	---	0.073	0.244	0.233	0.487
92	0.041	---	0.119	---	0.151
109	0.417	0.739	2.62	5.51	7.66
110	1.63	2.80	9.89	15.1	19.6
111	4.18	6.98	19.4	26.7	30.2
112	2.59	7.09	13.4	17.2	18.4
113	0.091	5.77	11.4	10.2	9.98
114	0.351	1.69	3.32	4.46	4.93
115	0.067	0.524	0.869	1.16	1.38
116	---	0.446	0.536	0.577	0.695
117	---	0.112	0.171	0.210	0.275
118	---	---	---	0.210	0.584
30	1.76	3.30	9.77	15.2	19.6
31	2.21	4.46	12.3	18.4	22.3
32	2.74	5.41	13.9	19.4	22.1
33	1.61	3.91	14.5	10.7	11.5
34	0.388	1.72	3.61	4.64	5.02
35	0.152	---	---	---	---
36	0.020	0.710	0.818	1.06	1.26
37	0.014	0.086	0.090	0.109	0.158
38	0.068	---	0.089	---	0.617
39	---	---	0.097	---	0.079

*Maximum value

Table 5-4. Nondimensional Concentration Coefficients, K (x 10^5) for Unit 18

Sample Number	Prototype Wind Speed (m/s)				
	7.5	10.0	15.0	20.0	28.0
1	0.032	0.059	0.028	---	0.072
2	0.332	0.259	0.439	0.459	0.622
3	2.52	2.15	3.91	4.23	5.25
4	0.197	0.271	0.812	2.27	4.32
5	9.87	12.7	31.8	44.8	52.1
6	48.6*	82.1*	147.0*	190.0*	221.0*
7	21.6	38.8	95.5	127.0	148.0
8	6.32	3.64	13.3	29.8	35.1
9	0.023	0.062	0.157	0.111	0.051
14	0.310	0.364	1.03	1.09	1.15
15	10.9	13.3	40.1	54.6	64.1
16	21.6	23.9	60.4	74.2	83.1
17	31.2	49.3	89.6	111.0	123.0
18	24.8	46.9	82.0	101.0	113.0
19	8.59	22.2	38.1	43.9	52.0
20	3.34	8.65	16.7	20.8	21.2
21	1.42	3.17	6.70	8.51	9.27
22	---	0.086	0.171	0.115	0.115
103	---	0.039	0.015	0	0.063
101	0.106	0.149	0.878	1.44	2.35
98	5.67	10.3	17.4	23.9	26.3
97	20.7	37.3	68.5	85.0	93.0
96	11.7	29.0	48.2	63.1	69.6
95	1.37	3.45	---	10.2	11.3
94	2.30	4.83	8.22	10.8	11.6
93	---	1.75	2.76	3.84	4.64
92	0.396	0.776	1.34	1.93	2.20
109	0.147	0.230	0.976	1.69	2.32
110	1.13	1.48	8.47	12.5	16.9
111	6.96	8.76	35.3	47.5	53.8
112	3.76	16.9	38.6	47.5	51.3
113	0.284	13.8	35.8	42.8	6.14
114	4.99	8.83	18.3	26.0	28.9
115	2.11	4.33	5.64	10.1	11.2
116	0.840	2.87	4.08	5.47	6.52
117	0.224	1.47	1.35	2.00	2.92
118	0.033	0.251	0.073	0.137	0.211
30	1.58	2.50	10.3	17.2	22.8
31	2.59	4.54	17.3	26.9	34.0
32	4.89	7.86	25.4	35.5	41.6
33	6.85	11.6	18.9	32.6	35.7
34	4.60	8.89	16.4	22.2	24.4
35	0.233	---	---	---	---
36	0.579	3.53	4.42	6.65	7.57
37	0.081	0.872	0.372	0.608	0.760
38	0.124	0.178	0.154	0.131	0.213
39	0.031	0.080	0.042	0.076	0.156

*Maximum value

FIGURES

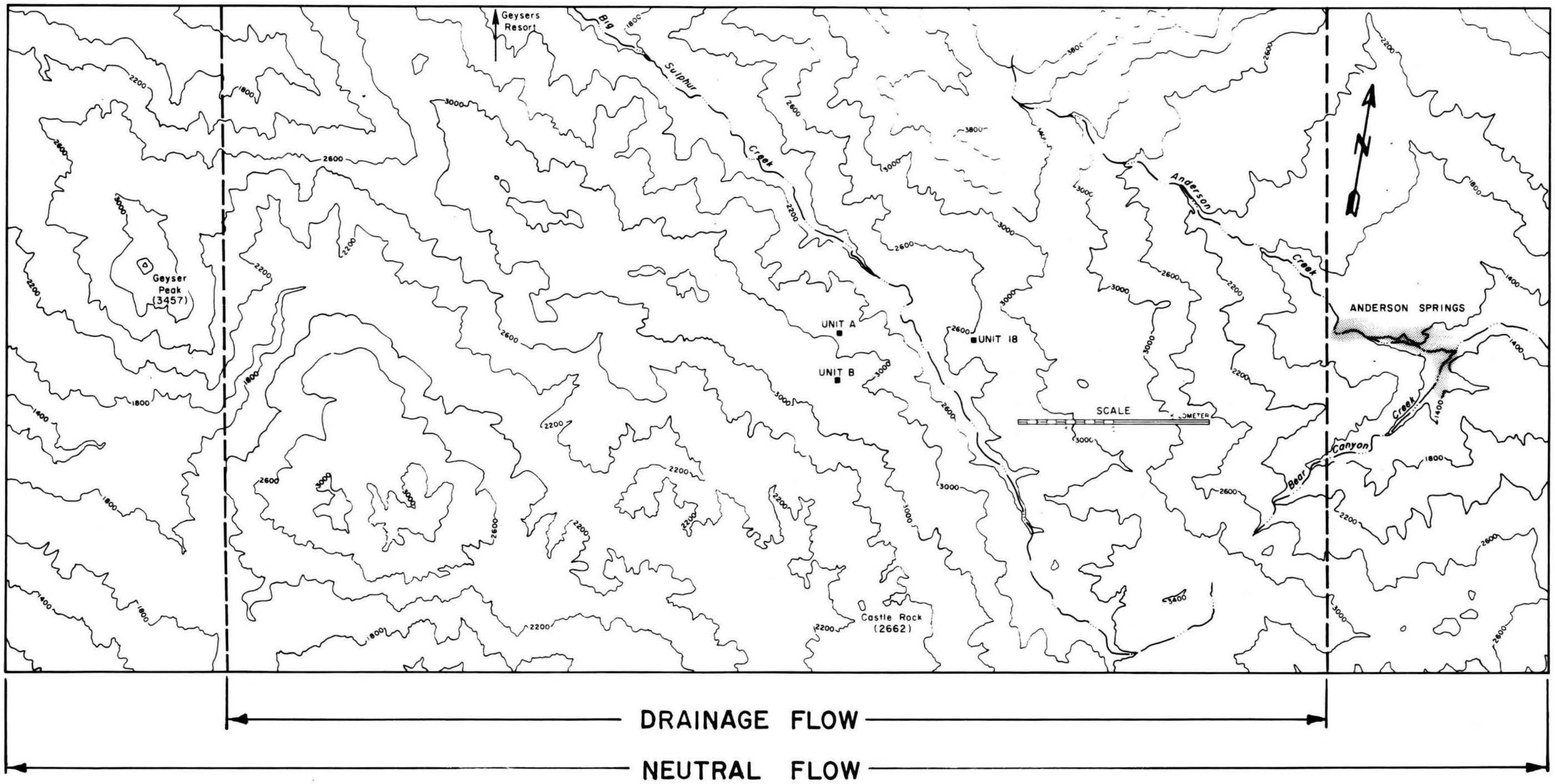


Figure 3-1. Contour Map of the Topographic Areas Modeled

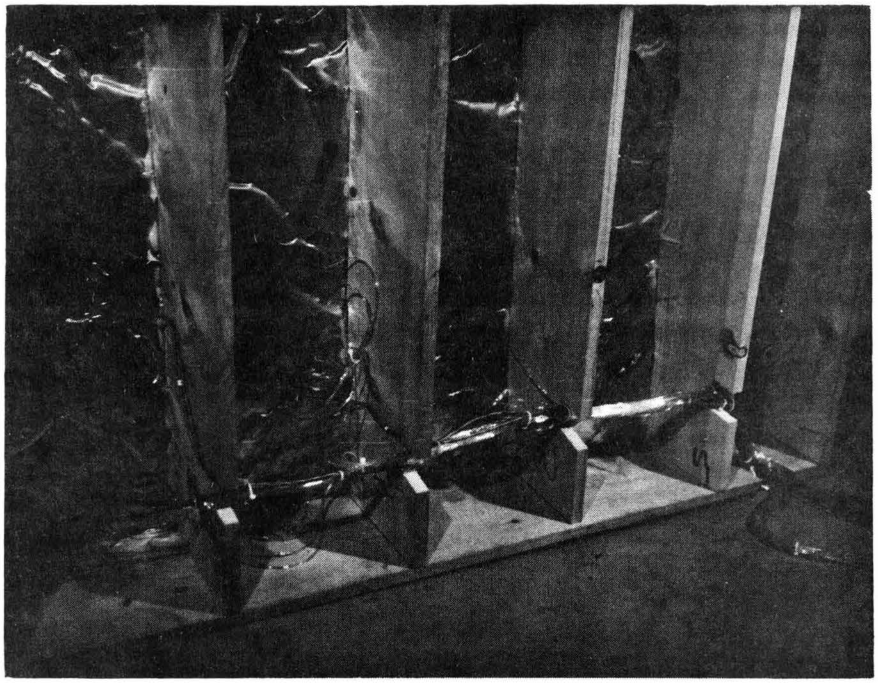


Figure 3-2. Picture of a Portion of Wood Frame Used to Support Aluminum Surface Representing Model Topography.

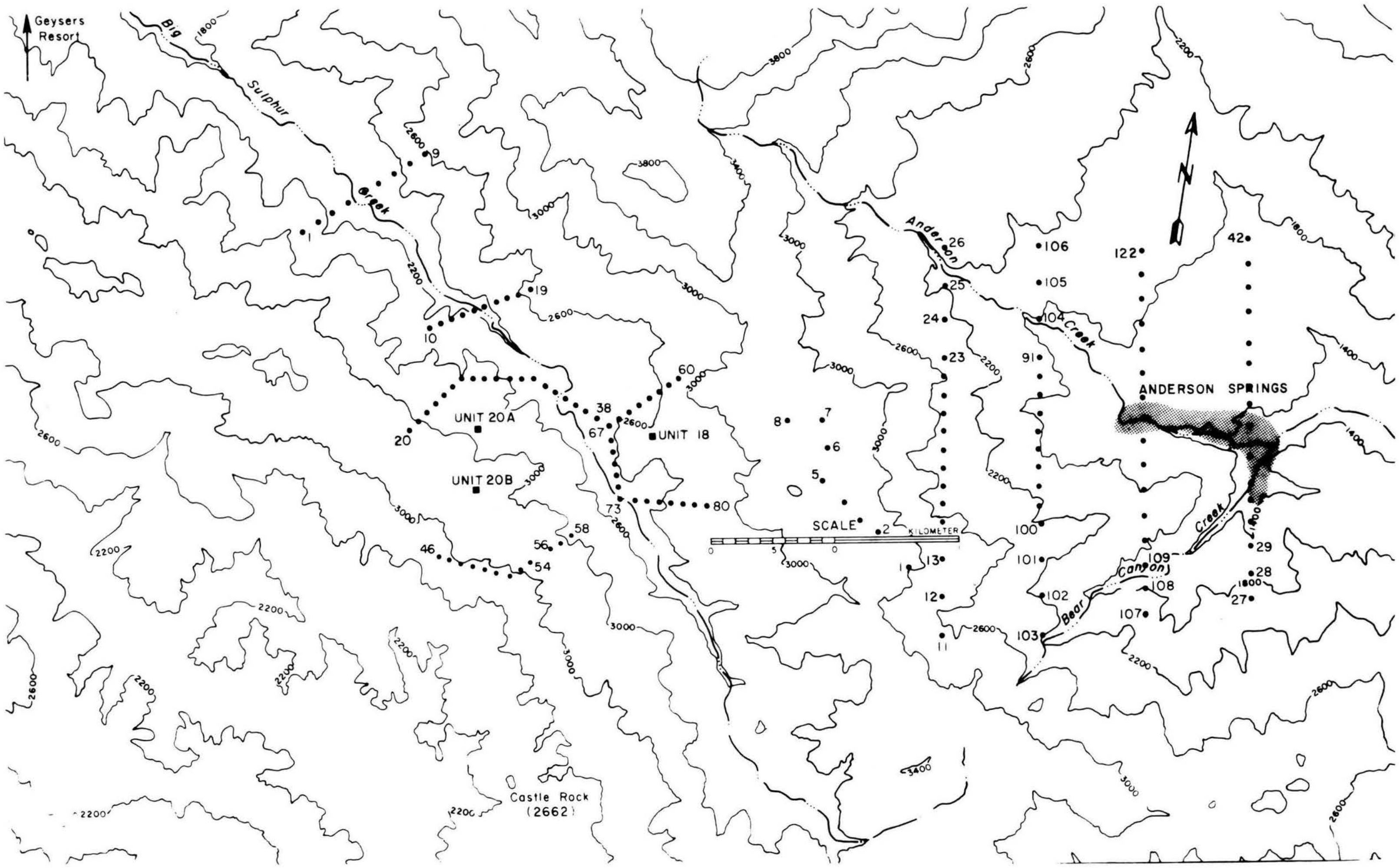


Figure 3-3. Contour Map Showing Location of Concentration Sampling Points

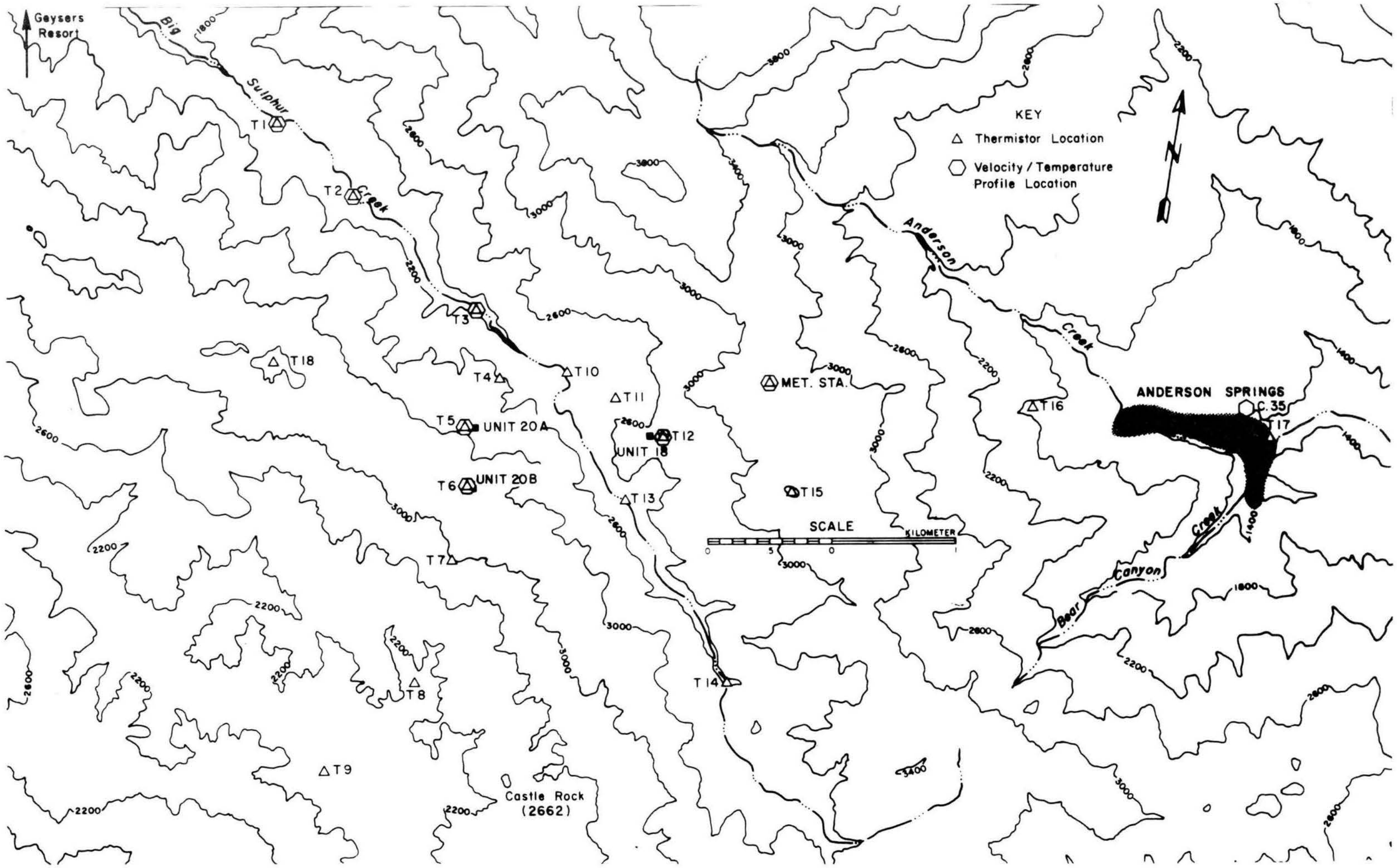


Figure 3-4. Contour Map Depicting Thermistor and Velocity Profile Locations

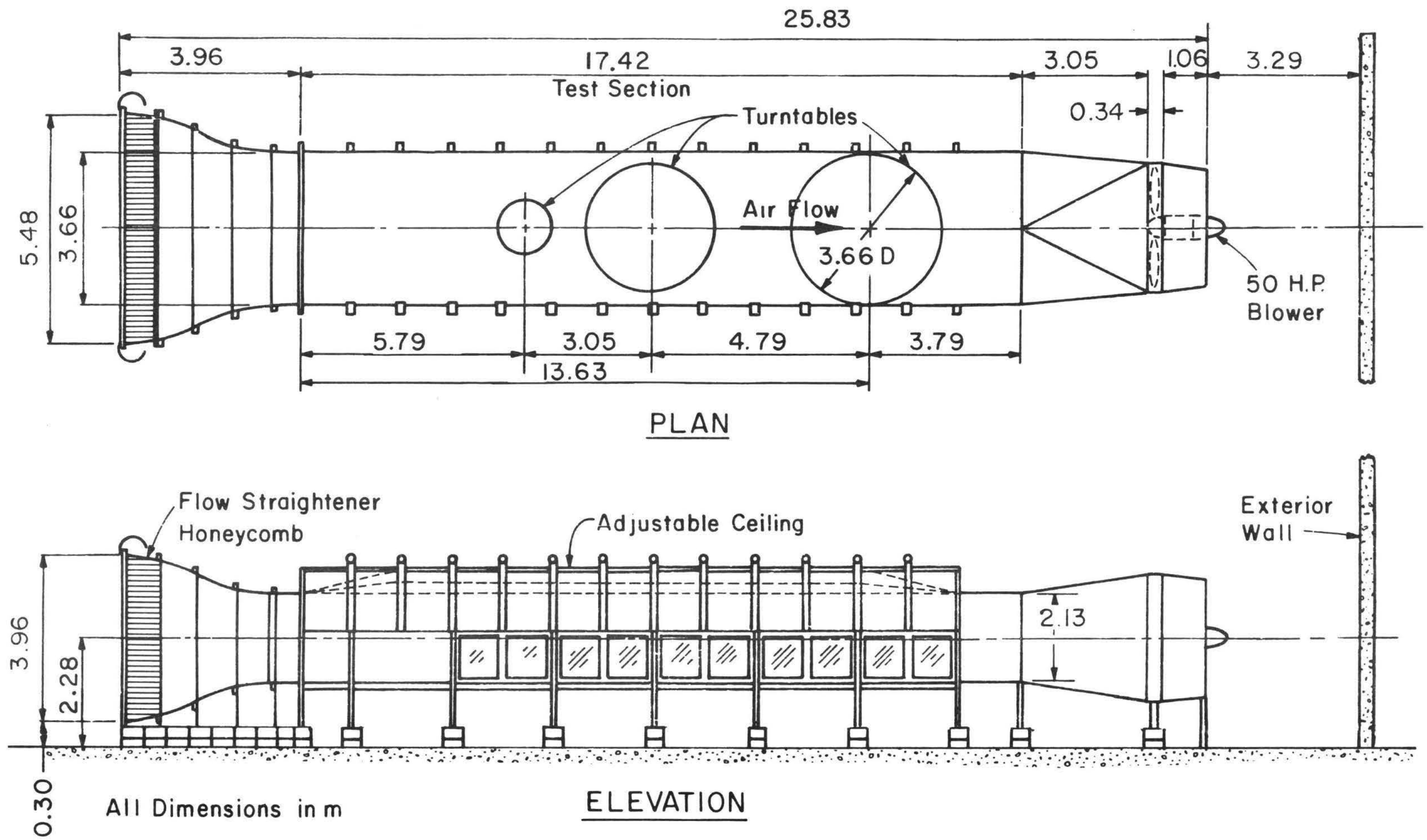


Figure 3-5. Colorado State University Environmental Wind Tunnel

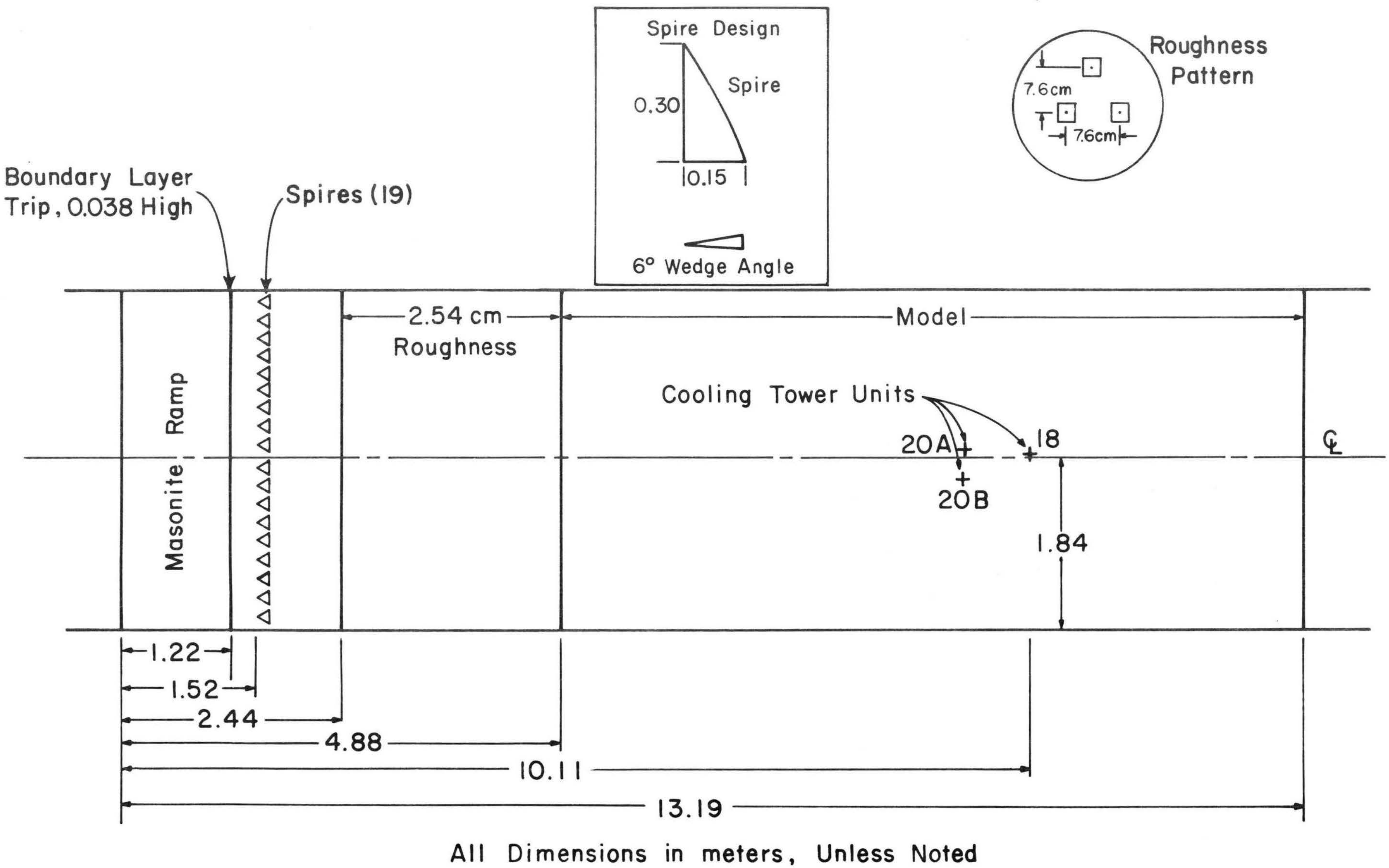


Figure 3-6. Wind Tunnel Set-up for Neutral Stability Tests

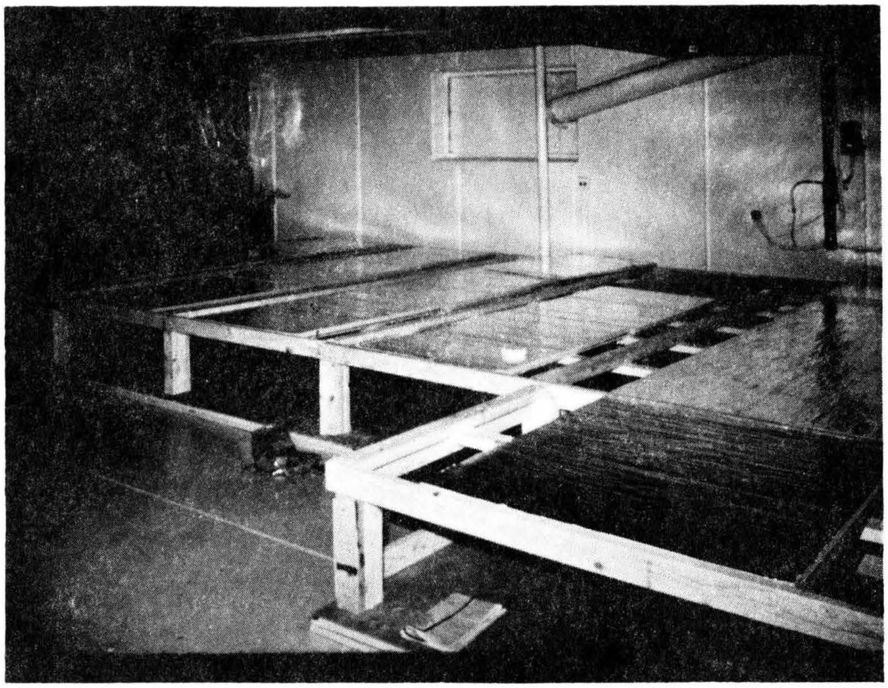


Figure 3-7. Drainage Platform Used to Support Aluminum Model.

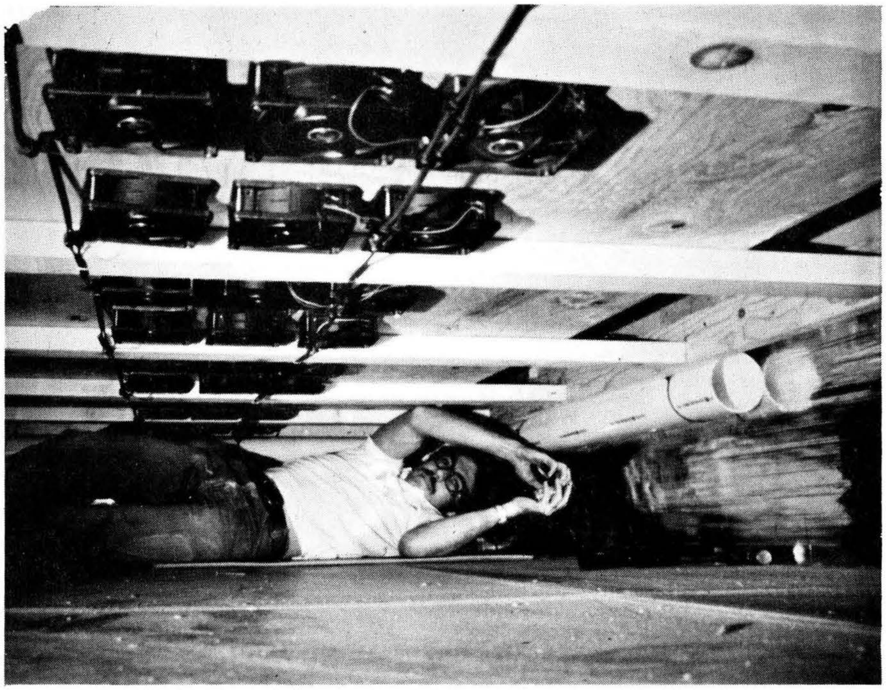


Figure 3-8. Fans Installed Under Platform to Circulate Cold CO_2 Vapors.

Figure 3-9. Dry Ice Being Loaded on Pallets Prior to Positioning under Model.

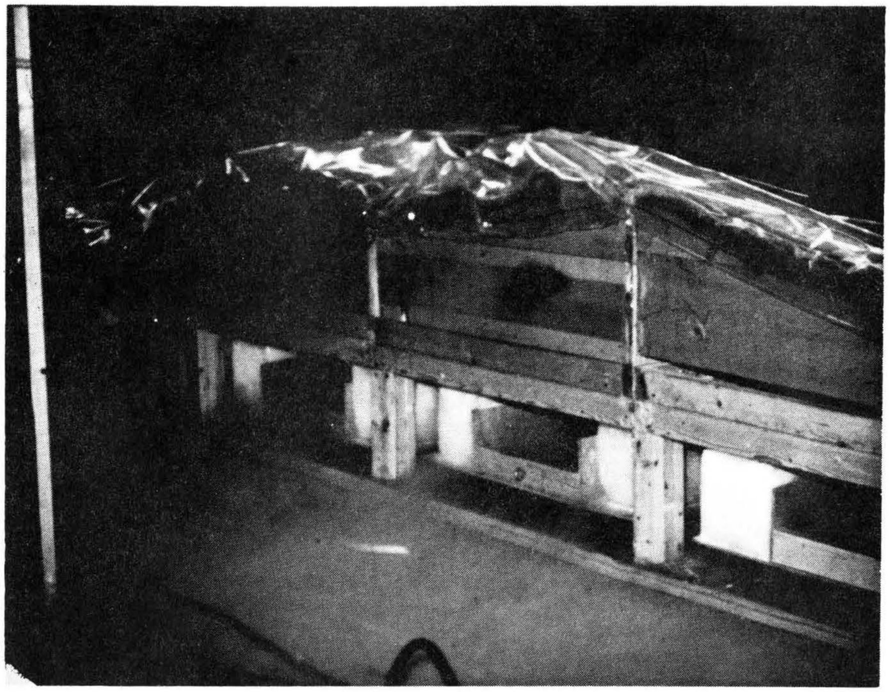
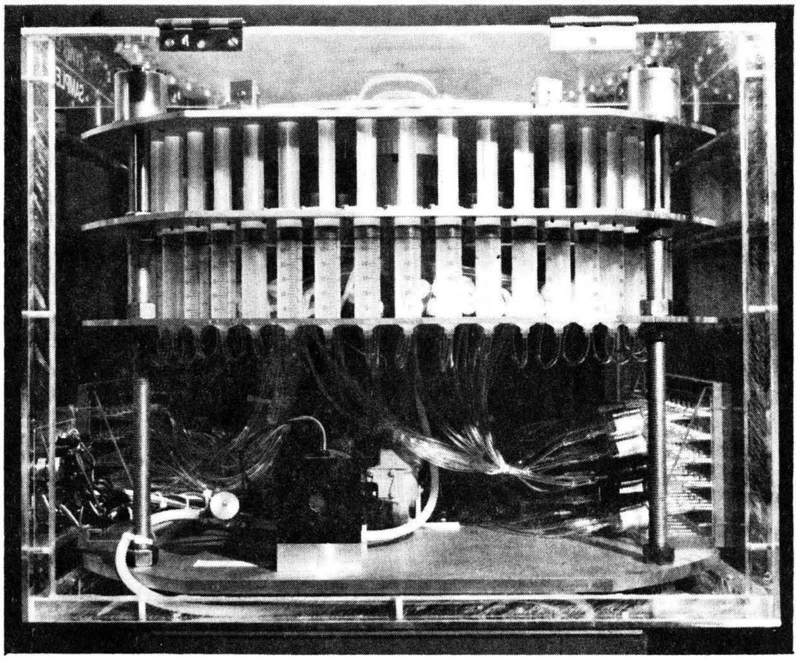
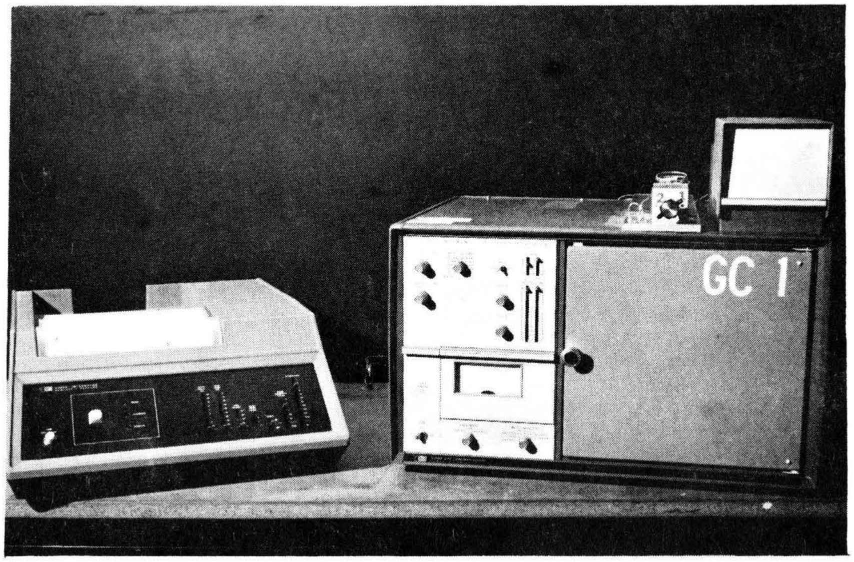


Figure 3-10. Complete Dry Ice Load with Model in Place.



(a)



(b)

Figure 3-11. Photographs of (a) the Gas Sampling System, and (b) the HP Integrator and Chromatograph.

Sample #	Integrated Output from GC (μv-s)
1	205694
2	203629
3	202588
4	204305
5	204430
6	203817
7	204636
8	204425
9	204820
10	202794
11	202874
12	203496
13	197171
14	203790
15	202432
16	202426
17	202317
18	200461
19	200372
20	201950
21	201829
22	201817
23	199365
24	201459
25	200297
26	200940
27	200012
28	200622
29	------
30	199445
31	199914
32	198845
33	198725
34	198899
35	198898
36	195163
37	198945
38	197443
39	197502
40	196235
41	196938
42	196890
43	147606
44	196634
45	196964
46	197027
47	195721
48	196414
49	196934
50	196582
Calibration	197778

Figure 3-12. Typical Sampling System Calibration Showing the Integrated FIGC Response after Injecting a Known Concentration from each Syringe

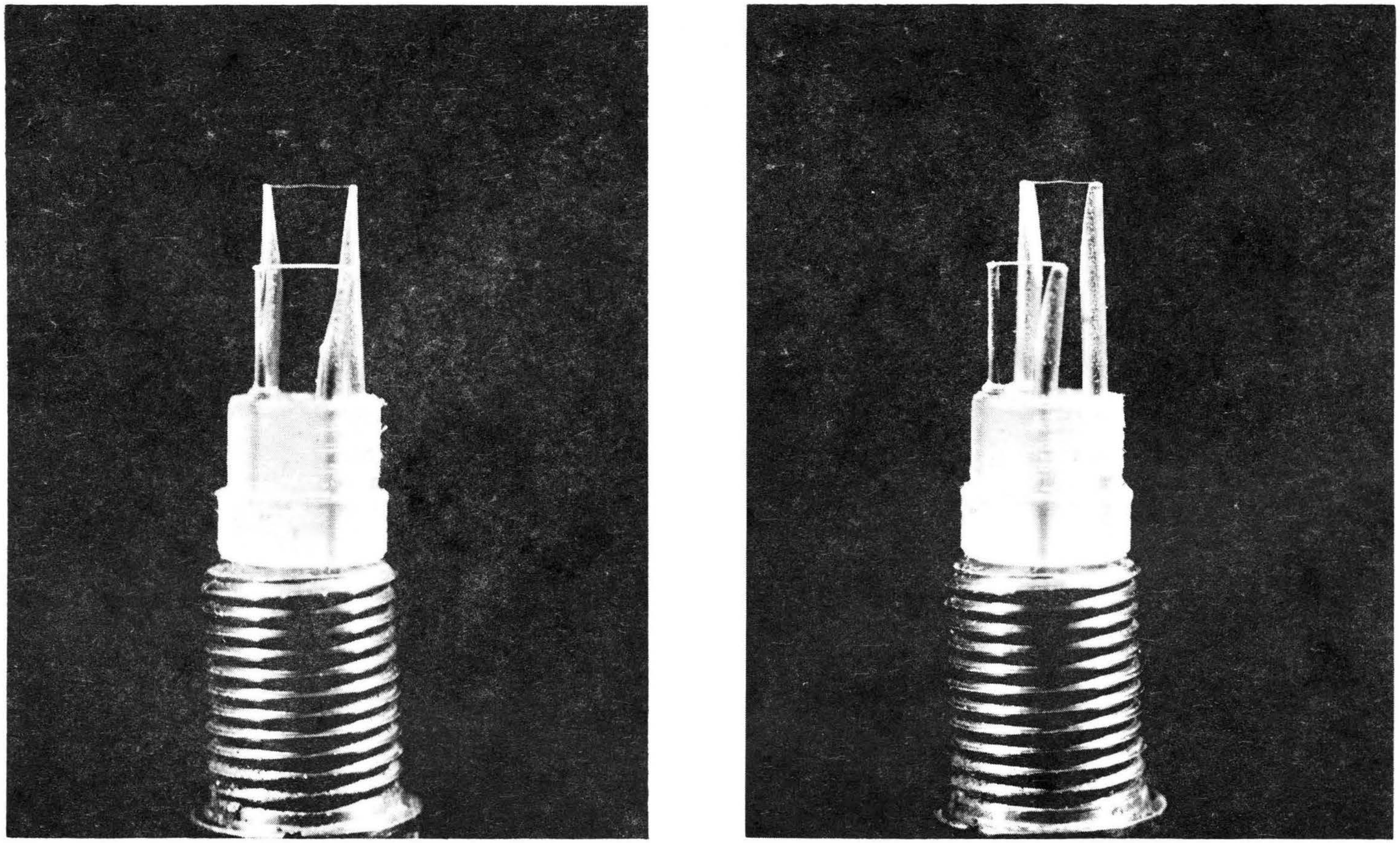


Figure 3-13. Photographs at Two Angles of Datametrics Probe with Shield Removed. (Top Sensor for Velocity and Bottom for Temperature.)(Spacing approximately 0.5 mm.)

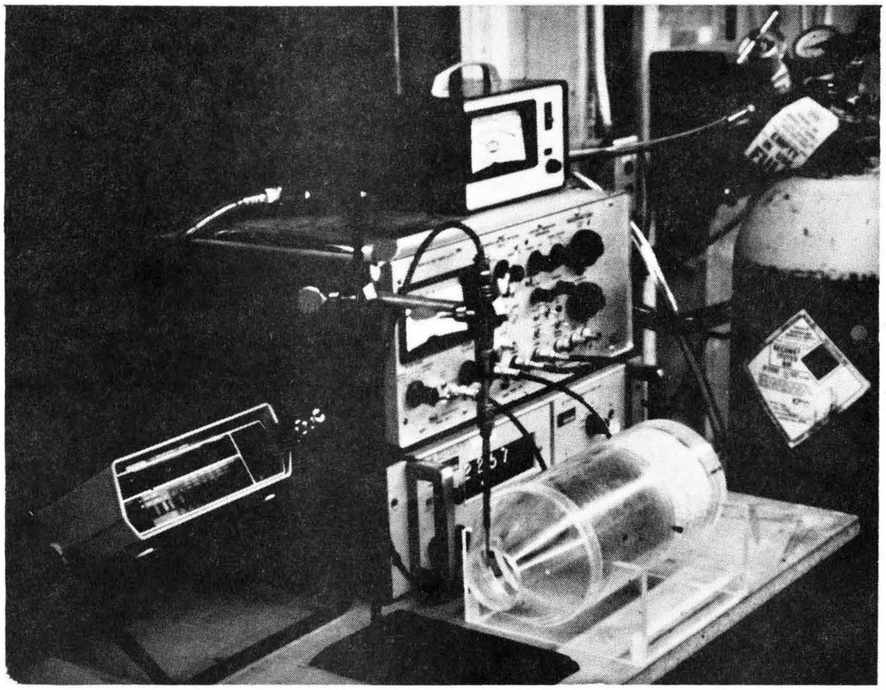


Figure 3-14. Equipment Used for Calibrating Hot-Film and Datametrics Probes.

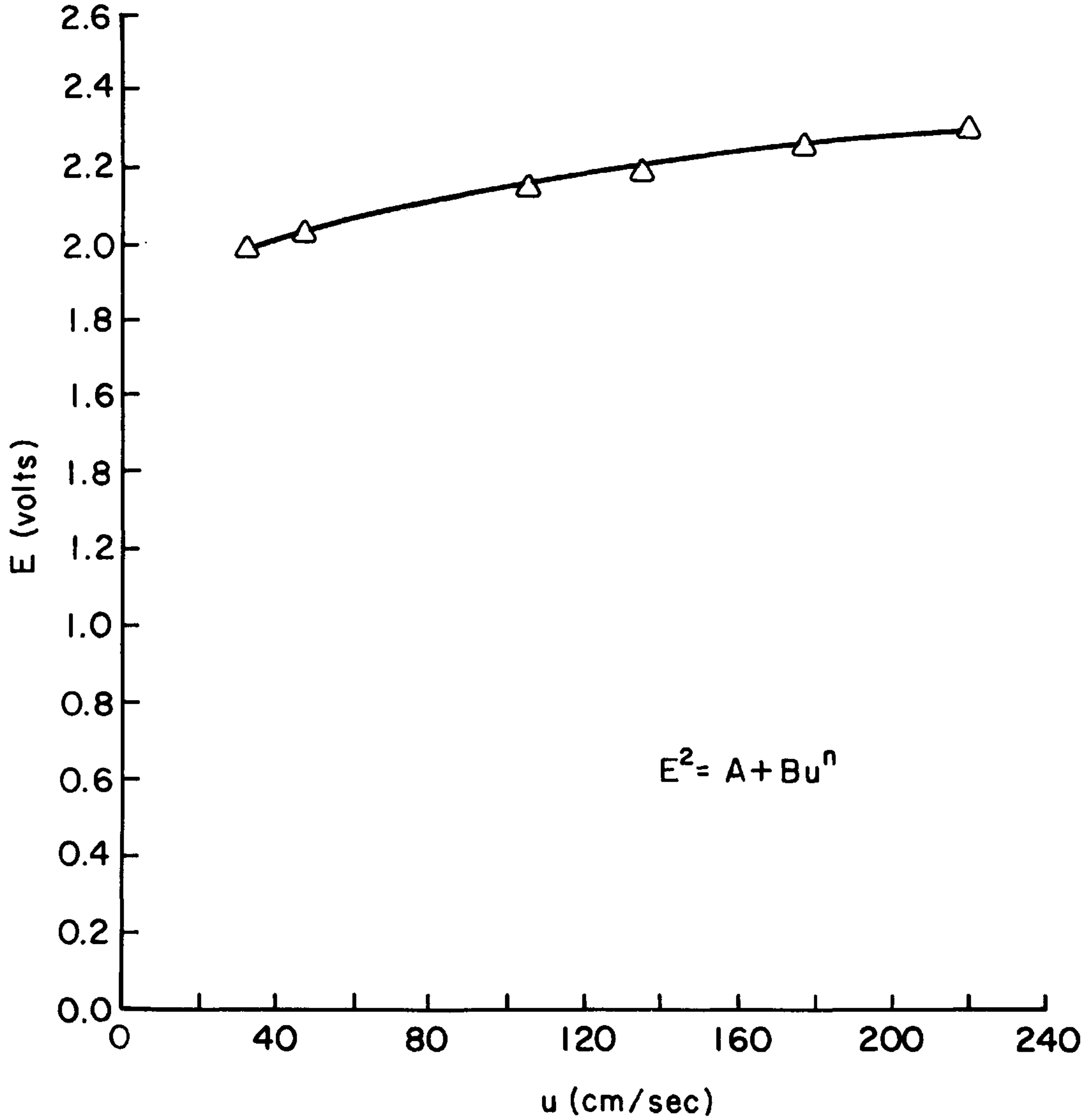


Figure 3-15. Calibration Curve for Hot-Film Sensor

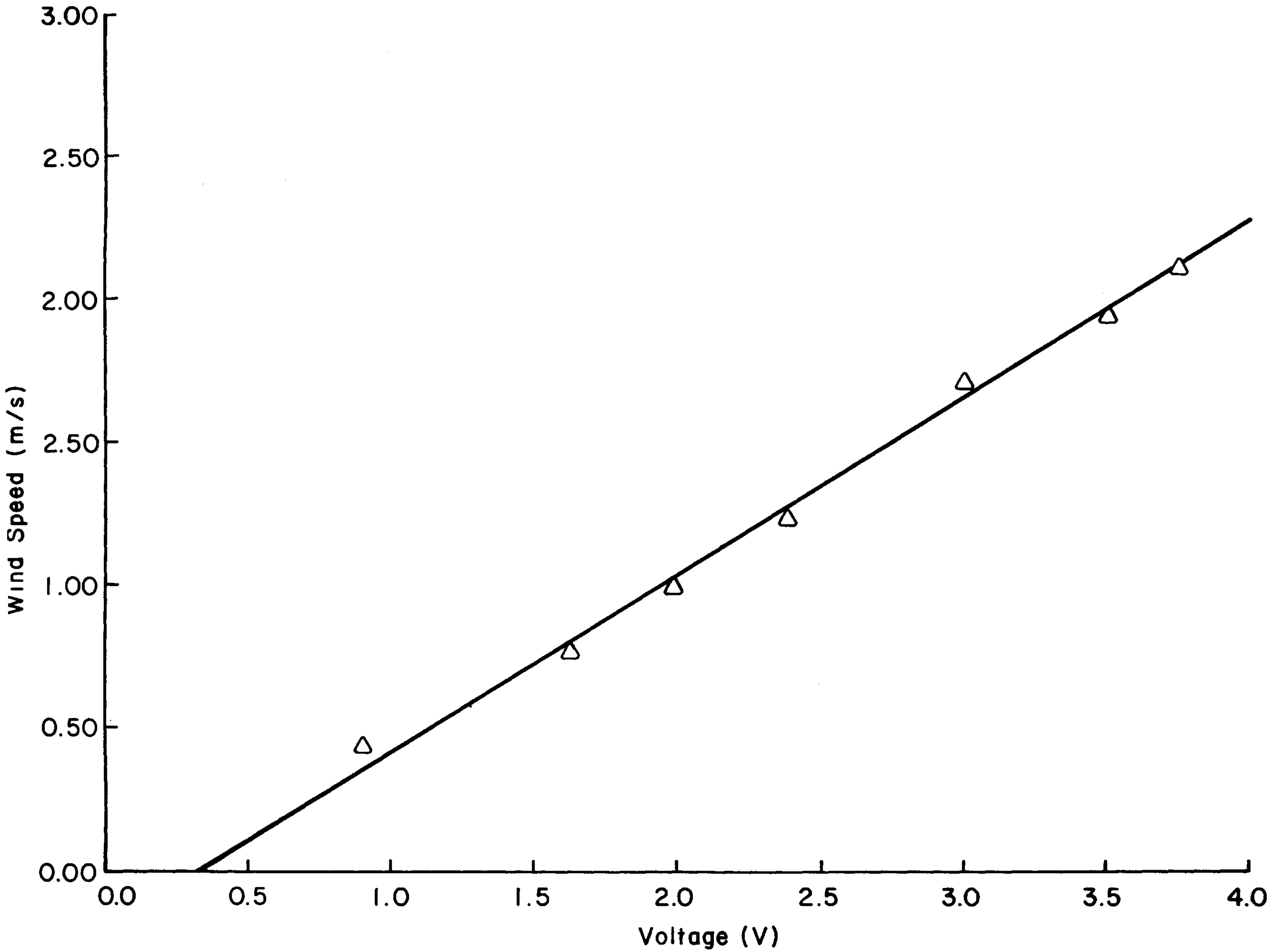


Figure 3-16. Calibration Curve for Datametrics

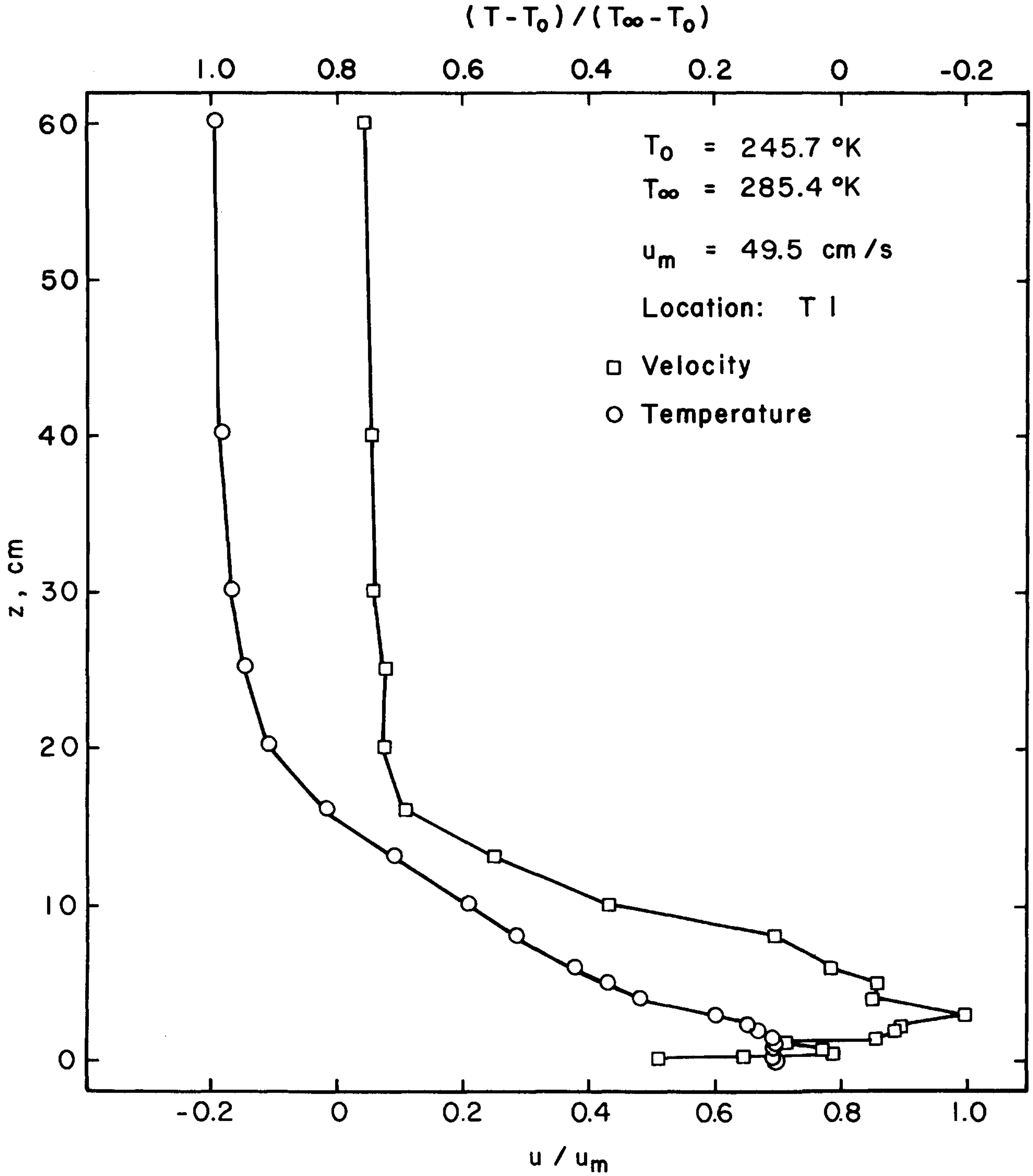


Figure 4-1. Velocity and Temperature Profiles Taken at T1 (see Figure 3-4) for the Drainage Flow Tests

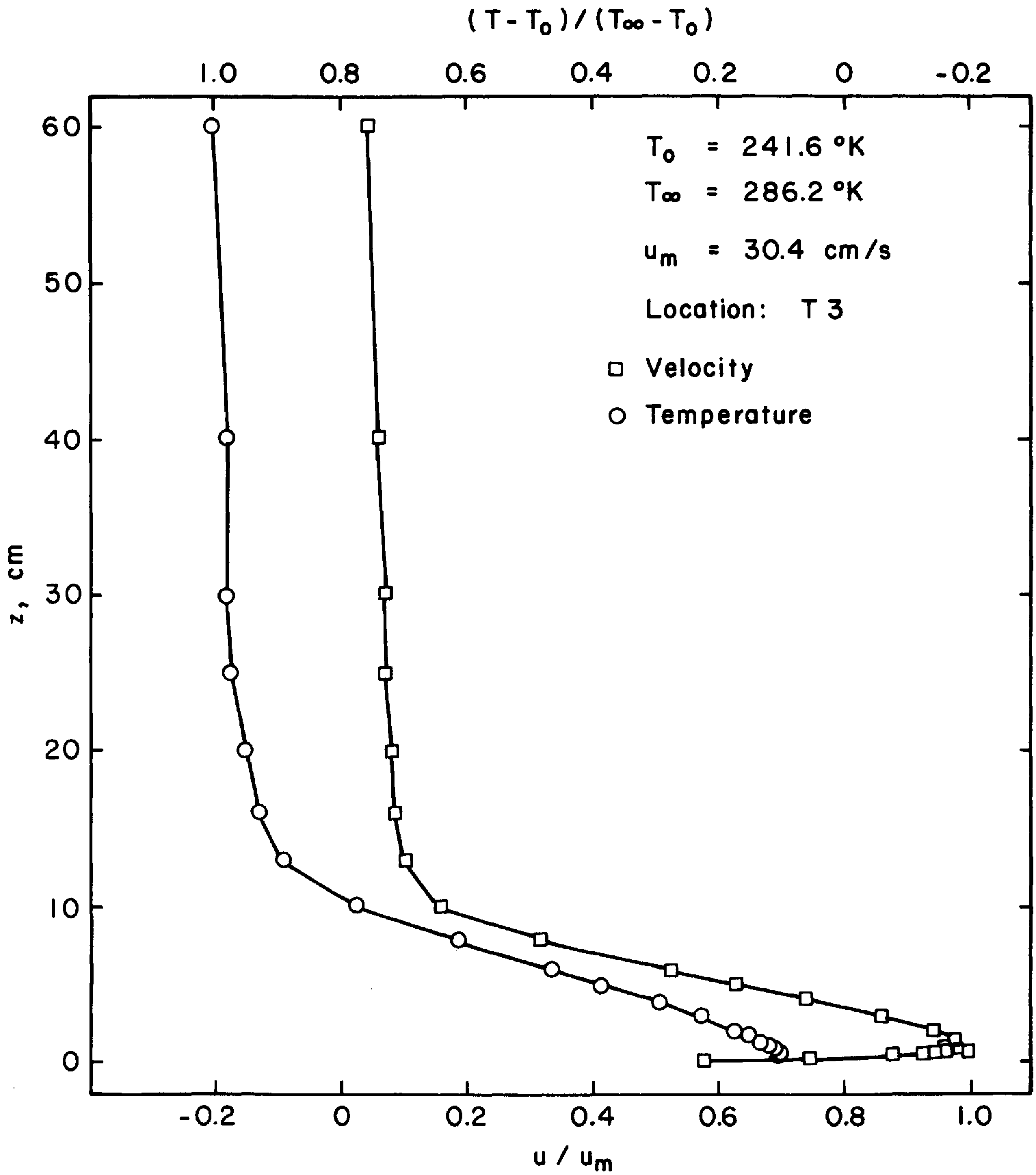


Figure 4-2. Velocity and Temperature Profiles Taken at T3 (see Figure 3-4) for the Drainage Flow Tests

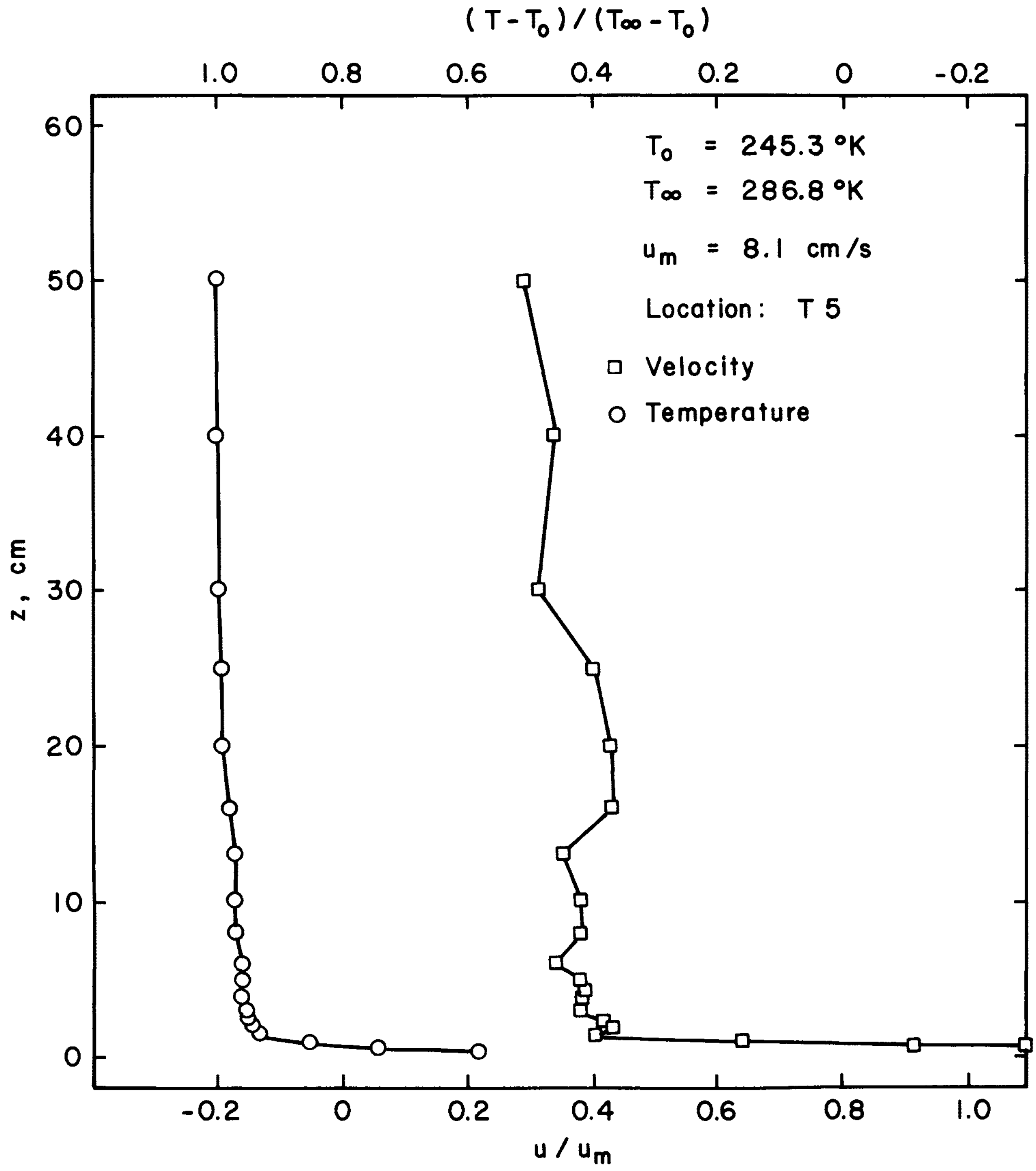


Figure 4-3. Velocity and Temperature Profiles Taken at T5 (see Figure 3-4) for the Drainage Flow Tests

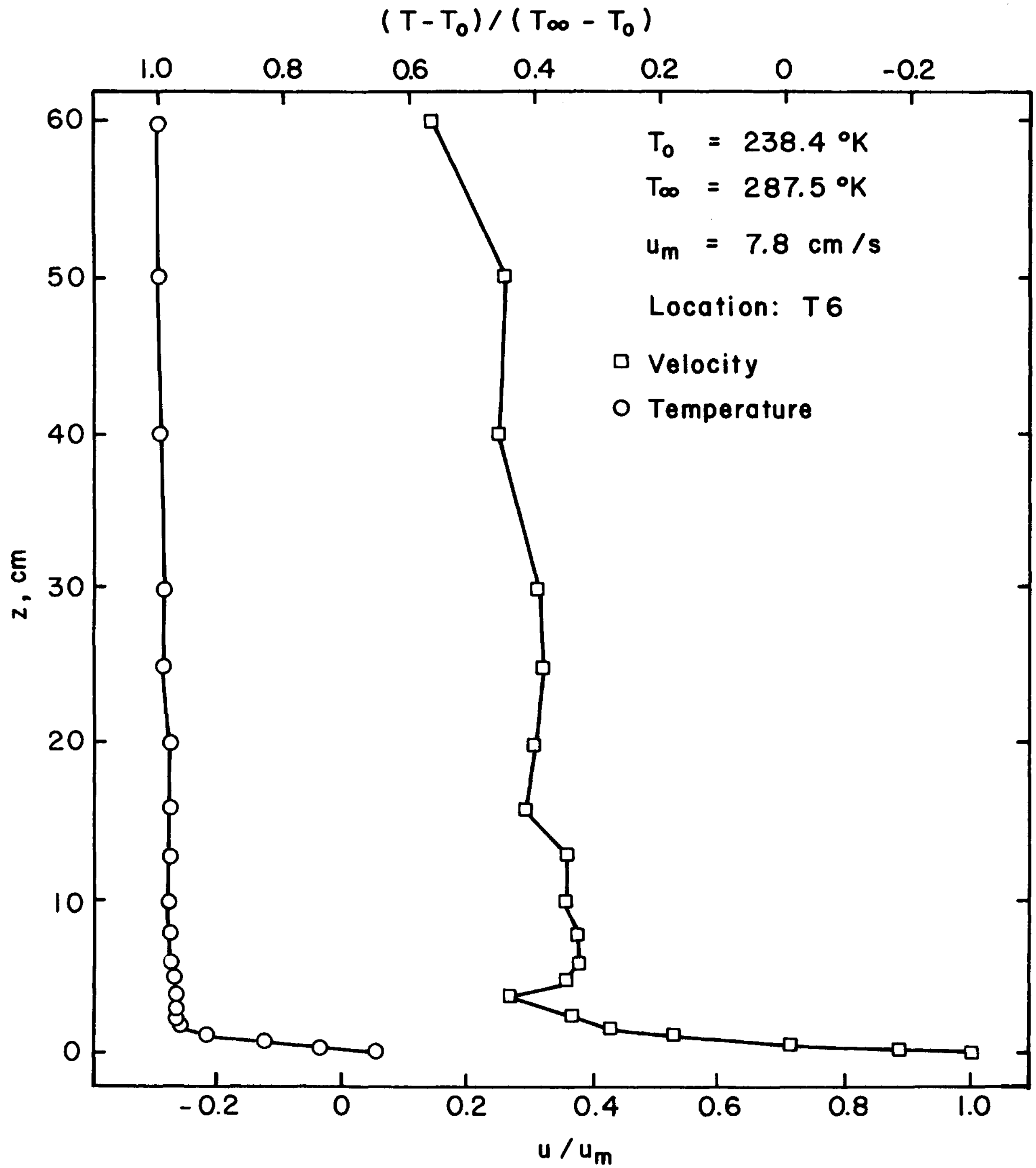


Figure 4-4. Velocity and Temperature Profiles Taken at T6 (see Figure 3-4) for the Drainage Flow Tests

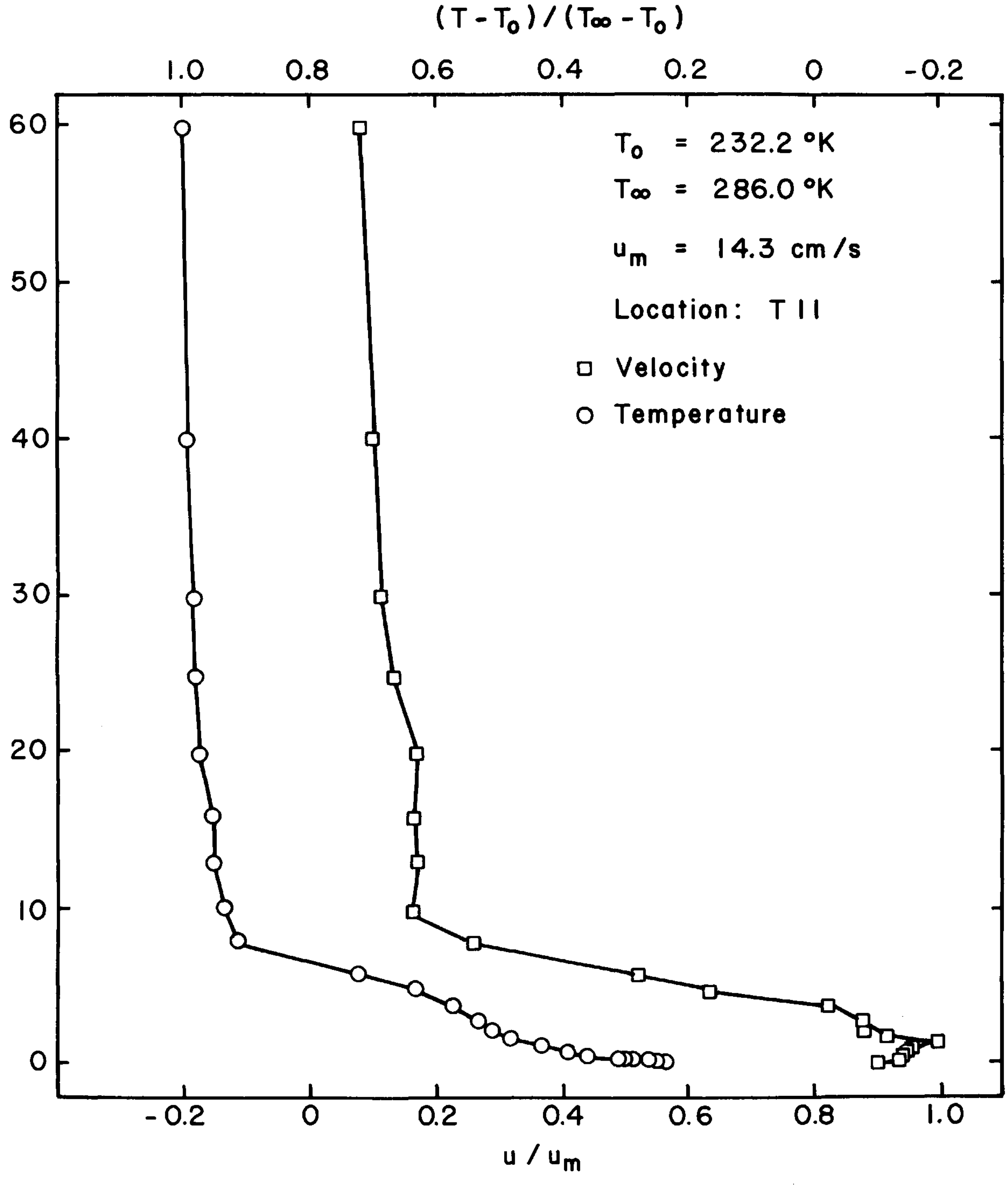


Figure 4-5. Velocity and Temperature Profiles Taken at T11 (see Figure 3-4) for the Drainage Flow Tests

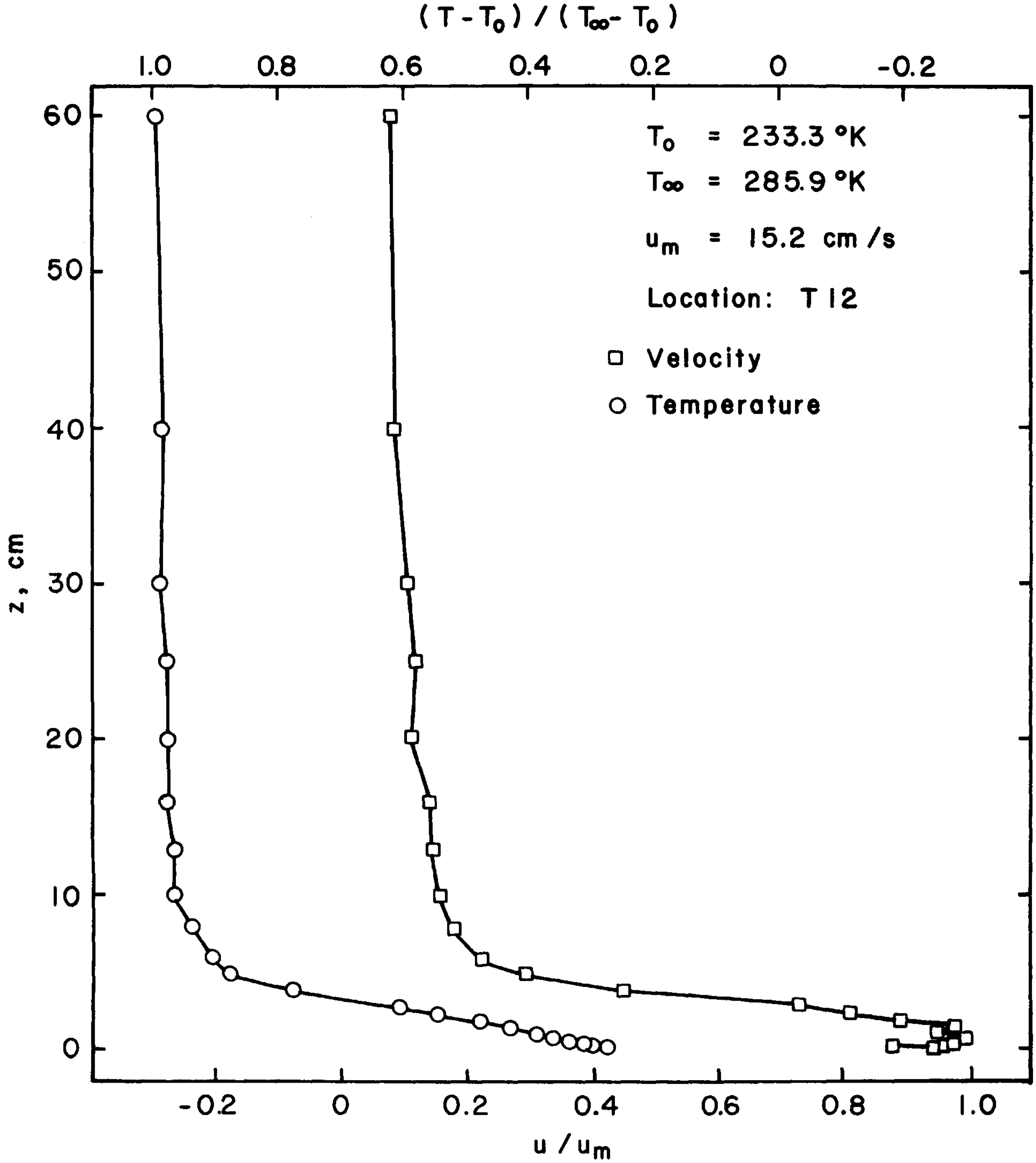


Figure 4-6. Velocity and Temperature Profiles Taken at T12 (see Figure 3-4) for the Drainage Flow Tests

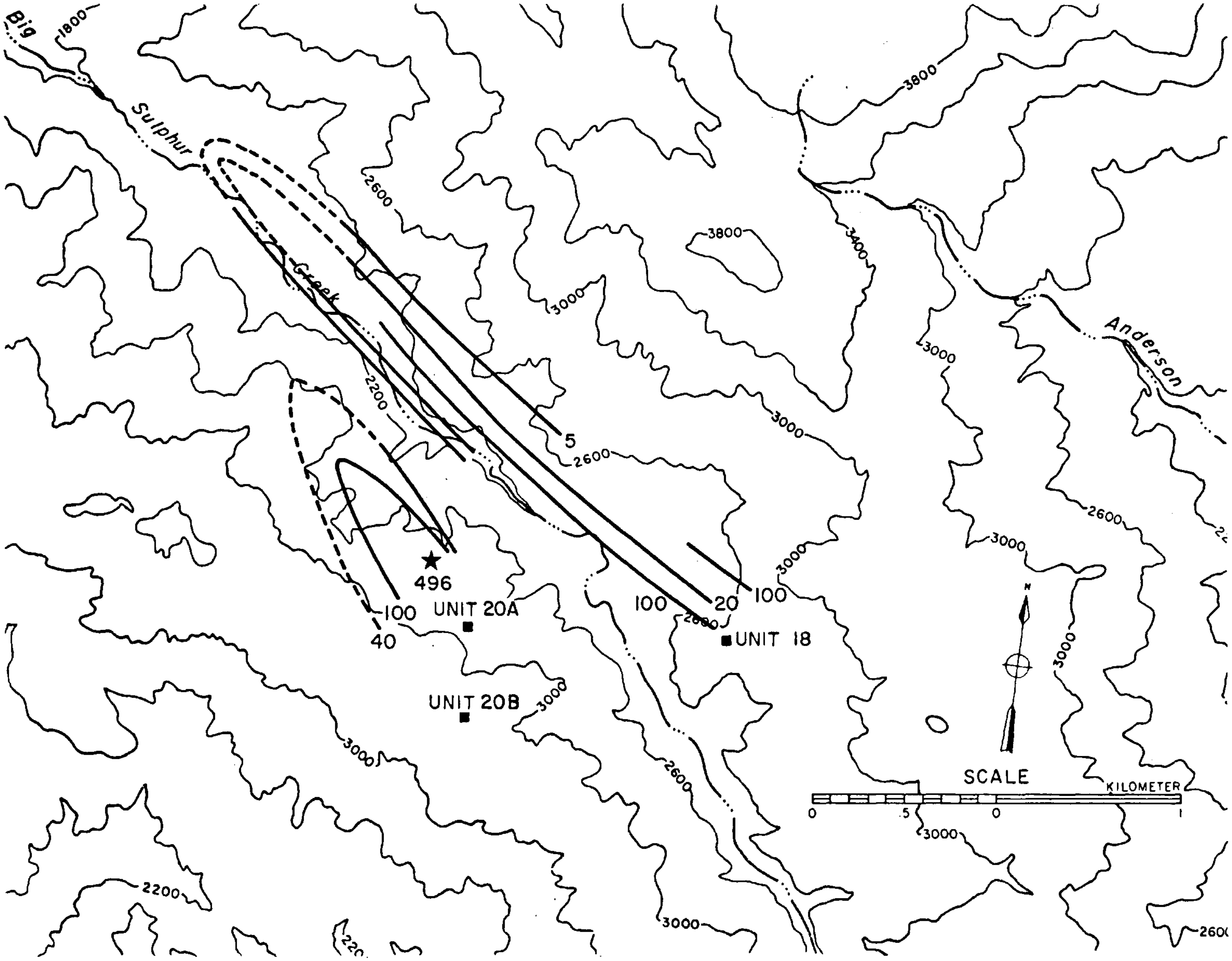


Figure 4-7. Ground-Level Isopleths of K x 10^5 for Drainage Flow Conditions, Unit 18 Operating

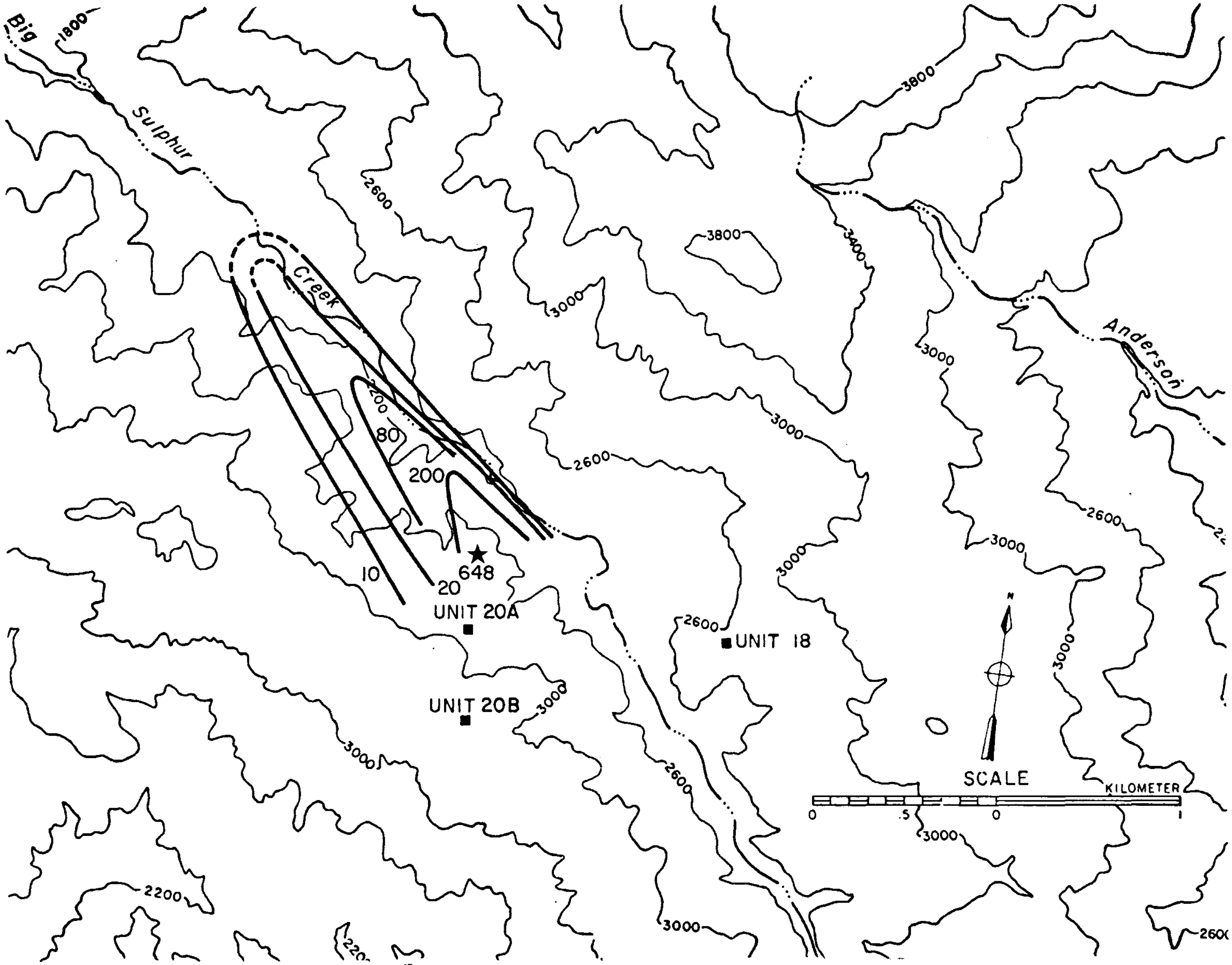


Figure 4-8. Ground-Level Isopleths of K x 10^5 for Drainage Flow Conditions, Unit 20A Operating

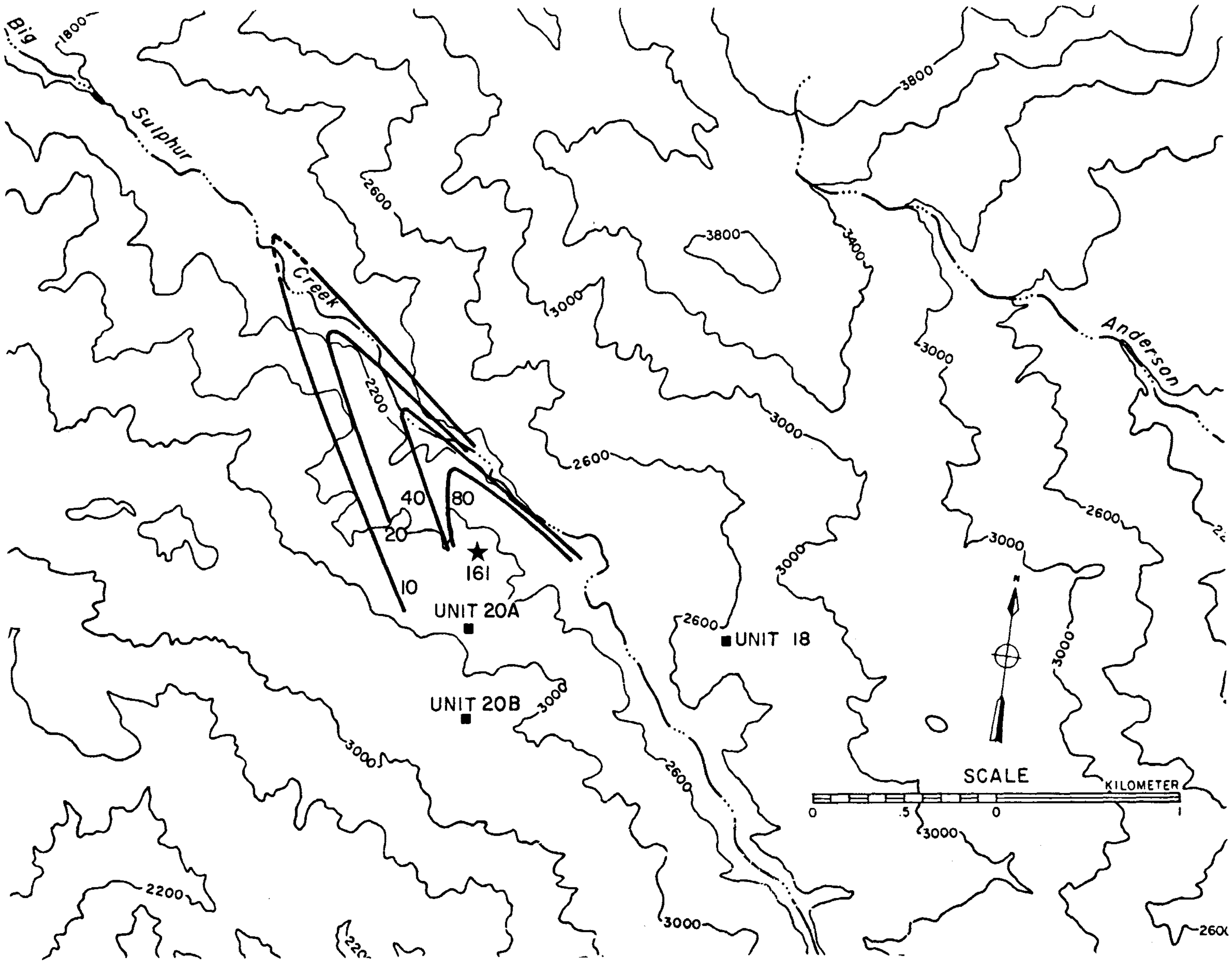


Figure 4-9. Ground-Level Isopleths of K x 10^5 for Drainage Flow Conditions, Unit 20B Operating

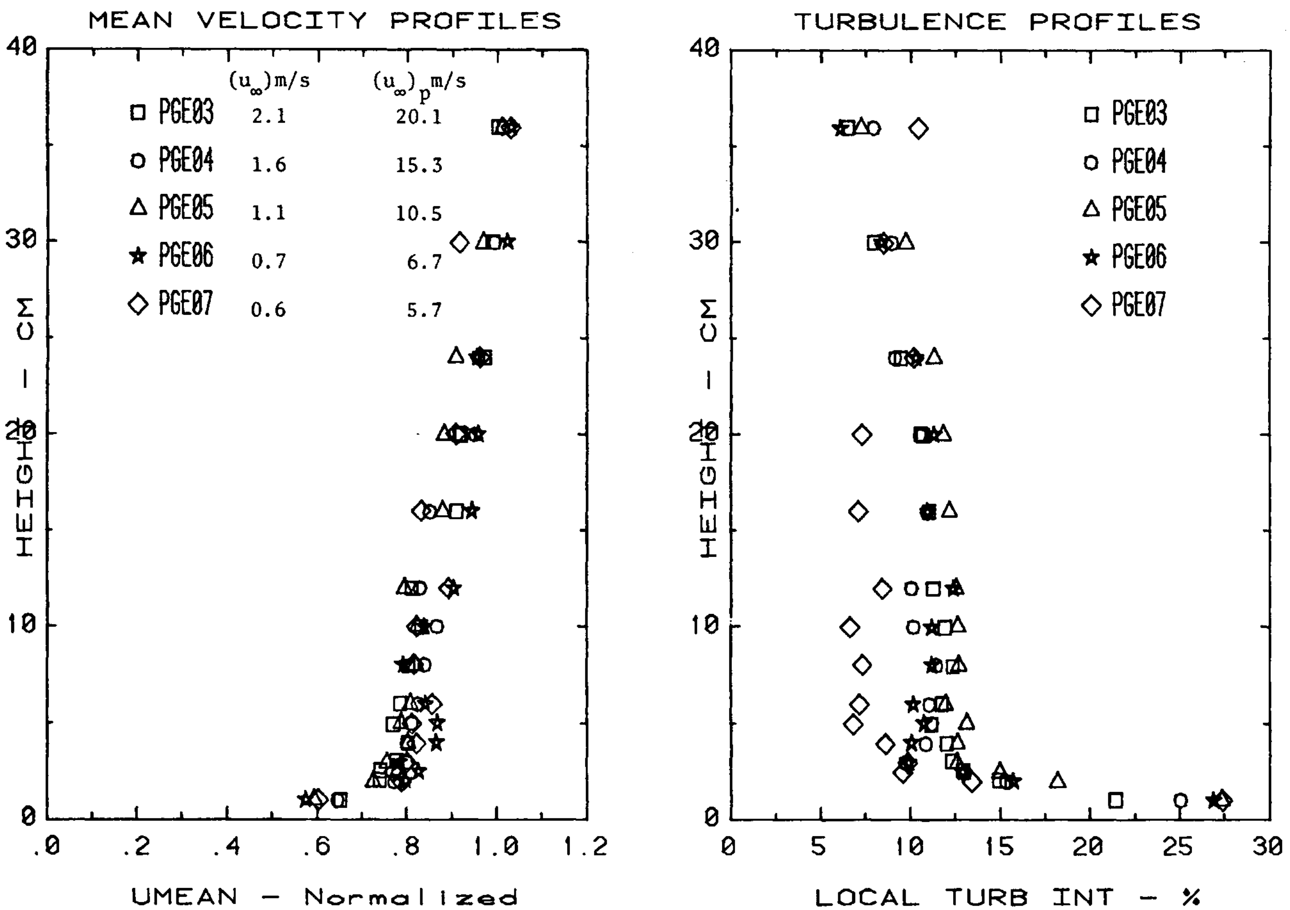


Figure 5-1. Velocity Profiles for Neutral Stratification Taken at the Meteorological Station

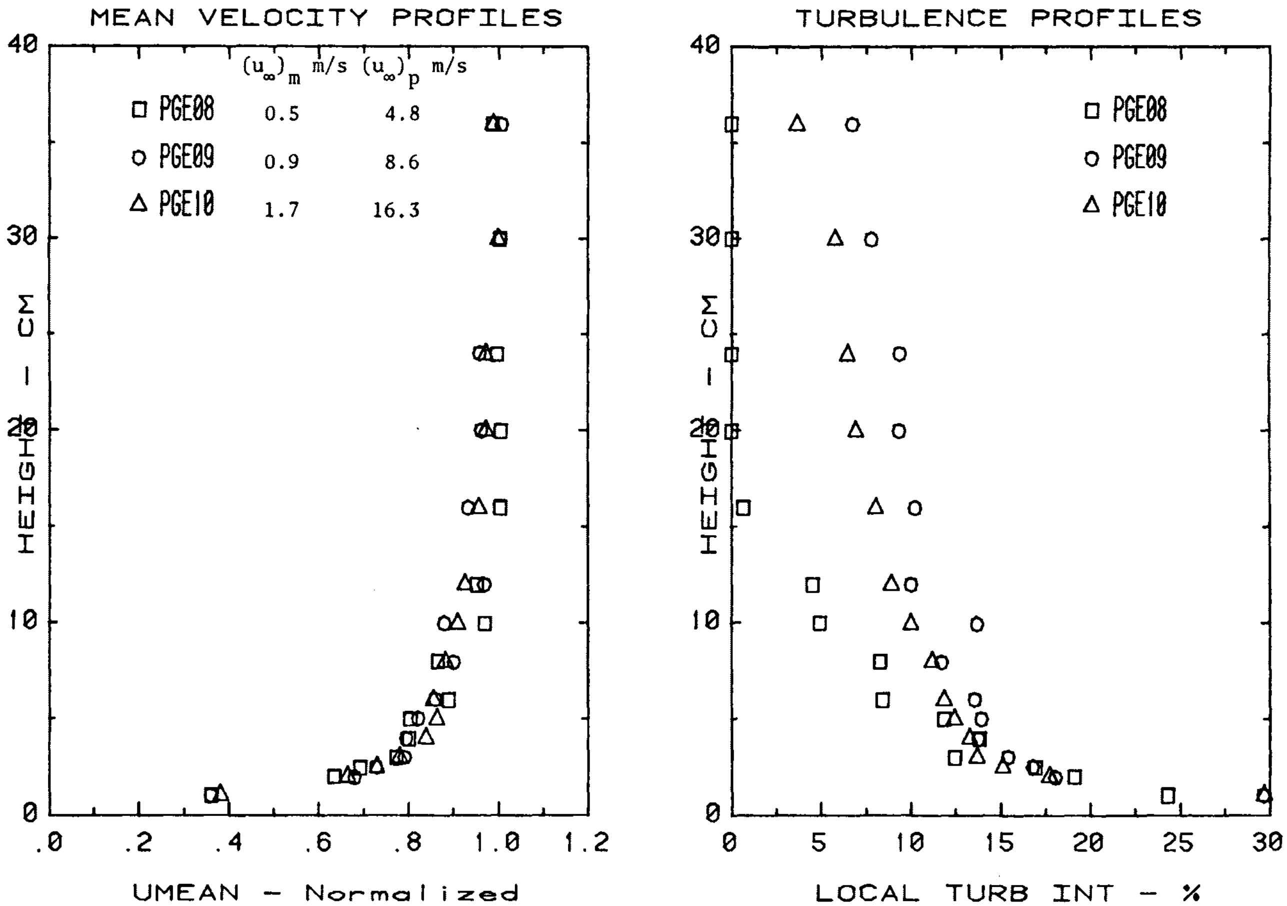


Figure 5-2. Velocity Profiles for Neutral Stratification Taken at T6 (see Figure 3-4)

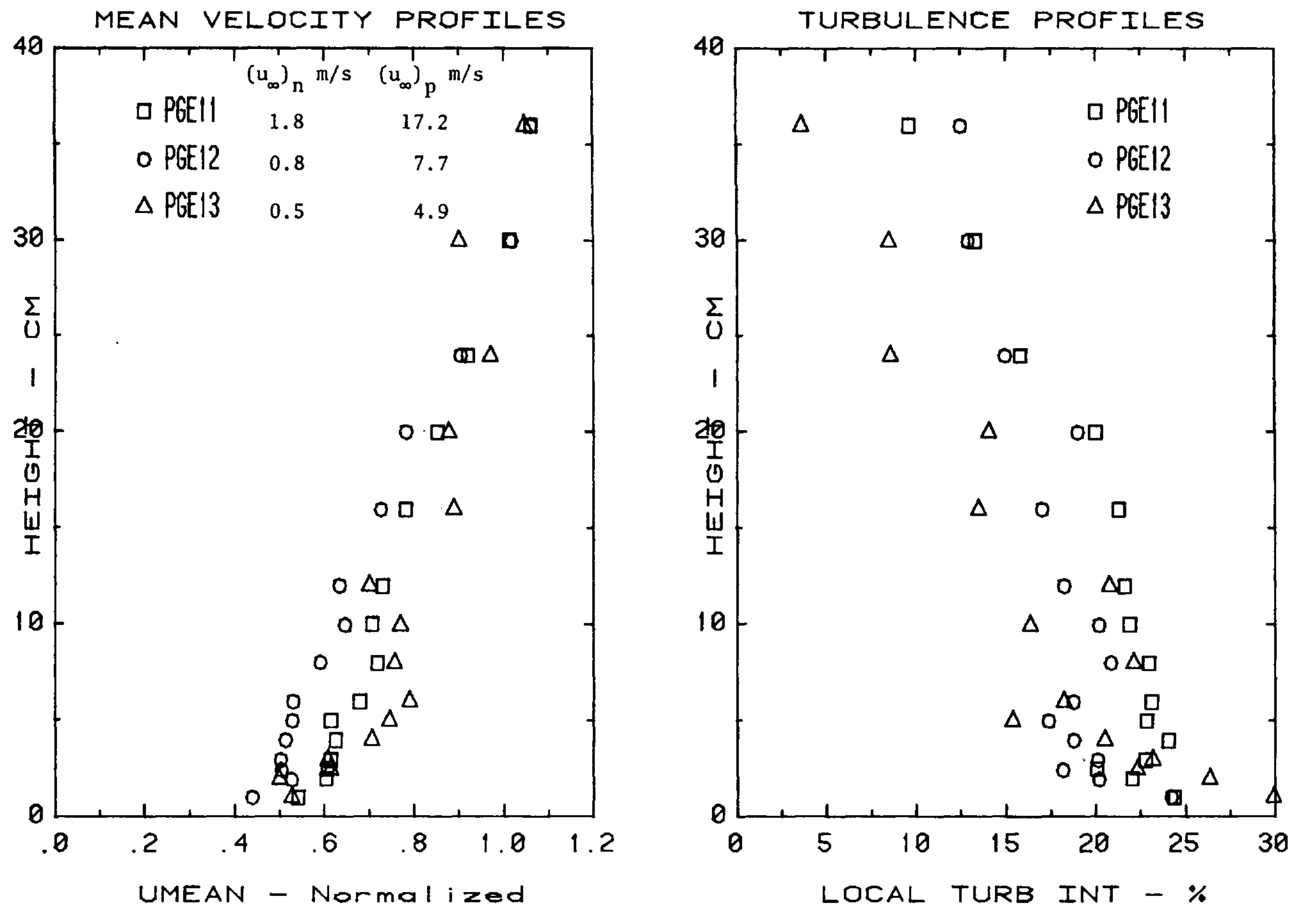


Figure 5-3. Velocity Profiles for Neutral Stratification Taken at Concentration Point 35

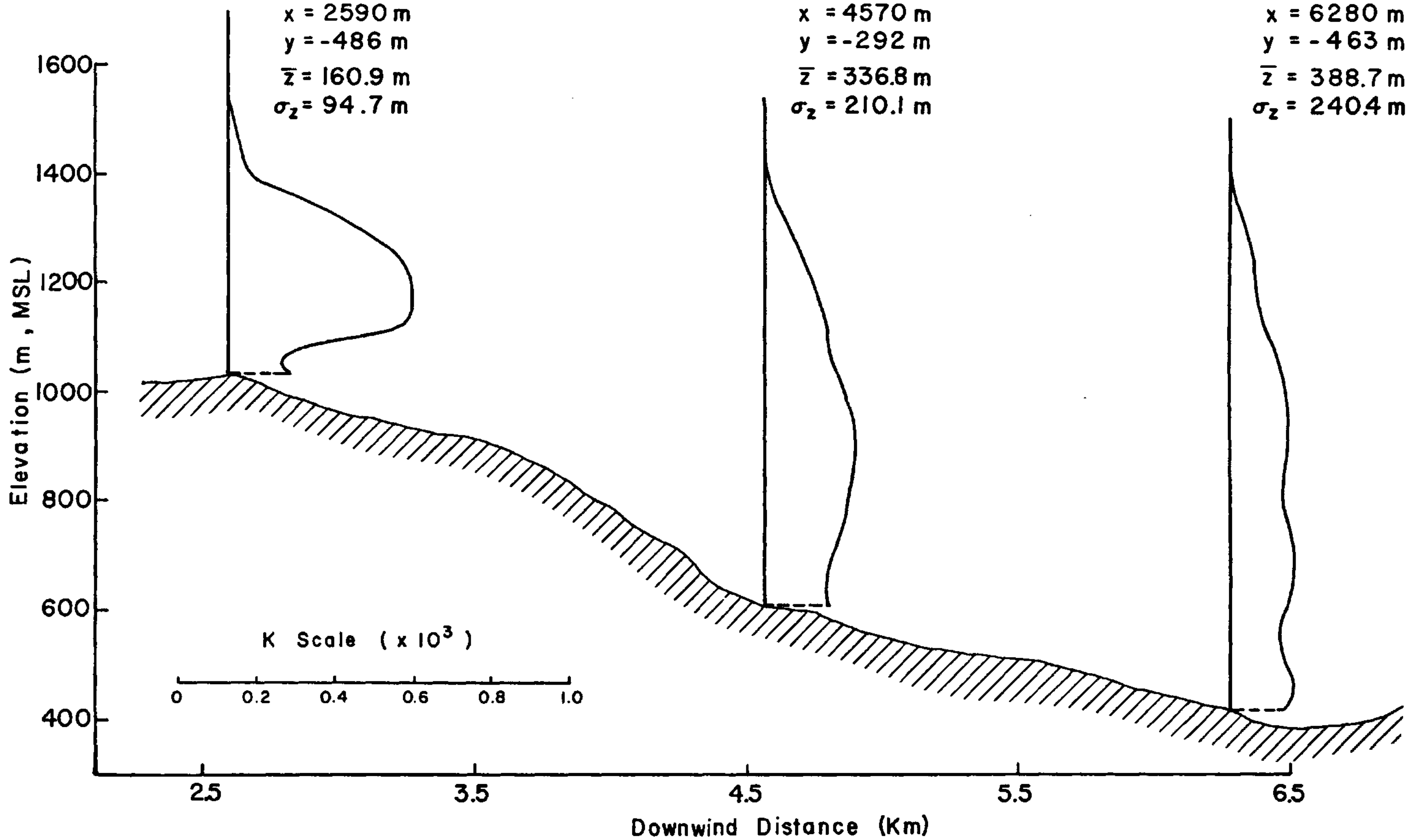


Figure 5-4. Vertical Concentration Distribution Downwind of Unit 20B for u_∞ = 15 m/s.

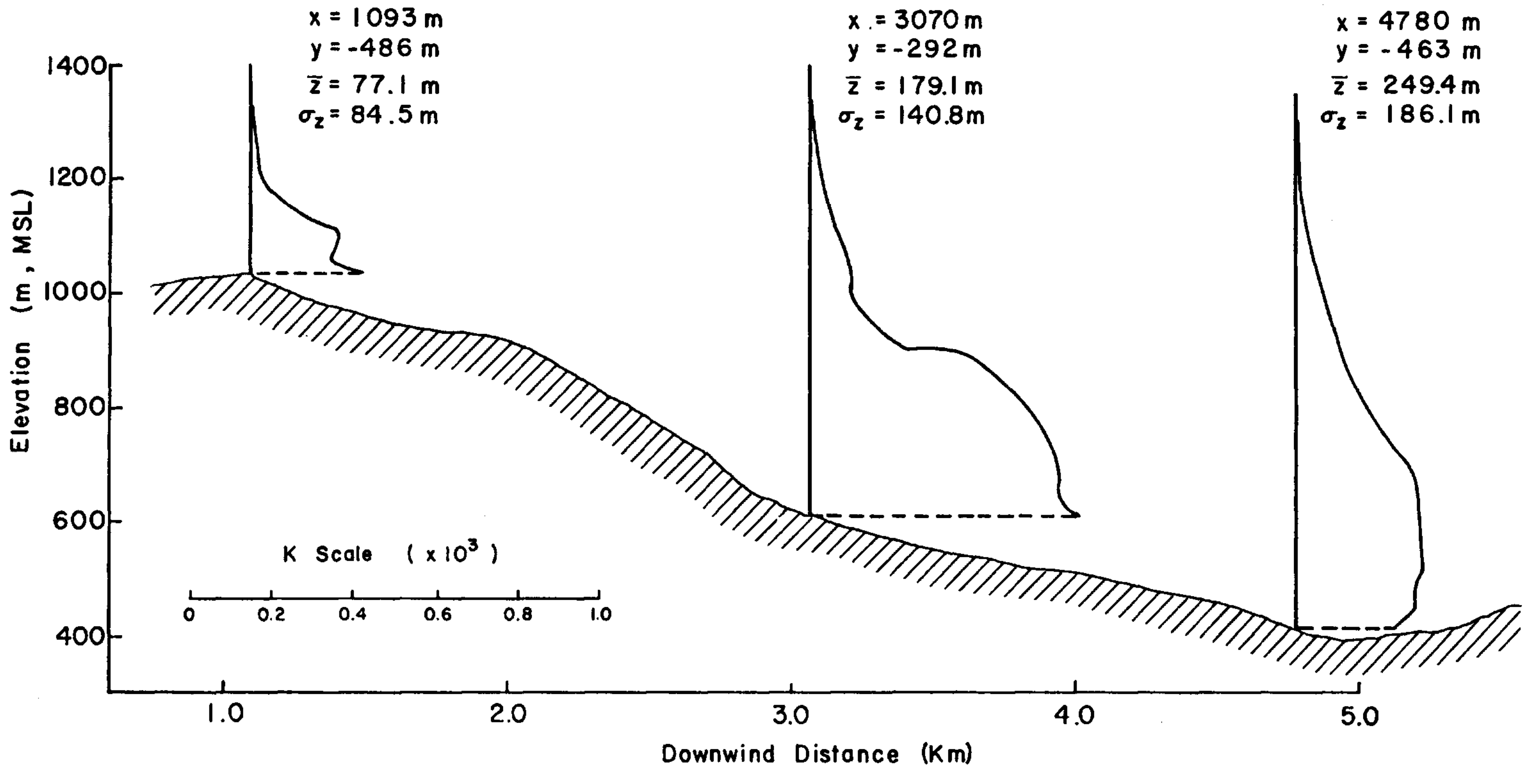


Figure 5-5. Vertical Concentration Distribution Downwind of Unit 18 for u_∞ = 15 m/s.

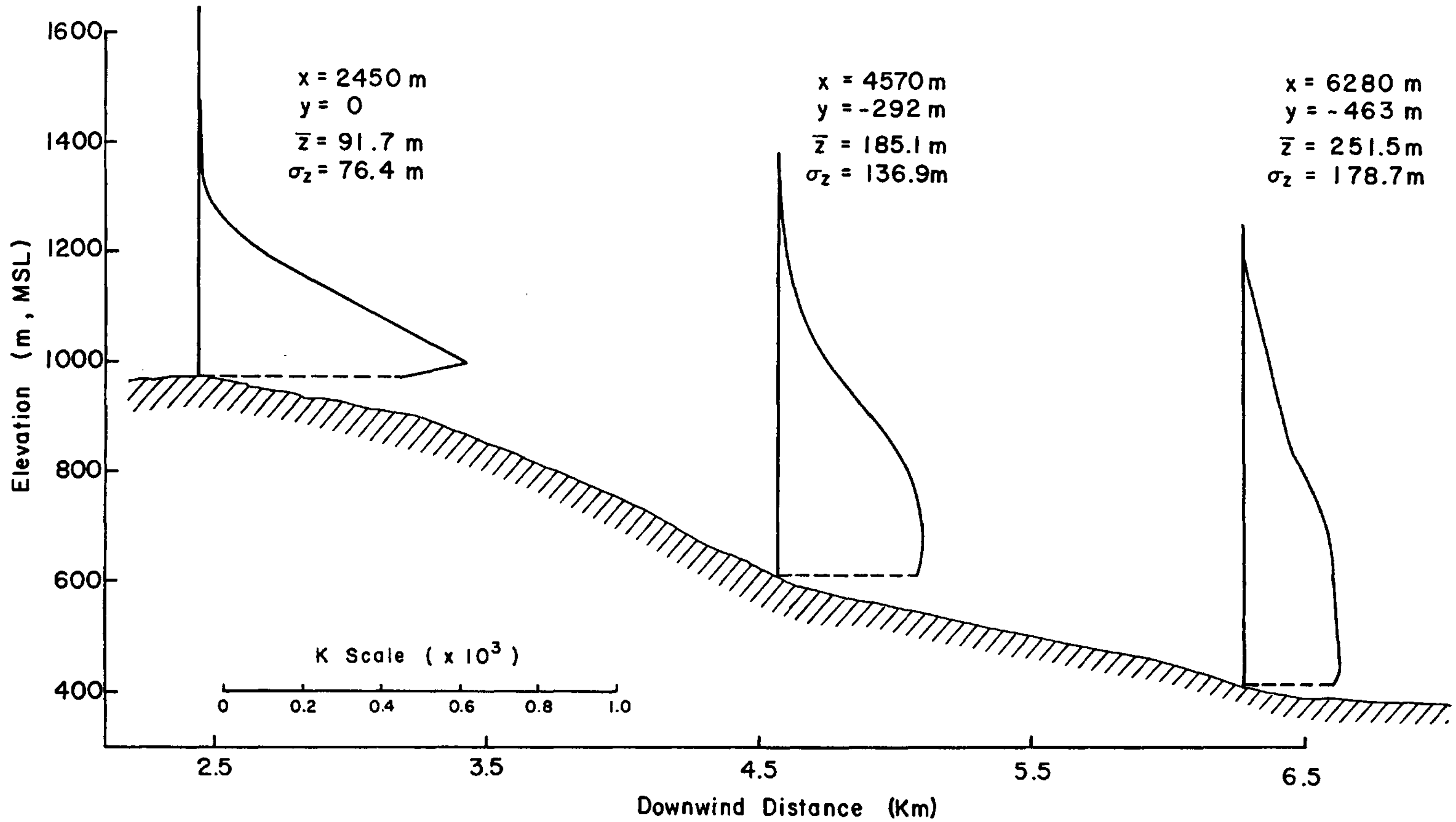


Figure 5-6. Vertical Concentration Distribution Downwind of Unit 20A for u_∞ = 20 m/s.

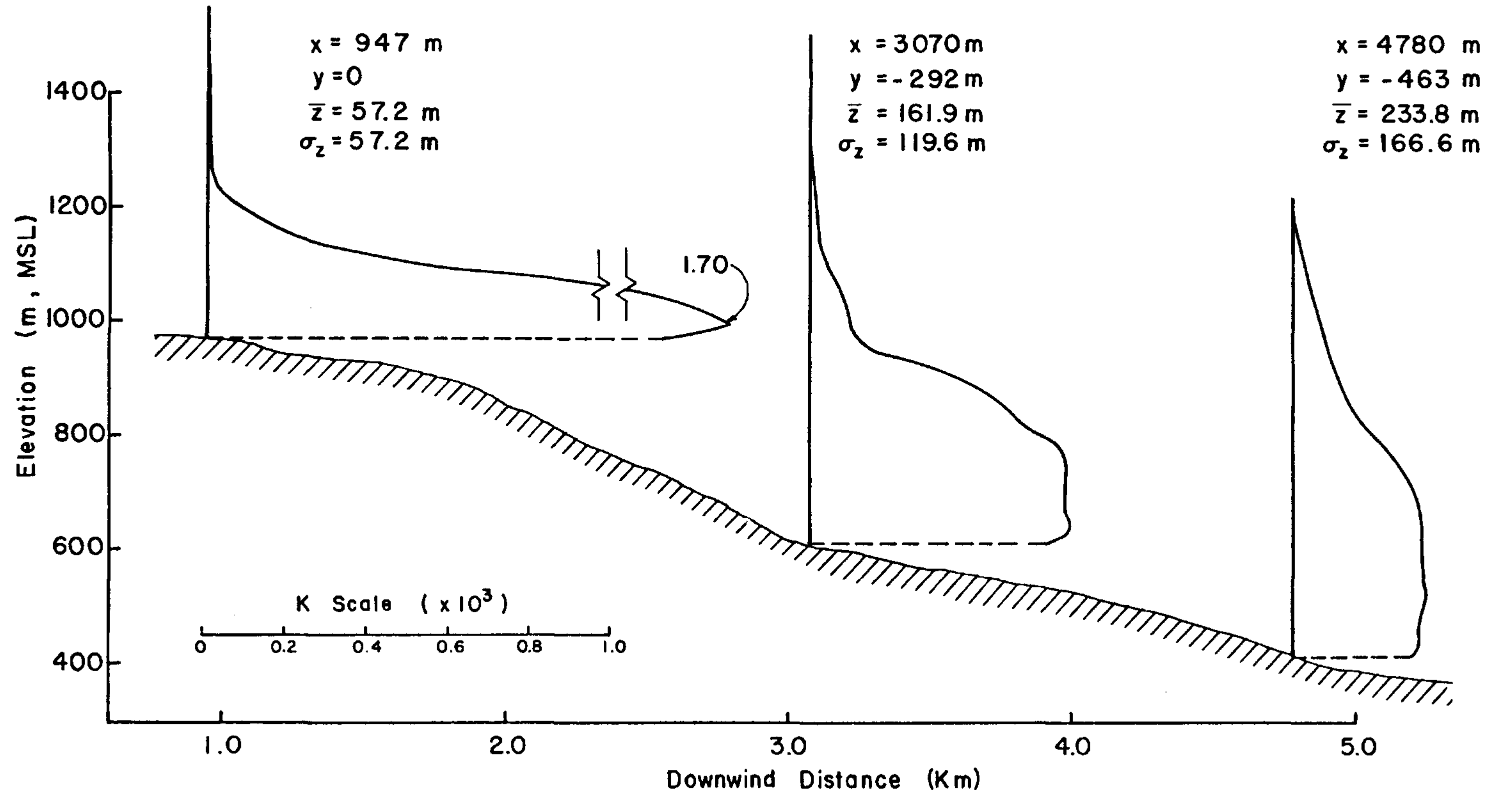


Figure 5-7. Vertical Concentration Distribution Downwind of Unit 18 for $u_\infty = 20$ m/s.

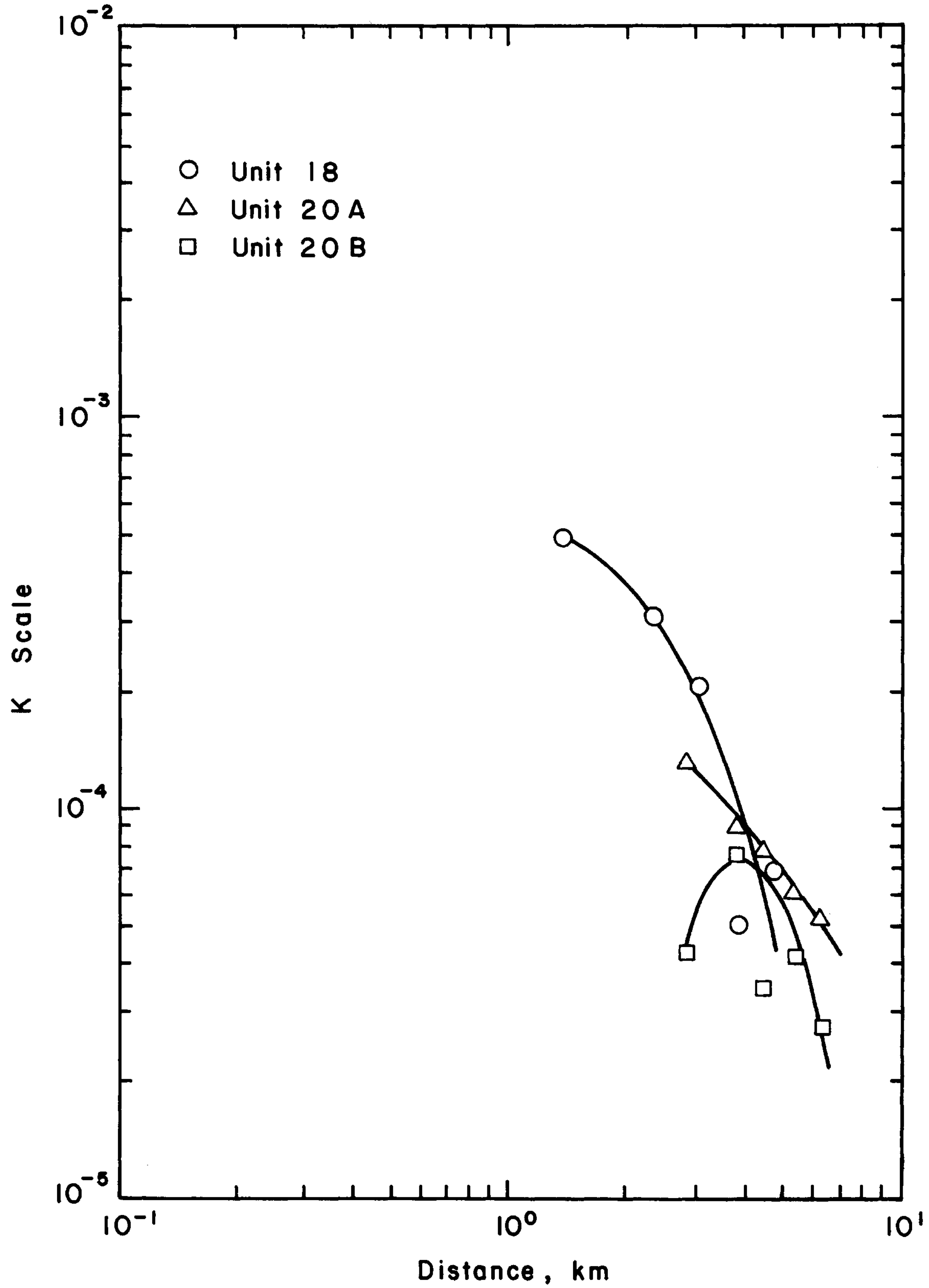


Figure 5-8. Maximum K versus Distance Downwind of Units 18, 20A and 20B for a u_∞ = 7.5 m/s

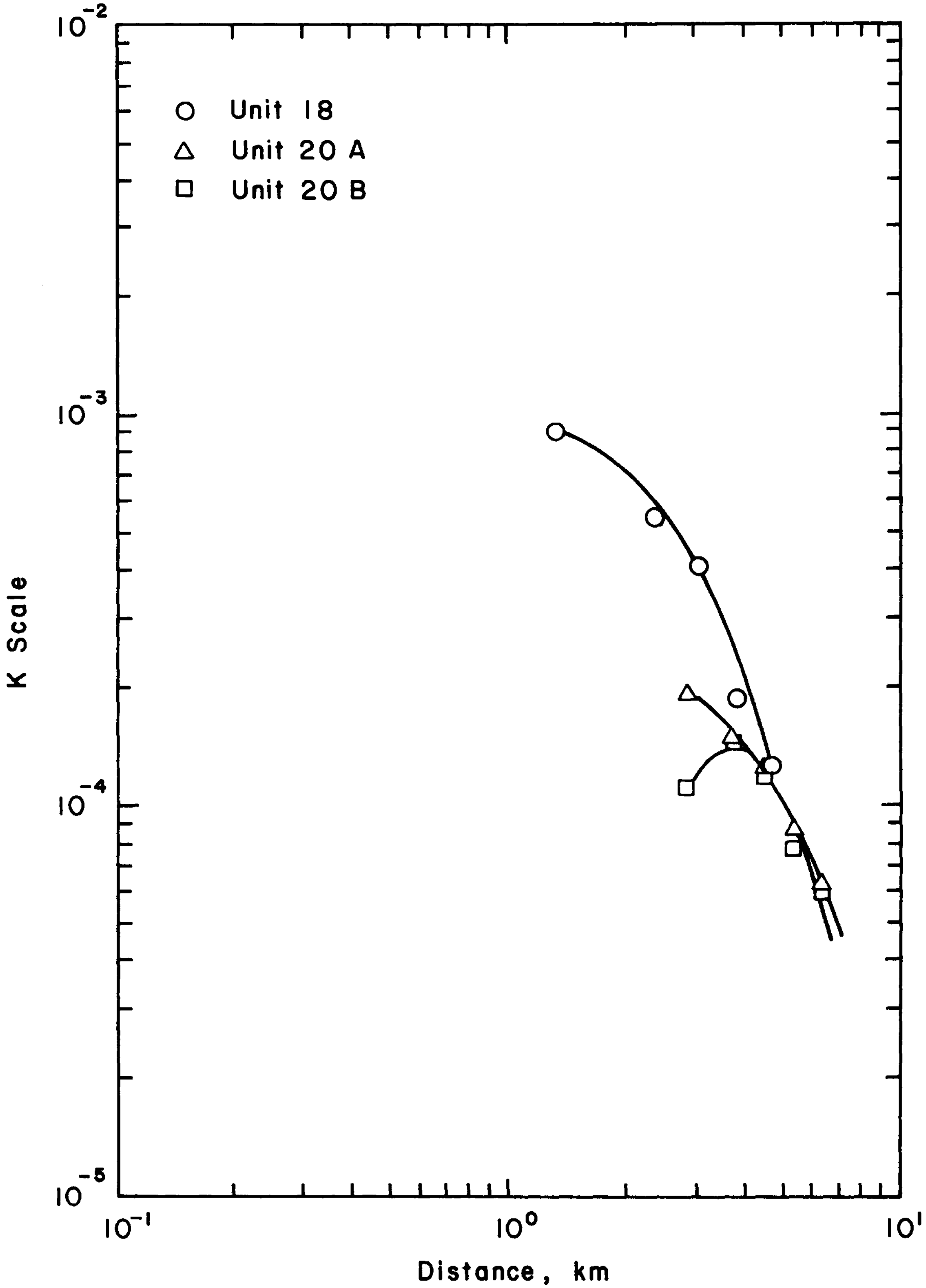


Figure 5-9. Maximum K versus Distance Downwind of Units 18, 20A and 20B for a u_∞ = 10.0 m/s

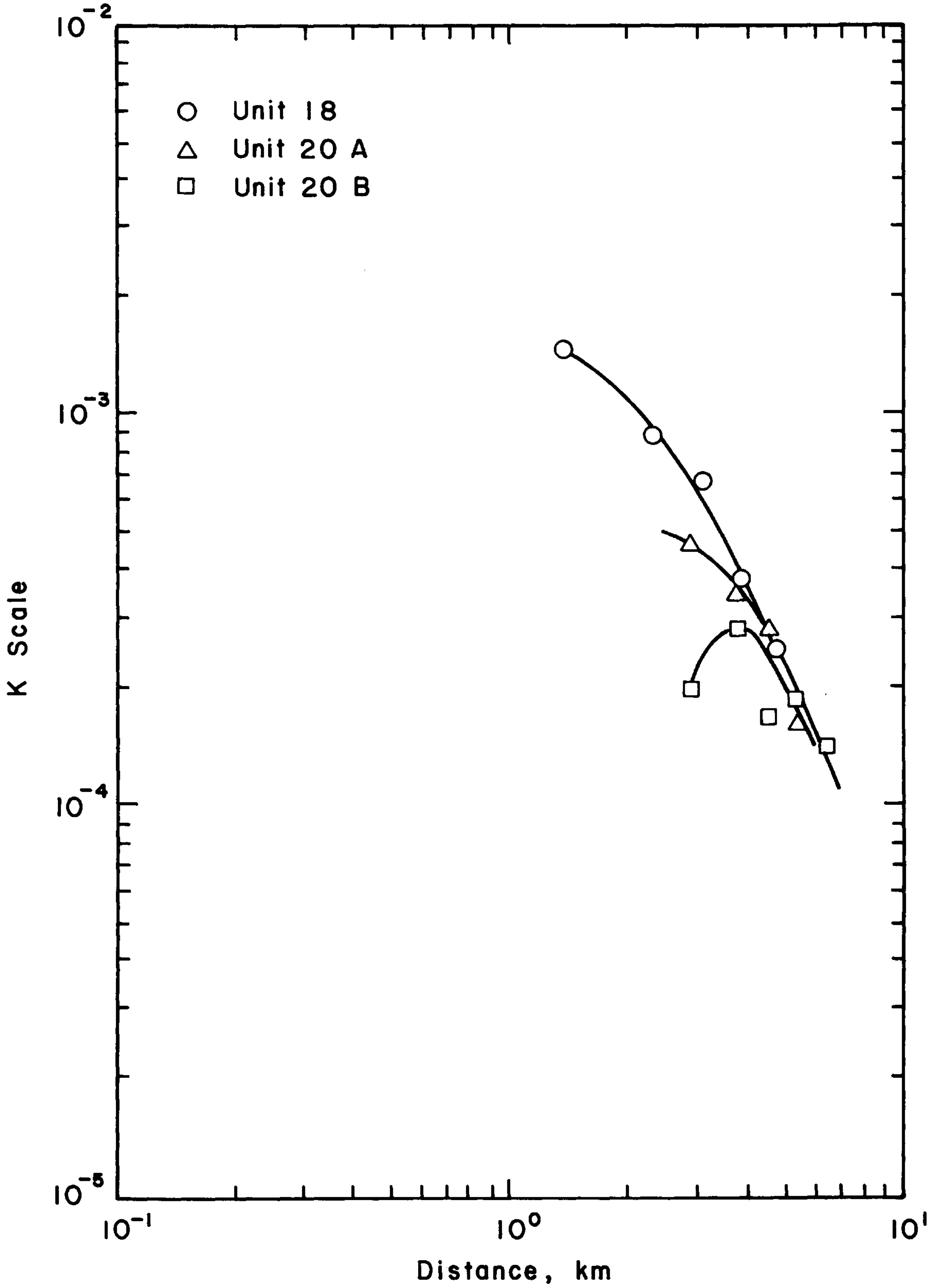


Figure 5-10. Maximum K versus Distance Downwind of Units 18, 20A and 20B for a u_∞ = 15.0 m/s

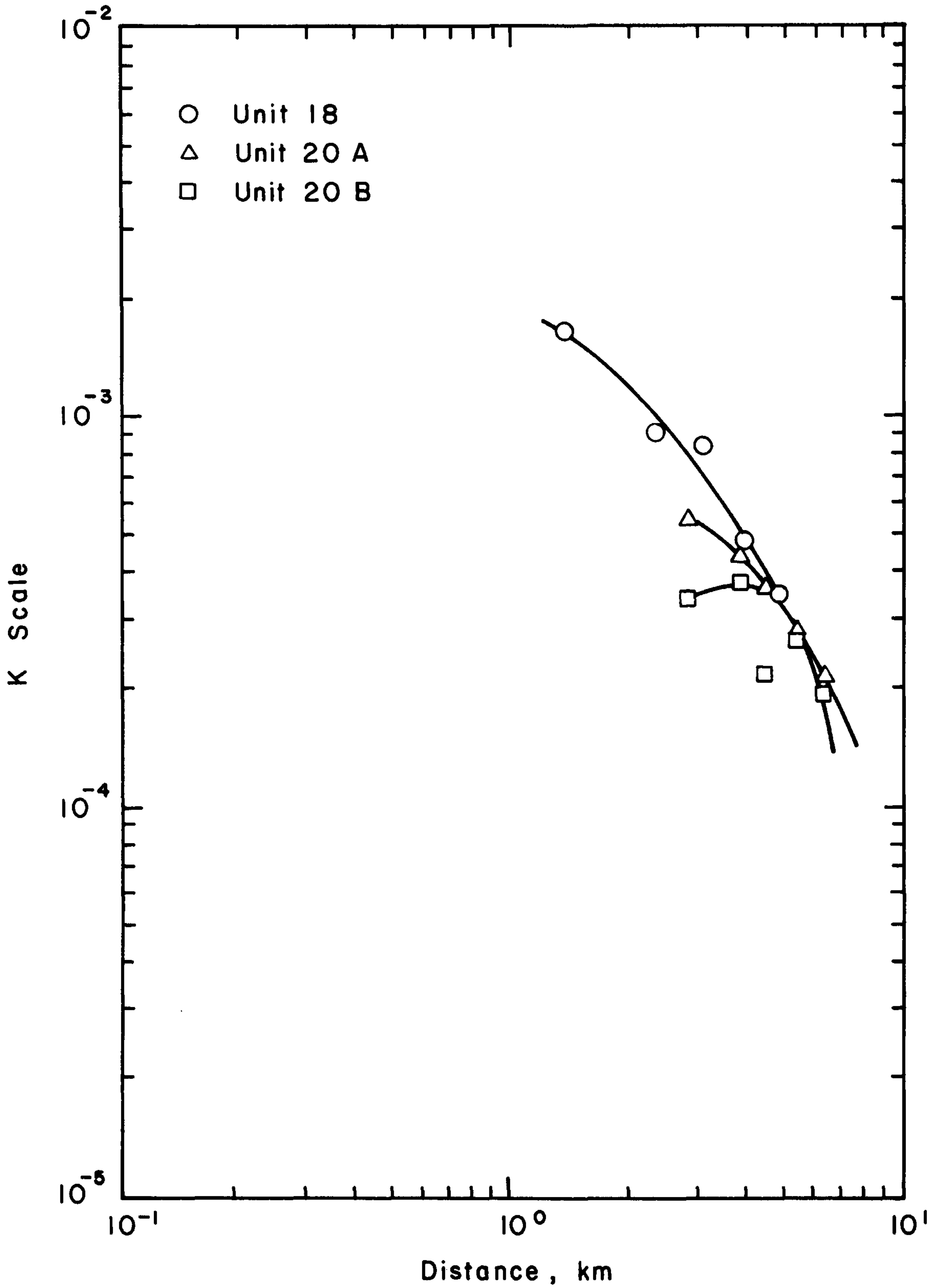


Figure 5-11. Maximum K versus Distance Downwind of Units 18, 20A and 20B for a u_∞ = 20.0 m/s

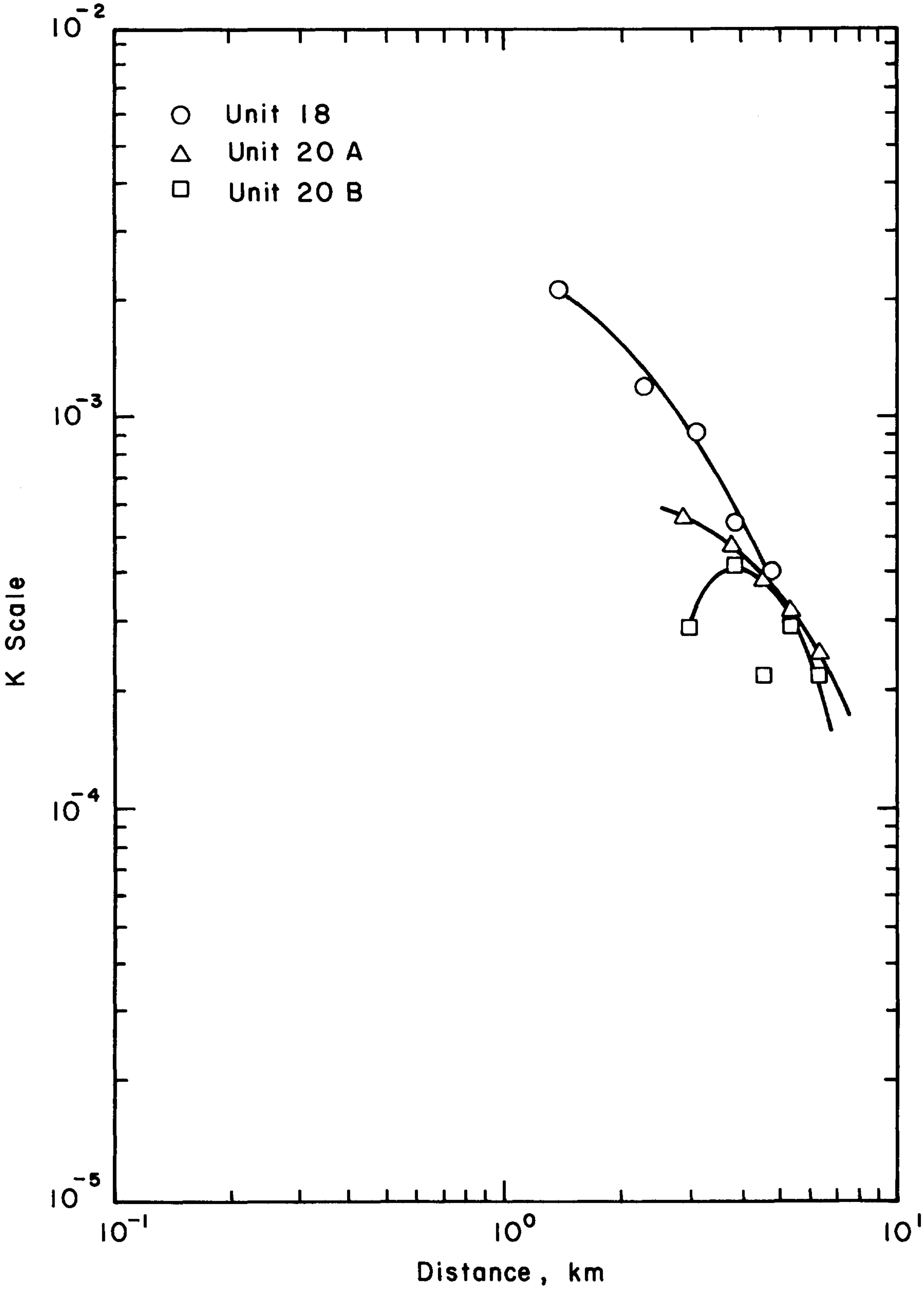


Figure 5-12. Maximum K versus Downwind Distance of Units 18, 20A and 20B for a u_∞ = 28.0 m/s

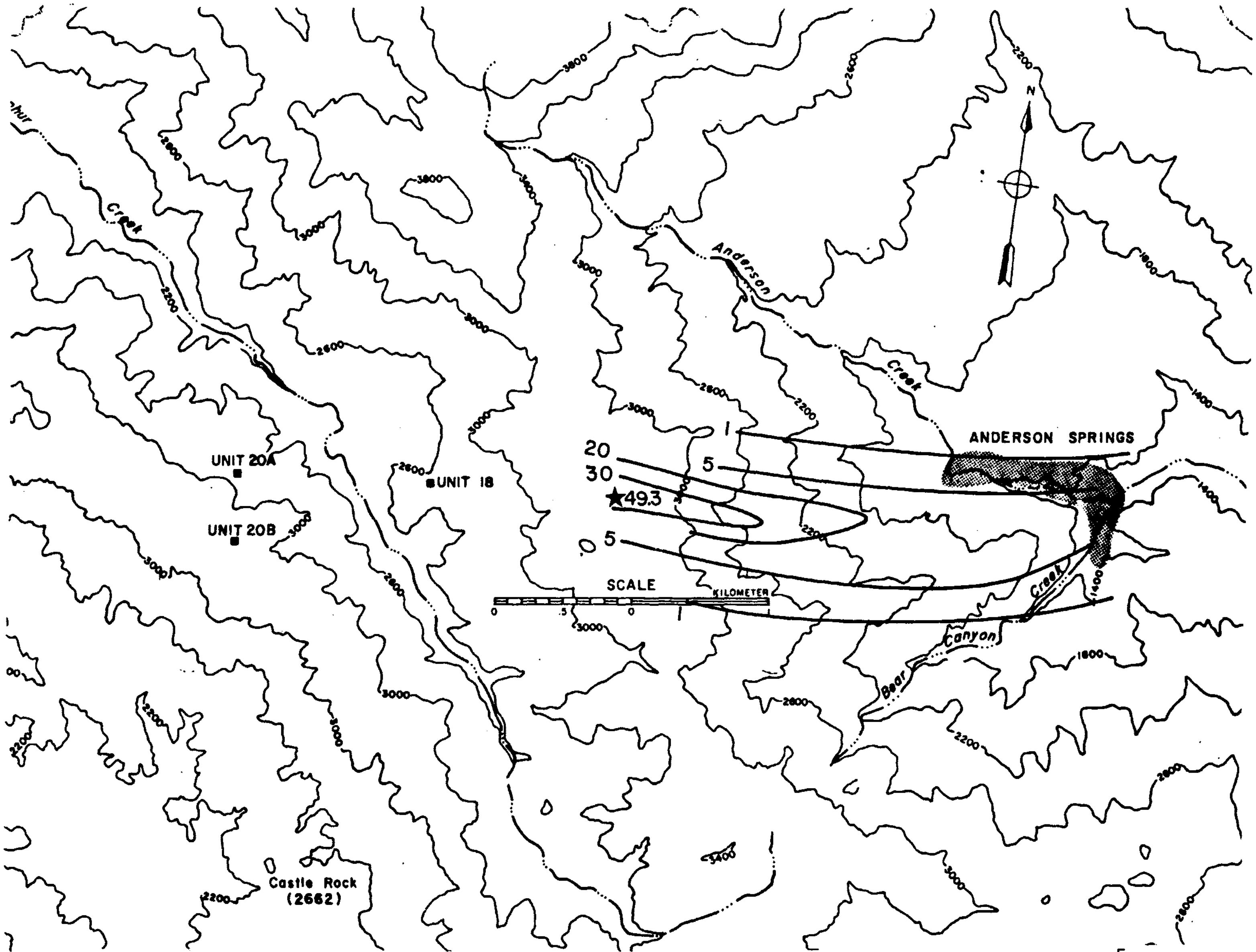


Figure 5-13a. Ground-Level Isopleths of Nondimensional Concentration K x 10^5
Measured Downwind of Unit 18 for u_∞ = 7.5 m/s

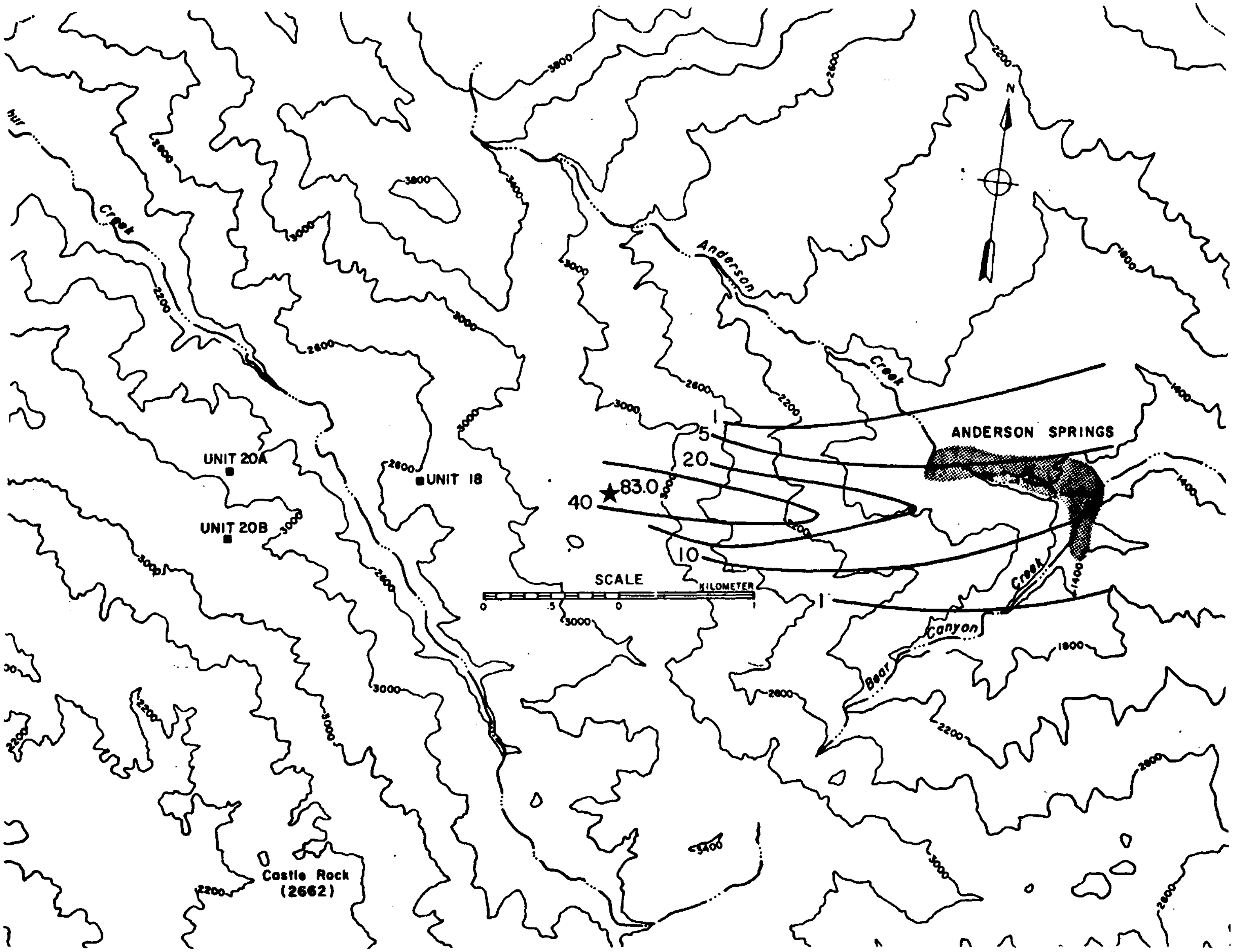


Figure 5-13b. Ground-Level Isopleths of Nondimensional Concentration K x 10^5
Measured Downwind of Unit 18 for u_∞ = 10.0 m/s

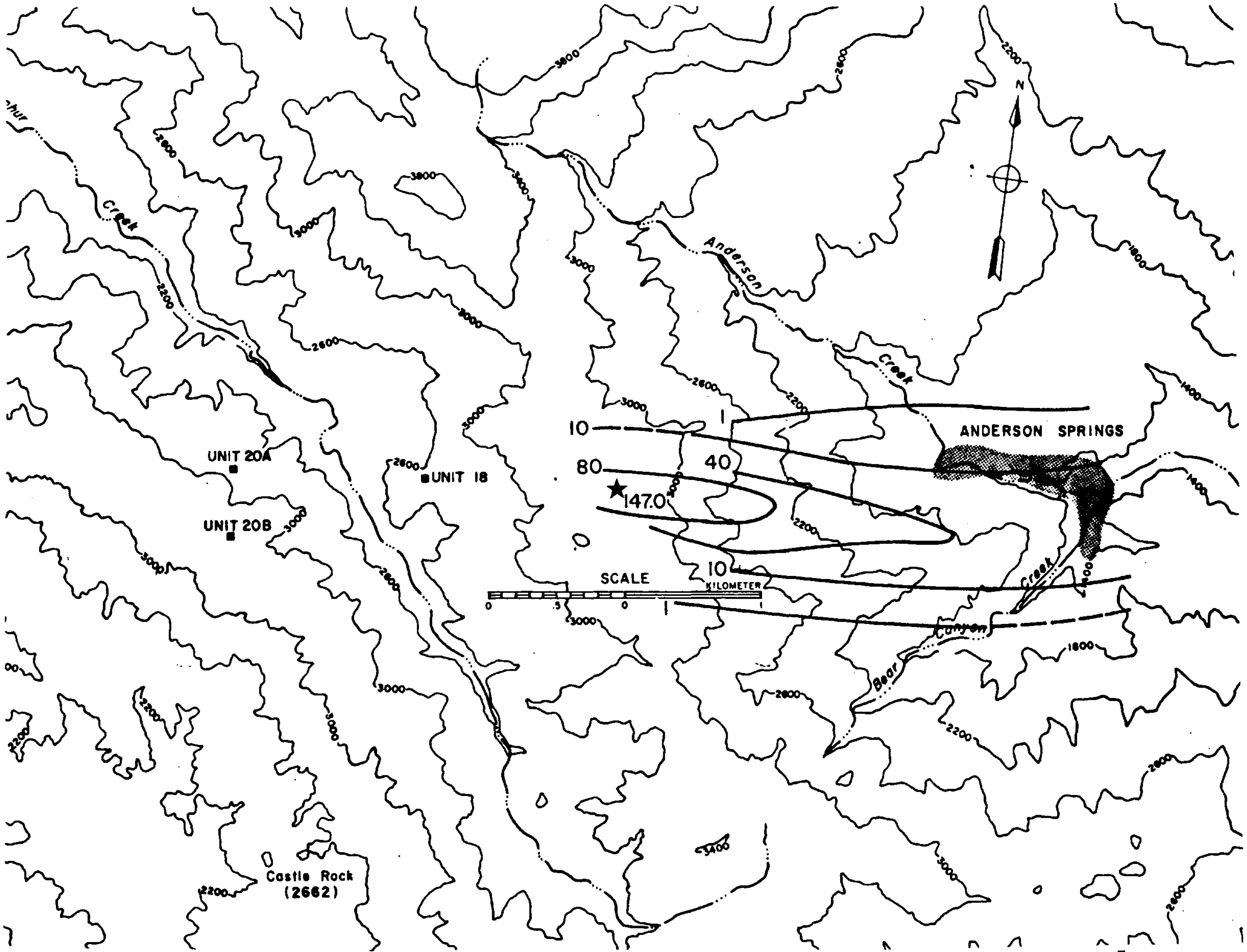


Figure 5-13c. Ground-Level Isopleths of Nondimensional Concentration K x 10^5 Measured Downwind of Unit 18 for u_∞ = 15.0 m/s

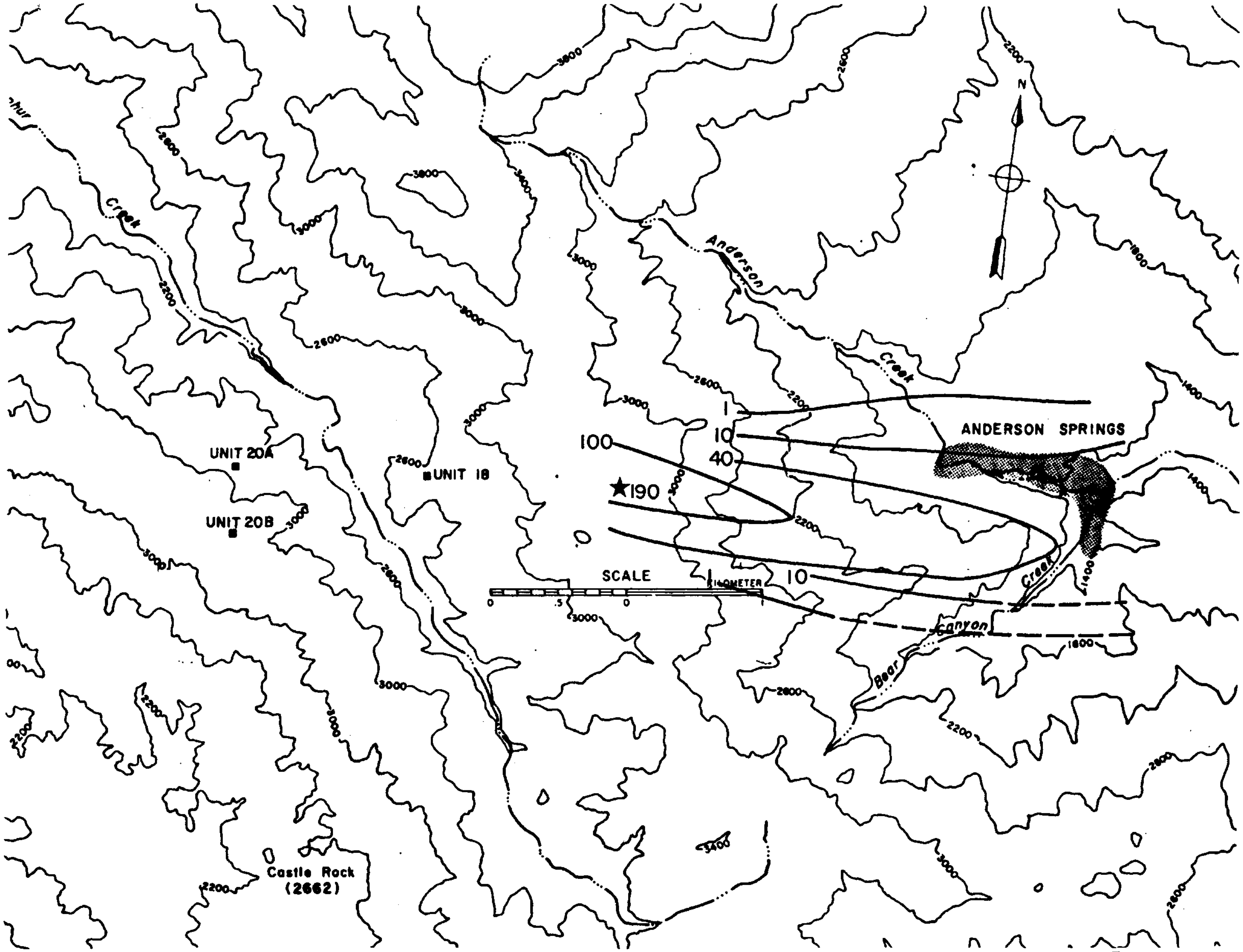


Figure 5-13d. Ground-Level Isopleths of Nondimensional Concentration $K \times 10^5$ Measured Downwind of Unit 18 for $u_\infty = 20.0$ m/s

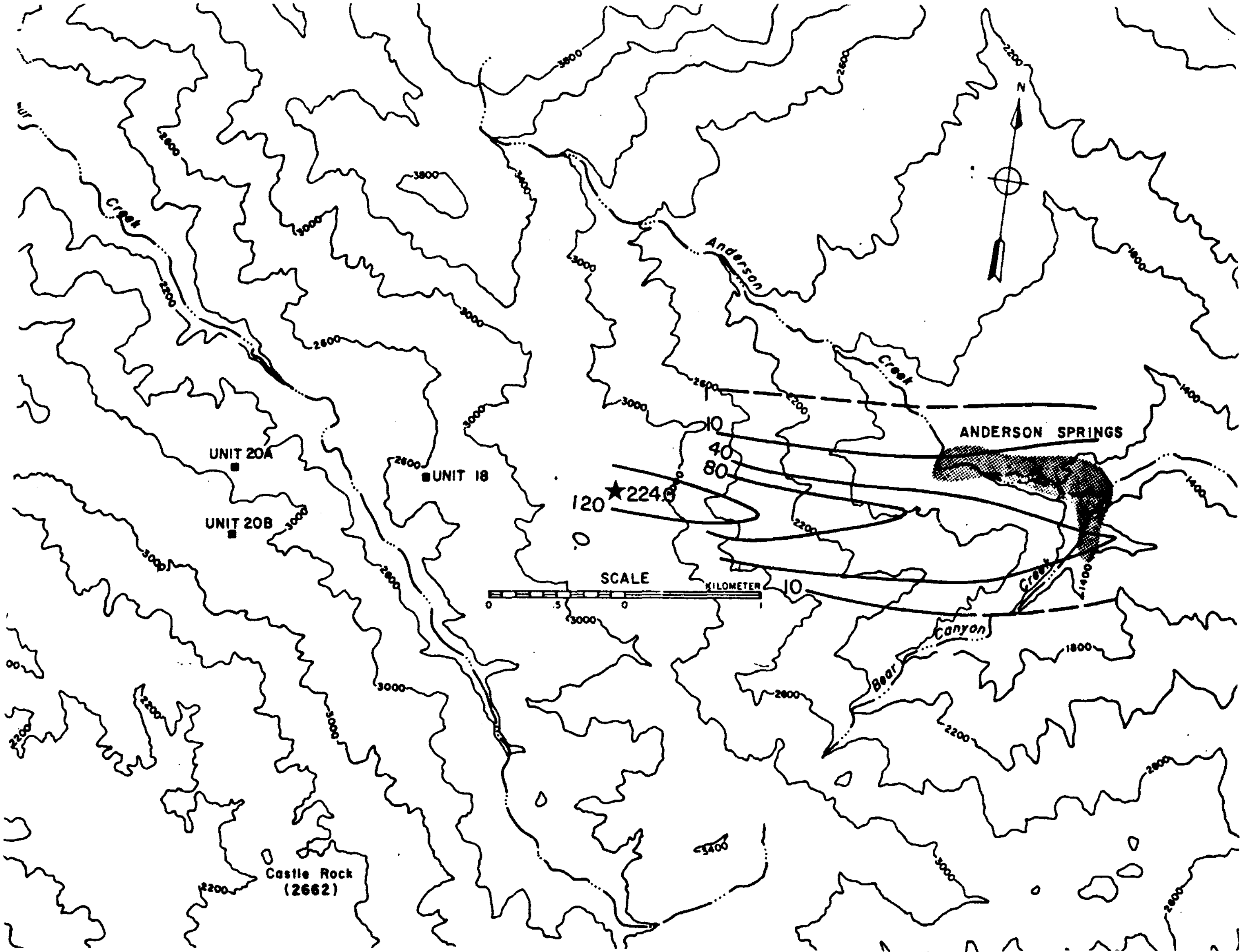


Figure 5-13e. Ground-Level Isopleths of Nondimensional Concentration K x 10^5 Measured Downwind of Unit 18 for u_∞ = 28.0 m/s

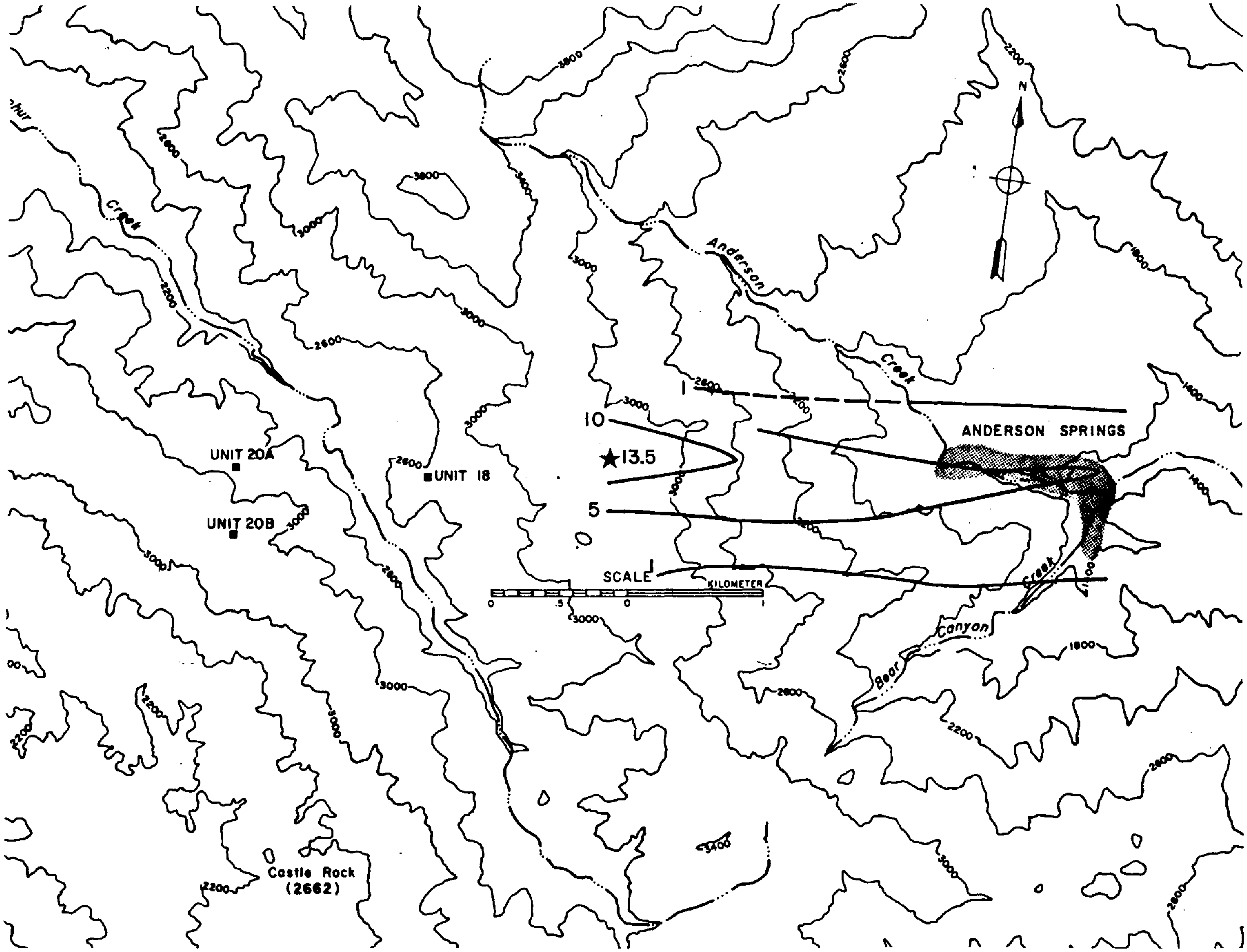


Figure 5-14a. Ground-Level Isopleths of Nondimensional Concentration $K \times 10^5$ Measured Downwind of Unit 20A for $u_\infty = 7.5$ m/s

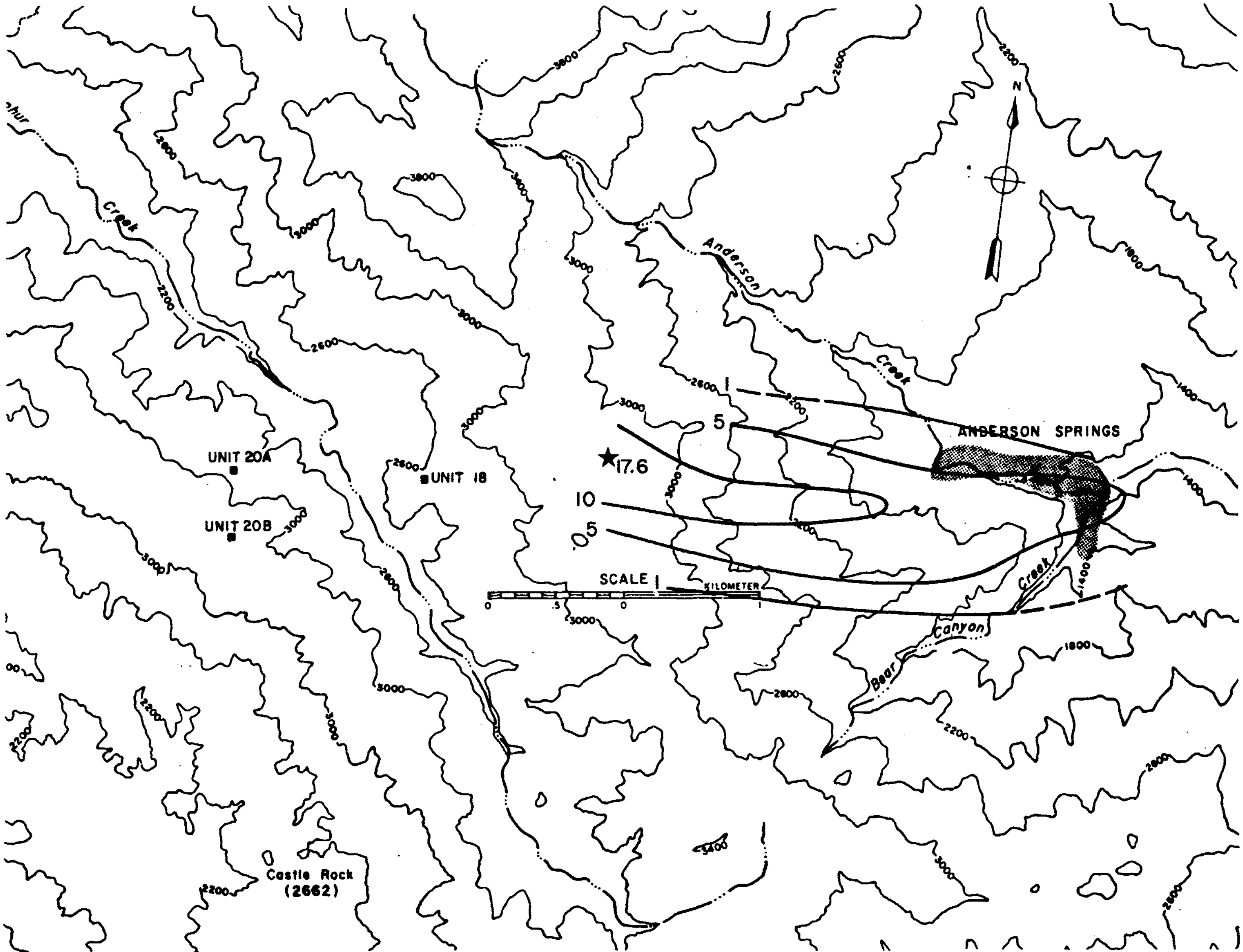


Figure 5-14b. Ground-Level Isopleths of Nondimensional Concentration K x 10^5 Measured Downwind of Unit 20A for u_∞ = 10.0 m/s

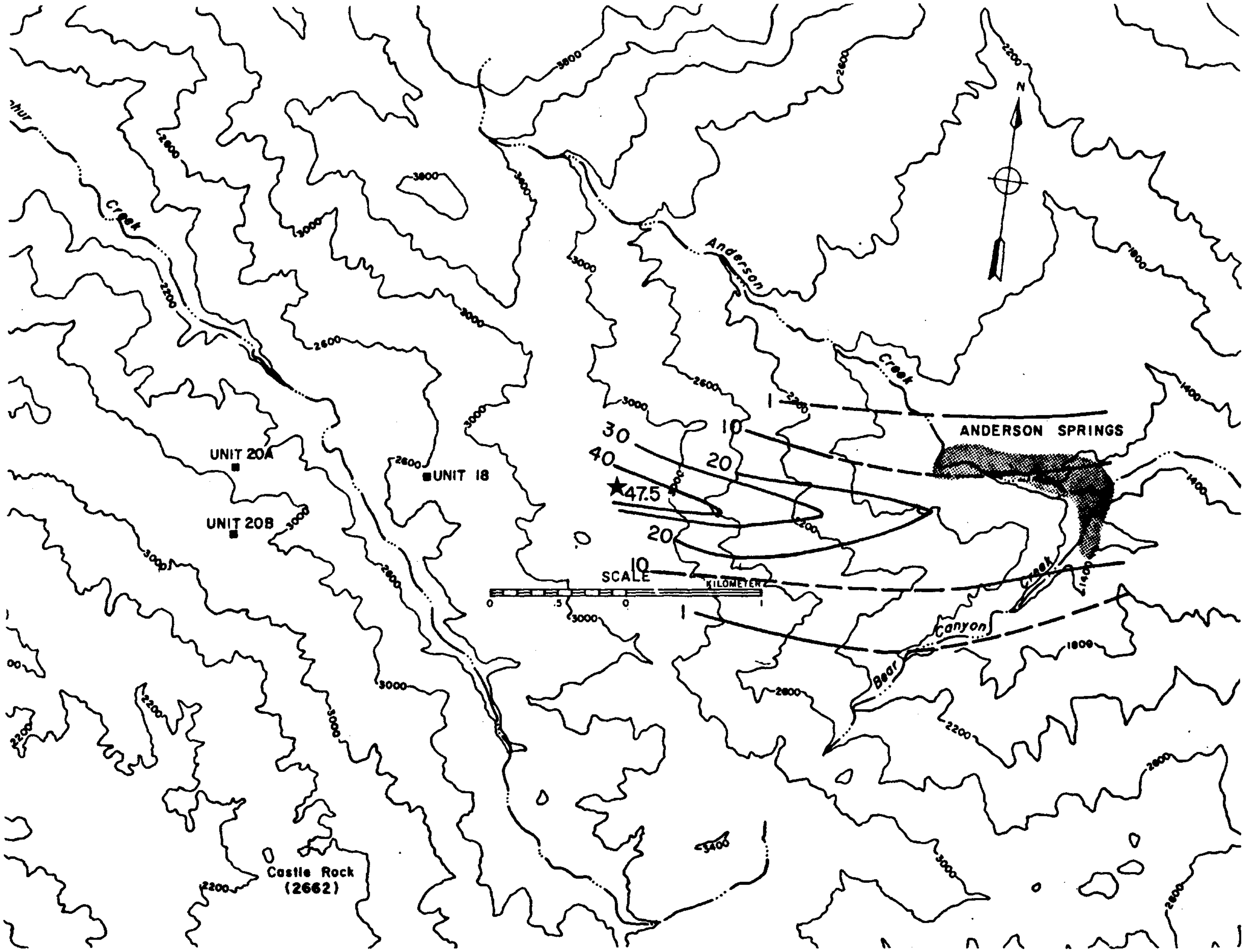


Figure 5-14c. Ground-Level Isopleths of Nondimensional Concentration K x 10^5
Measured Downwind of Unit 20A for u_∞ = 15.0 m/s

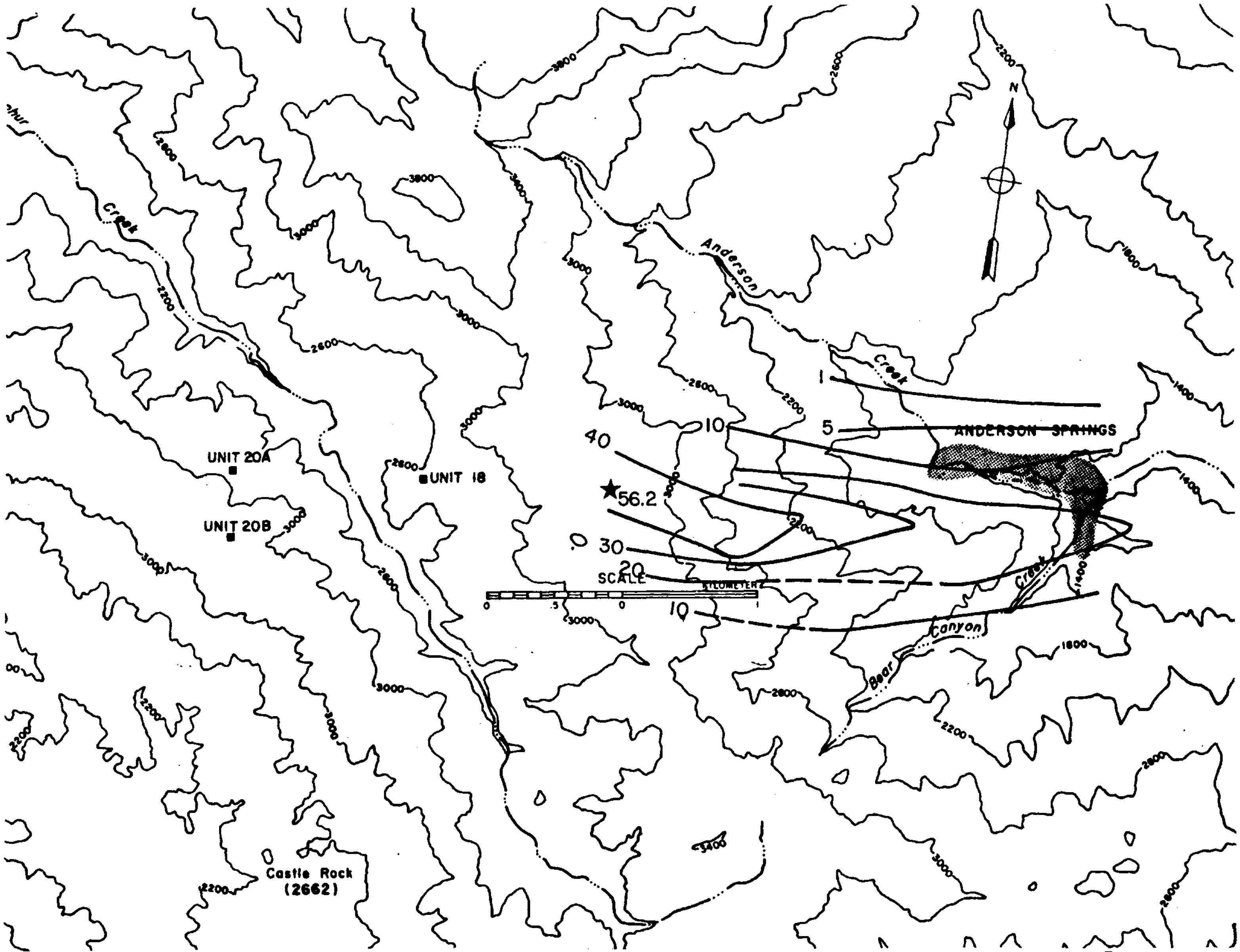


Figure 5-14d. Ground-Level Isopleths of Nondimensional Concentration $K \times 10^5$ Measured Downwind of Unit 20A for $u_\infty = 20.0$ m/s

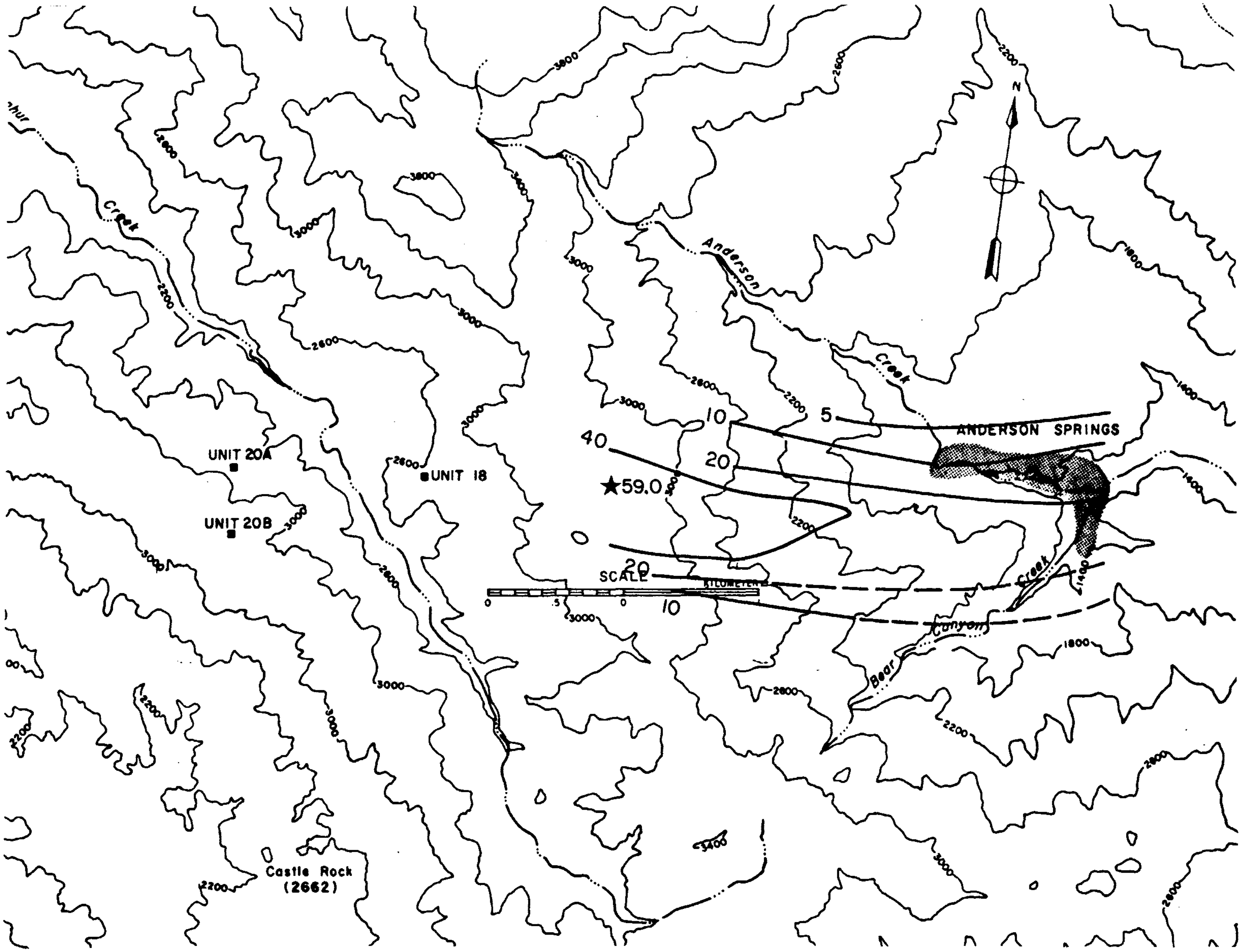


Figure 5-14e. Ground-Level Isopleths of Nondimensional Concentration K x 10^5 Measured Downwind of Unit 20A for u_∞ = 28.0 m/s

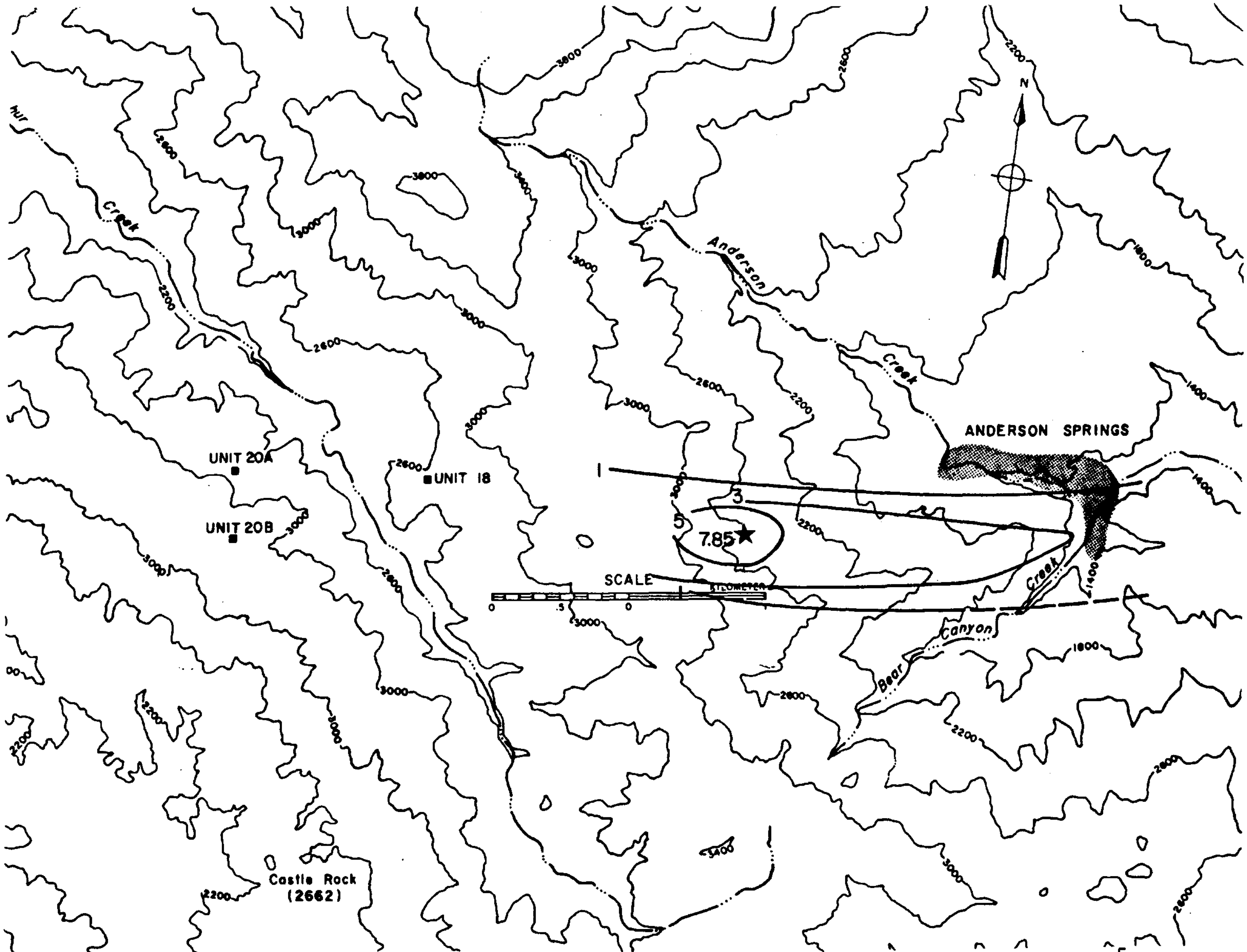


Figure 5-15a. Ground-Level Isopleths of Nondimensional Concentration K x 10^5 Measured Downwind of Unit 20B for u_∞ = 7.5 m/s

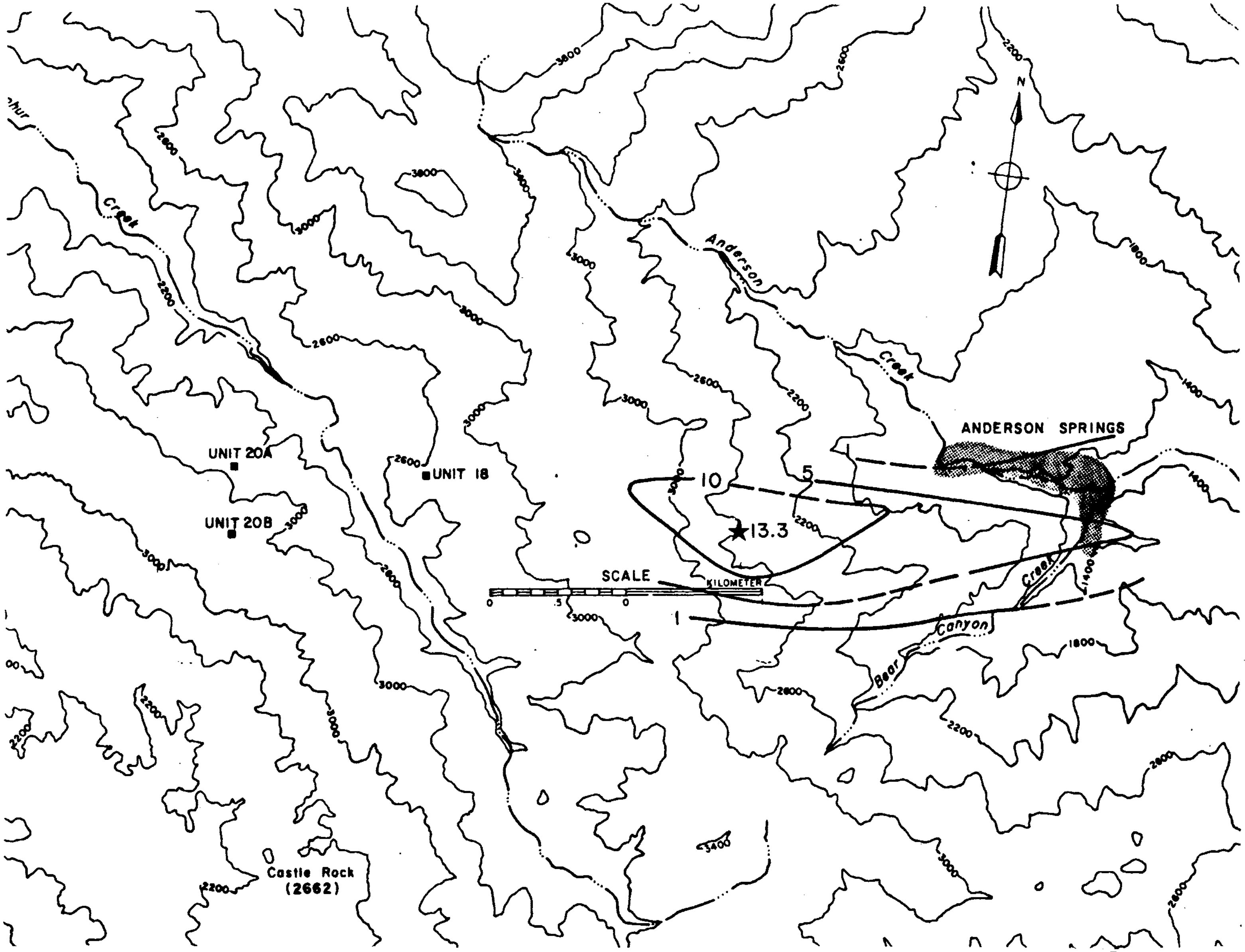


Figure 5-15b. Ground-Level Isopleths of Nondimensional Concentration K x 10^5 Measured Downwind of Unit 20B for u_∞ = 10.0 m/s

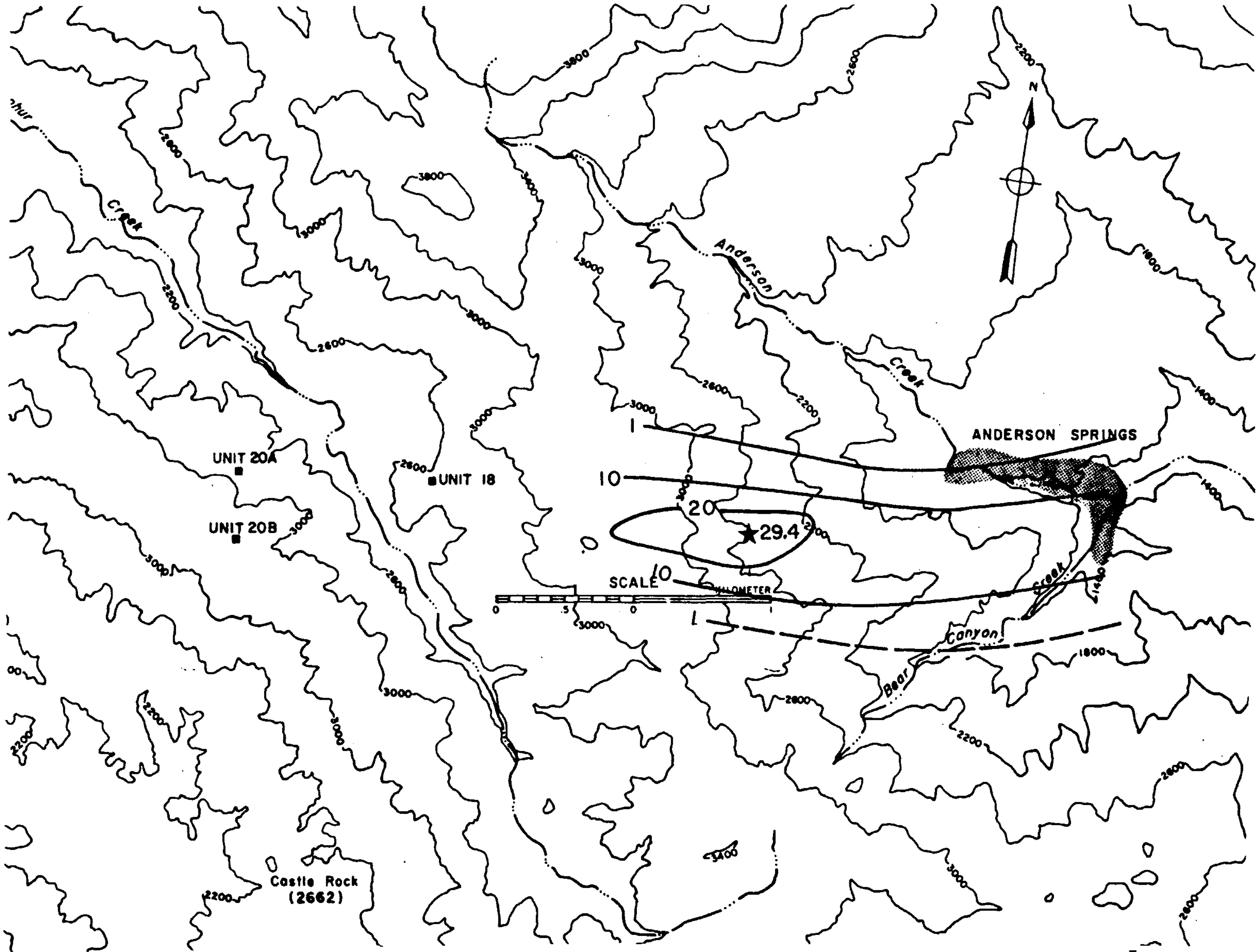


Figure 5-15c. Ground-Level Isopleths of Nondimensional Concentration K x 10^5 Measured Downwind of Unit 20B for u_∞ = 15.0 m/s

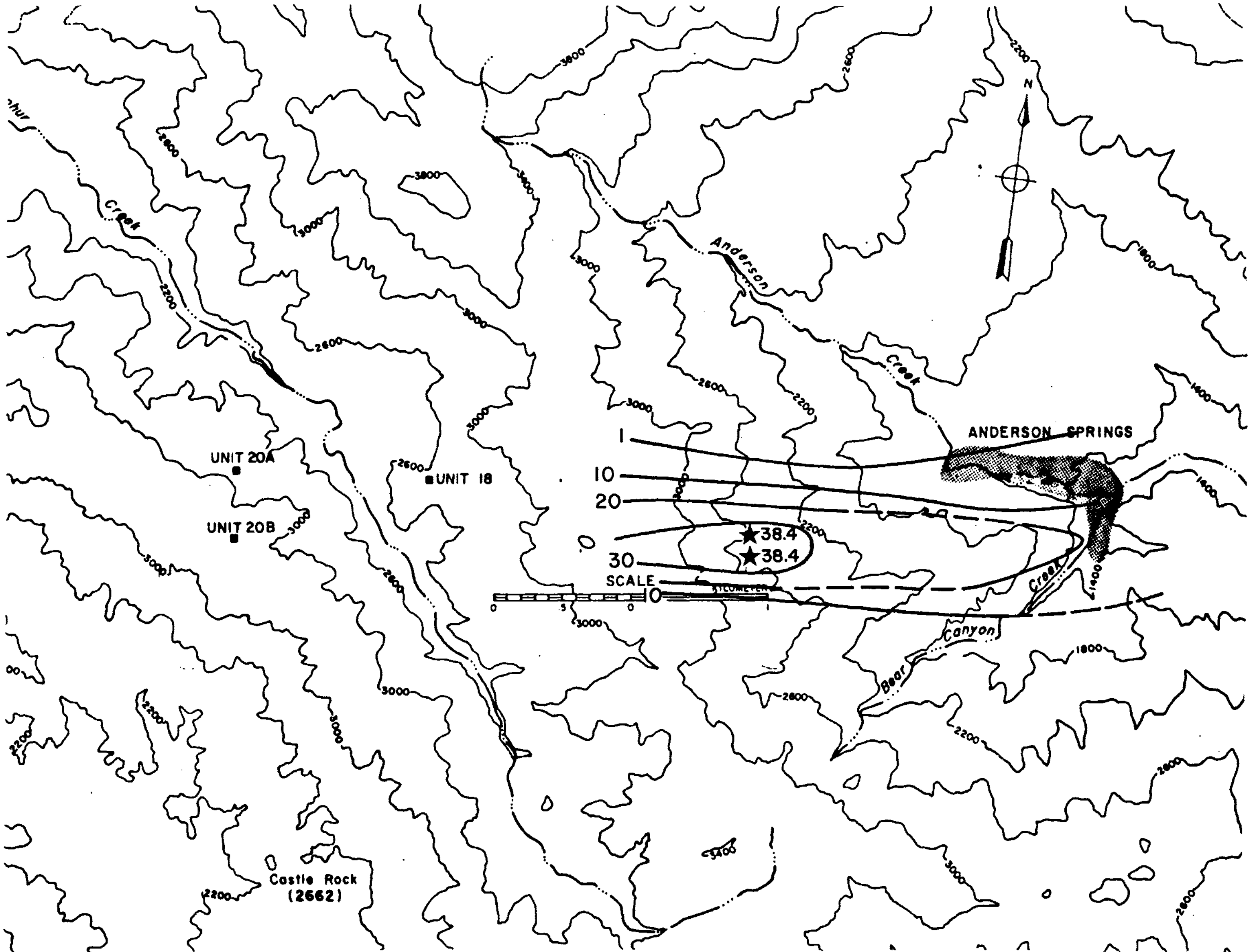


Figure 5-15d. Ground-Level Isopleths of Nondimensional Concentration $K \times 10^5$ Measured Downwind of Unit 20B for u_∞ = 20.0 m/s

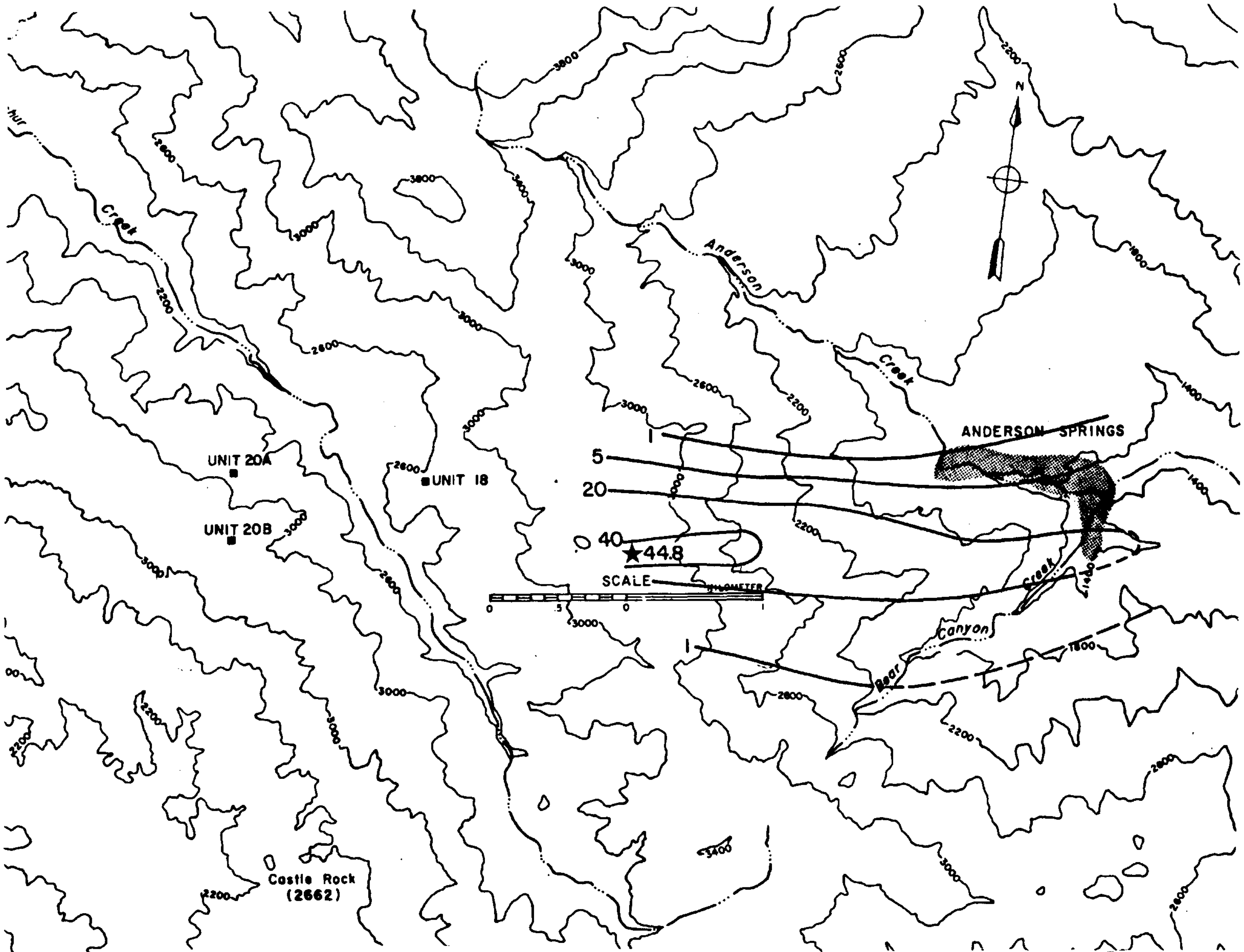


Figure 5-15e. Ground-Level Isopleths of Nondimensional Concentration K x 10^5 Measured Downwind of Unit 20B for u_∞ = 28.0 m/s

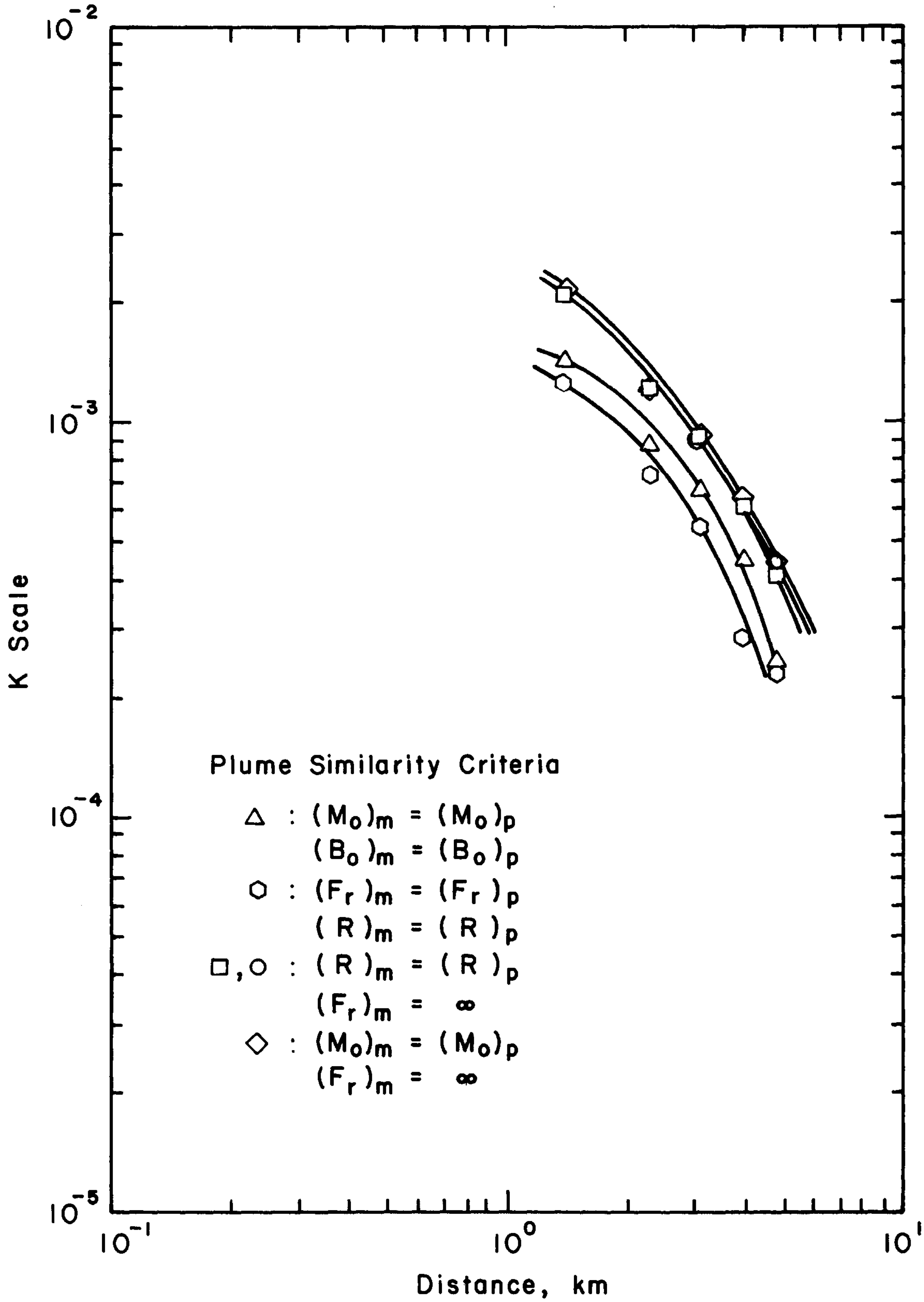


Figure 5-16. Maximum K versus Distance Downwind of Unit 18 Using Five Different Similarity Criteria

APPENDICES

APPENDIX A

Concentration Measurement Data

from Drainage Flow Tests

Run 1 = Unit 20A

Run 2 = Unit 20B

Run 3 = Unit 18

RUN # 1

	MODEL	PROTOTYPE	MODEL	PROTOTYPE	MODEL	PROTOTYPE	MODEL	PROTOTYPE
FREE STREAM VEL.	.08 M/S	1.00 M/S	.08 M/S	1.00 M/S	.08 M/S	1.00 M/S		
EXIT VEL.	.13 M/S	.00 M/S	.13 M/S	.00 M/S	.13 M/S	.00 M/S		
VOL. FLOW	.20E-04M3/S	.10E+01M3/S	.20E-04M3/S	.10E+01M3/S	.20E-04M3/S	.10E+01M3/S		
SOURCE STRENGTH	.10E+06	.10E+01	.10E+06	.10E+01	.10E+06	.10E+01		
BACKGROUND	.93E+03		.41E+04		.19E+03			
CALIBRATION FACTOR	.22E-02		.22E-02		.22E-02			
RANGE	10		10		10			
STACK HEIGHT	1.04 CM	19.97 M	1.04 CM	19.97 M	1.04 CM	19.97 M		
CELL DIAMETER	0.44 CM	8.45 M	0.44 CM	8.45 M	0.44 CM	8.45 M		

SAMPLE PT.	AVE	RAW (AREA)	NORMALIZED CONC	RAW (AREA)	NORMALIZED CONC	RAW (AREA)	NORMALIZED CONC	RAW (AREA)	NORMALIZED CONC
1	.886E-05	5901	.886E-05	*******	********	*******	********		
2	.182E-05	2042	.198E-05	4101	.410E-07	2120	.345E-05		
3	.255E-03	4849	.698E-05	187195	.326E-03	242900	.433E-03		
4	.140E-03	136736	.242E-03	25253	.377E-04	78610	.140E-03		
5	.281E-03	89852	.159E-03	136548	.236E-03	251400	.448E-03		
6	.332E-04	1158	.405E-06	17612	.241E-04	42290	.751E-04		
7	.282E-05	535	.0	7323	.578E-05	1690	.268E-05		
8	.208E-04	562	.0	600	.0	35230	.625E-04		
9	.824E-04	69698	.123E-03	27530	.418E-04	46600	.827E-04		
10	.936E-03	1101908	.196E-02	204357	.357E-03	273810	.488E-03		
11	.116E-02	1133428	.202E-02	209195	.366E-03	611240	.109E-02		
12	.136E-02	758857	.135E-02	979315	.174E-02	553360	.986E-03		
13	.189E-02	980417	.175E-02	1216982	.216E-02	984650	.176E-02		
14	.344E-03	11970	.197E-04	75085	.127E-03	496670	.885E-03		
15	.156E-05	1166	.419E-06	3865	.0	2570	.425E-05		
16	0.	610	.0	*******	********	*******	********		
17	0.	740	.0	*******	********	*******	********		
18	0.	622	.0	*******	********	*******	********		
19	.121E-06	999	.121E-06	*******	********	*******	********		
20	.551E-03	342661	.609E-03	*******	********	276720	.493E-03		
21	.130E-04	8246	.130E-04	*******	********	*******	********		
22	.862E-04	129679	.230E-03	3859	.0	16540	.292E-04		
23	.169E-03	136352	.241E-03	59747	.992E-04	93840	.167E-03		
24	.260E-04	32513	.563E-04	943	.0	12400	.218E-04		
25	.366E-03	496323	.883E-03	8970	.872E-05	115470	.206E-03		
26	.277E-03	194214	.345E-03	118251	.204E-03	159060	.283E-03		
28	.648E-02	3257308	.581E-02	2884226	.513E-02	4763330	.849E-02		
29	.586E-02	3278353	.584E-02	2643530	.471E-02	3941720	.703E-02		
30	.431E-02	1646058	.293E-02	2143020	.381E-02	3470140	.619E-02		
31	.389E-03	158882	.282E-03	220480	.386E-03	281100	.501E-03		
32	.156E-02	459974	.818E-03	1143430	.203E-02	1024200	.183E-02		
33	.139E-04	16013	.269E-04	4560	.859E-06	*******	********		
34	.144E-05	2549	.288E-05	3320	.0	*******	********		
35	0.	751	.0	*******	********	*******	********		
36	0.	719	.0	*******	********	*******	********		
37	0.	839	.0	*******	********	*******	********		
38	0.	887	.0	*******	********	*******	********		
64	0.	688	.0	*******	********	*******	********		
65	0.	562	.0	*******	********	*******	********		
66	0.	662	.0	*******	********	*******	********		
67	0.	752	.0	*******	********	*******	********		
68	0.	800	.0	*******	********	*******	********		
69	.289E-05	2551	.289E-05	*******	********	*******	********		
70	0.	915	.0	*******	********	*******	********		
71	0.	802	.0	*******	********	*******	********		
27	.226E-02	*******	********	1644055	.289E-02	916960	.163E-02		

RUN # 2

	MODEL	PROTOTYPE	MODEL	PROTOTYPE	MODEL	PROTOTYPE	MODEL	PROTOTYPE
FREE STREAM VEL.	.08 M/S	1.00 M/S	.08 M/S	1.00 M/S	.08 M/S	1.00 M/S		
EXIT VEL.	.13 M/S	.00 M/S	.13 M/S	.00 M/S	.13 M/S	.00 M/S		
VOL. FLOW	.20E-04M3/S	.10E+01M3/S	.20E-04M3/S	.10E+01M3/S	.20E-04M3/S	.10E+01M3/S		
SOURCE STRENGTH	.10E+06	.10E+01	.10E+06	.10E+01	.10E+06	.10E+01		
BACKGROUND	.20E+03		.72E+03		.29E+04			
CALIBRATION FACTOR	.22E-02		.22E-02		.22E-02			
RANGE	10		10		10			
STACK HEIGHT	1.04 CM	19.97 M	1.04 CM	19.97 M	1.04 CM	19.97 M		
CELL DIAMETER	0.44 CM	8.45 M	0.44 CM	8.45 M	0.44 CM	8.45 M		

SAMPLE PT.	AVE	RAW (AREA)	NORMALIZED CONC	RAW (AREA)	NORMALIZED CONC	RAW (AREA)	NORMALIZED CONC	RAW (AREA)	NORMALIZED CONC
1	.675E-05	4124	.675E-05	*******	********	*******	********		
2	.364E-05	2316	.364E-05	*******	********	*******	********		
3	.312E-05	2018	.312E-05	*******	********	*******	********		
4	.428E-04	46151	.791E-04	25260	.423E-04	7000	.698E-05		
5	.142E-03	127740	.220E-03	42685	.723E-04	80910	.134E-03		
6	.365E-04	20870	.356E-04	8290	.130E-04	38380	.610E-04		
7	.842E-05	5092	.842E-05	*******	********	*******	********		
8	.326E-05	2095	.326E-05	*******	********	*******	********		
9	.765E-04	44645	.765E-04	*******	********	*******	********		
10	.263E-03	153134	.263E-03	*******	********	*******	********		
11	.244E-03	141770	.244E-03	*******	********	*******	********		
12	.474E-03	250180	.430E-03	152397	.261E-03	427860	.732E-03		
13	.715E-03	490936	.845E-03	224359	.385E-03	534490	.915E-03		
14	.207E-03	80034	.137E-03	80724	.138E-03	203350	.345E-03		
15	.180E-05	1248	.180E-05	*******	********	*******	********		
16	.148E-05	1065	.148E-05	*******	********	*******	********		
17	.164E-05	1158	.164E-05	*******	********	*******	********		
18	.176E-05	1224	.176E-05	*******	********	*******	********		
19	.739E-05	4498	.739E-05	*******	********	*******	********		
20	.216E-03	223166	.384E-03	95688	.164E-03	61730	.101E-03		
21	.143E-04	16648	.283E-04	916	.336E-06	*******	********		
22	.793E-04	92577	.159E-03	45426	.770E-04	3980	.179E-05		
23	.139E-03	80875	.139E-03	*******	********	*******	********		
24	.100E-03	58378	.100E-03	*******	********	*******	********		
25	.123E-03	114335	.197E-03	96671	.165E-03	6490	.610E-05		
26	.141E-03	70169	.120E-03	127904	.219E-03	52130	.847E-04		
27	.116E-02	675233	.116E-02	*******	********	*******	********		
28	.161E-02	937795	.161E-02	*******	********	*******	********		
29	.125E-02	1081096	.186E-02	428556	.737E-03	669530	.115E-02		
30	.159E-02	1134504	.195E-02	1017411	.175E-02	620450	.106E-02		
31	.754E-03	1006122	.173E-02	248070	.426E-03	63230	.104E-03		
32	.125E-02	1321720	.228E-02	339271	.583E-03	517100	.885E-03		
33	.114E-02	1308956	.225E-02	651449	.112E-02	24060	.364E-04		
34	.296E-03	437690	.752E-03	79328	.135E-03	2700	.0		
35	.184E-05	1274	.184E-05	*******	********	*******	********		
36	.289E-06	372	.289E-06	*******	********	*******	********		
37	.429E-06	453	.429E-06	*******	********	*******	********		
38	.150E-05	1073	.150E-05	*******	********	*******	********		
46	.164E-04	9713	.164E-04	*******	********	*******	********		
47	.793E-05	4809	.793E-05	*******	********	*******	********		
48	.634E-05	3888	.634E-05	*******	********	*******	********		
49	.149E-05	1069	.149E-05	*******	********	*******	********		
50	.343E-03	10263	.173E-04	525820	.904E-03	66160	.109E-03		
51	.327E-03	22451	.383E-04	491992	.846E-03	58710	.960E-04		
69	.285E-05	1861	.285E-05	*******	********	*******	********		
71	.277E-06	365	.277E-06	*******	********	*******	********		
52	.256E-03	*******	********	298278	.512E-03	2760	.0		
53	.157E-03	*******	********	183318	.314E-03	2640	.0		
54	.253E-06	*******	********	868	.253E-06	*******	********		
56	.628E-04	*******	********	17404	.287E-04	59250	.970E-04		
57	.112E-04	*******	********	13035	.212E-04	3660	.123E-05		
58	.182E-04	*******	********	21890	.365E-04	1470	.0		

RUN # 3

	MODEL	PROTOTYPE	MODEL	PROTOTYPE	MODEL	PROTOTYPE	MODEL	PROTOTYPE
FREE STREAM VEL.	.15 M/S	1.00 M/S	.15 M/S	1.00 M/S	.15 M/S	1.00 M/S		
EXIT VEL.	.13 M/S	.00 M/S	.13 M/S	.00 M/S	.13 M/S	.00 M/S		
VOL. FLOW	.20E-04M3/S	.10E+01M3/S	.20E-04M3/S	.10E+01M3/S	.20E-04M3/S	.10E+01M3/S		
SOURCE STRENGTH	.10E+06	.10E+01	.10E+06	.10E+01	.10E+06	.10E+01		
BACKGROUND	.12E+03		.25E+04		.45E+04			
CALIBRATION FACTOR	.22E-02		.22E-02		.22E-02			
RANGE	10		10		10			
STACK HEIGHT	1.04 CM	19.97 M	1.04 CM	19.97 M	1.04 CM	19.97 M		
CELL DIAMETER	0.44 CM	8.45 M	0.44 CM	8.45 M	0.44 CM	8.45 M		

SAMPLE PT.	AVE	RAW (AREA)	NORMALIZED CONC	RAW (AREA)	NORMALIZED CONC	RAW (AREA)	NORMALIZED CONC	RAW (AREA)	NORMALIZED CONC
1	.130E-05	510	.130E-05	*******	********	*******	********		
2	.860E-06	377	.860E-06	*******	********	*******	********		
3	.633E-07	138	.633E-07	*******	********	*******	********		
4	.134E-05	200	.270E-06	2669	.510E-06	5511	.325E-05		
5	.199E-03	34335	.114E-03	75983	.245E-03	76374	.239E-03		
6	.765E-03	215318	.717E-03	248764	.821E-03	231622	.757E-03		
7	.817E-04	37989	.126E-03	29575	.902E-04	13164	.288E-04		
8	.344E-04	2113	.664E-05	17512	.500E-04	18495	.465E-04		
9	.106E-03	20759	.680E-04	45755	.144E-03	36286	.106E-03		
10	.443E-03	148	.966E-07	217169	.715E-03	188435	.613E-03		
11	.267E-07	127	.267E-07	*******	********	*******	********		
12	.933E-07	147	.933E-07	*******	********	*******	********		
13	.802E-05	287	.560E-06	7578	.169E-04	6522	.662E-05		
14	.928E-04	47772	.159E-03	24609	.736E-04	18297	.459E-04		
15	.116E-02	221096	.736E-03	469749	.156E-02	364365	.120E-02		
16	.744E-03	177762	.592E-03	255977	.845E-03	242845	.794E-03		
17	.104E-03	18863	.625E-04	43819	.138E-03	37878	.111E-03		
18	.261E-04	23598	.782E-04	1676	.0	2421	.0		
19	.646E-04	7486	.245E-04	31766	.975E-04	26113	.719E-04		
27	.344E-05	836	.239E-05	137	.0	6912	.792E-05		
28	.513E-06	273	.513E-06	*******	********	*******	********		
29	.357E-06	226	.357E-06	*******	********	*******	********		
30	.457E-06	256	.457E-06	*******	********	*******	********		
32	.410E-06	242	.410E-06	*******	********	*******	********		
33	.370E-06	230	.370E-06	*******	********	*******	********		
34	.117E-06	154	.117E-06	*******	********	*******	********		
35	.220E-06	185	.220E-06	*******	********	*******	********		
36	.653E-06	315	.653E-06	*******	********	*******	********		
37	.176E-05	647	.176E-05	*******	********	*******	********		
38	.112E-05	454	.112E-05	*******	********	*******	********		
61	.235E-03	70560	.235E-03	*******	********	*******	********		
62	.237E-02	712423	.237E-02	*******	********	*******	********		
63	.707E-04	21346	.707E-04	*******	********	*******	********		
64	.197E-03	59118	.197E-03	*******	********	*******	********		
65	.225E-03	67704	.225E-03	*******	********	*******	********		
66	.109E-02	328329	.109E-02	*******	********	*******	********		
67	.131E-04	4038	.131E-04	*******	********	*******	********		
68	.450E-06	254	.450E-06	*******	********	*******	********		
69	.160E-06	167	.160E-06	*******	********	*******	********		
70	.143E-06	162	.143E-06	*******	********	*******	********		
71	.119E-05	475	.119E-05	*******	********	*******	********		
72	.177E-06	172	.177E-06	*******	********	*******	********		
73	.357E-06	226	.357E-06	*******	********	*******	********		
21	.561E-03	*******	********	182709	.600E-03	161273	.522E-03		
22	.175E-02	*******	********	655276	.218E-02	400633	.132E-02		
23	.116E-03	*******	********	45987	.145E-03	30446	.863E-04		
24	.242E-03	*******	********	72243	.232E-03	80293	.252E-03		
25	.496E-02	*******	********	1600707	.533E-02	1383701	.460E-02		
26	.114E-02	*******	********	406883	.135E-02	286409	.939E-03		

APPENDIX B

Concentration Measurement Data

for Neutral Flow Tests

UNIT 20A

Ground Concentration Measurement

Runs 1, 2, 3, 4 & 5

Vertical Concentration Measurement

Runs 11, 12 & 13

RUN # 1

	MODEL	PROTOTYPE
FREE STREAM VEL.	2.88 M/S	27.56 M/S
EXIT VEL.	1.71 M/S	7.60 M/S
VOL. FLOW	.26E-03M3/S	.43E+04M3/S
SOURCE STRENGTH	.69E+05	.10E+01
BACKGROUND	.21E+04	
CALIBRATION FACTOR	.19E-02	
RANGE	10	
STACK HEIGHT	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M

SAMPLE PT.	RAW (AREA)	NORMALIZED CONCENTRATION
1	3561	.874E-05
2	22837	.122E-03
3	57449	.325E-03
4	71064	.404E-03
5	63315	.359E-03
6	102796	.590E-03
7	75709	.432E-03
8	5912	.225E-04
9	2392	.189E-05
14	5675	.211E-04
15	83432	.477E-03
16	86113	.493E-03
17	84976	.486E-03
18	68859	.392E-03
19	39161	.217E-03
20	29007	.158E-03
21	22908	.122E-03
22	2016	.0
103	2795	.425E-05
101	19250	.101E-03
98	23588	.126E-03
97	70523	.401E-03
96	54866	.309E-03
95	13183	.651E-04
94	21442	.114E-03
93	12252	.597E-04
92	8882	.399E-04
110	33636	.185E-03
111	58947	.333E-03
112	48127	.270E-03
113	42455	.237E-03
114	30760	.168E-03
115	16691	.857E-04
116	13824	.689E-04
117	8179	.358E-04
119	13032	.643E-04
30	35079	.193E-03
31	43242	.241E-03
32	47053	.264E-03
33	38326	.213E-03
34	27793	.151E-03
36	14537	.731E-04
37	4340	.133E-04
38	2729	.386E-05
39	2188	.692E-06

RUN # 2

	MODEL	PROTOTYPE
FREE STREAM VEL.	.79 M/S	7.50 M/S
EXIT VEL.	1.71 M/S	7.60 M/S
VOL. FLOW	.26E-03M3/S	.43E+04M3/S
SOURCE STRENGTH	.69E+05	.10E+01
BACKGROUND	.11E+04	
CALIBRATION FACTOR	.19E-02	
RANGE	10	
STACK HEIGHT	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M

SAMPLE PT.	RAW (AREA)	NORMALIZED CONCENTRATION
1	1269	.276E-06
2	4189	.502E-05
3	9502	.136E-04
4	11508	.169E-04
5	17691	.269E-04
6	54902	.874E-04
7	84444	.135E-03
8	15537	.234E-04
9	2244	.186E-05
14	1874	.126E-05
15	16417	.249E-04
16	22682	.350E-04
17	36805	.580E-04
18	53946	.858E-04
19	58055	.925E-04
20	56697	.903E-04
21	41742	.660E-04
22	5679	.744E-05
103	1212	.183E-06
101	3306	.358E-05
98	9904	.143E-04
97	34505	.542E-04
96	50649	.805E-04
95	16237	.246E-04
94	37179	.586E-04
93	16378	.248E-04
92	10770	.157E-04
110	6271	.840E-05
111	14314	.215E-04
112	19431	.298E-04
113	26676	.415E-04
114	39135	.618E-04
115	24943	.387E-04
116	16475	.250E-04
117	9522	.137E-04
118	3353	.366E-05
119	3043	.316E-05
30	7645	.106E-04
31	11403	.167E-04
32	14497	.218E-04
33	25514	.396E-04
34	34044	.535E-04
35	1310	.343E-06
36	15258	.230E-04
37	5548	.722E-05
38	2464	.222E-05
39	1674	.934E-06

RUN # 3

	MODEL	PROTOTYPE
FREE STREAM VEL.	1.05 M/S	10.00 M/S
EXIT VEL.	1.71 M/S	7.60 M/S
VOL. FLOW	.26E-03M3/S	.43E+04M3/S
SOURCE STRENGTH	.69E+05	.10E+01
BACKGROUND	.39E+03	
CALIBRATION FACTOR	.19E-02	
RANGE	10	
STACK HEIGHT	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M

SAMPLE PT.	RAW (AREA)	NORMALIZED CONCENTRATION
1	207	.0
2	4767	.944E-05
3	13988	.293E-04
4	15392	.324E-04
5	25114	.534E-04
6	79793	.171E-03
7	83021	.178E-03
8	21705	.460E-04
9	2215	.394E-05
15	30540	.651E-04
16	40535	.866E-04
17	64447	.138E-03
18	63915	.137E-03
19	41197	.881E-04
20	33361	.712E-04
21	26492	.563E-04
22	3332	.635E-05
99	34272	.731E-04
98	13638	.286E-04
97	53670	.115E-03
96	49999	.107E-03
95	15776	.332E-04
94	3859	.748E-05
93	10217	.212E-04
92	5994	.121E-04
110	8533	.176E-04
111	24680	.524E-04
112	30484	.649E-04
113	37526	.801E-04
114	27000	.574E-04
115	14106	.296E-04
116	6370	.129E-04
117	1904	.327E-05
118	478	.188E-06
119	376	.0
30	10158	.211E-04
31	14517	.305E-04
32	21432	.454E-04
33	27908	.594E-04
34	22255	.472E-04
36	3394	.648E-05
37	1066	.146E-05
38	1115	.156E-05
39	373	.0

RUN # 4

	MODEL	PROTOTYPE
FREE STREAM VEL.	1.57 M/S	15.00 M/S
EXIT VEL.	1.71 M/S	7.60 M/S
VOL. FLOW	.26E-03M3/S	.43E+04M3/S
SOURCE STRENGTH	.69E+05	.10E+01
BACKGROUND	.85E+03	
CALIBRATION FACTOR	.19E-02	
RANGE	10	
STACK HEIGHT	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M

SAMPLE PT.	RAW (AREA)	NORMALIZED CONCENTRATION
1	1743	.289E-05
2	11250	.336E-04
3	34287	.108E-03
4	39252	.124E-03
5	56868	.181E-03
6	147910	.475E-03
7	116063	.372E-03
8	29807	.935E-04
9	1626	.252E-05
14	4398	.115E-04
15	73637	.235E-03
16	88321	.282E-03
17	111441	.357E-03
18	100297	.321E-03
19	57852	.184E-03
20	42093	.133E-03
21	32521	.102E-03
22	2915	.668E-05
103	1748	.291E-05
101	10675	.317E-04
98	25222	.787E-04
97	89509	.286E-03
96	71672	.229E-03
95	17787	.547E-04
94	28215	.883E-04
93	14195	.431E-04
92	7580	.217E-04
109	9804	.289E-04
110	24723	.771E-04
111	54328	.173E-03
112	52040	.165E-03
113	52805	.168E-03
114	35534	.112E-03
115	19824	.612E-04
116	10618	.315E-04
117	3743	.935E-05
118	1010	.529E-06
30	26593	.831E-04
31	35366	.111E-03
32	44842	.142E-03
33	45044	.143E-03
34	32916	.103E-03
36	8232	.238E-04
37	1716	.281E-05
38	1274	.138E-05
39	884	.123E-06

RUN # 5

	MODEL	PROTOTYPE	MODEL	PROTOTYPE	MODEL	PROTOTYPE
FREE STREAM VEL.	2.09 M/S	20.00 M/S	2.09 M/S	20.00 M/S	2.09 M/S	20.00 M/S
EXIT VEL.	1.71 M/S	7.60 M/S	1.71 M/S	7.60 M/S	1.71 M/S	7.60 M/S
VOL. FLOW	.26E-03M3/S	.43E+04M3/S	.26E-03M3/S	.43E+04M3/S	.26E-03M3/S	.43E+04M3/S
SOURCE STRENGTH	.69E+05	.10E+01	.69E+05	.10E+01	.69E+05	.10E+01
BACKGROUND	.11E+04		.19E+04		.91E+03	
CALIBRATION FACTOR	.19E-02		.19E-02		.19E-02	
RANGE	10		10		10	
STACK HEIGHT	1.04 CM	19.97 M	1.04 CM	19.97 M	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M	0.44 CM	8.45 M	0.44 CM	8.45 M

SAMPLE PT.	AVE	RAW (AREA)	NORMALIZED CONC	RAW (AREA)	NORMALIZED CONC	RAW (AREA)	NORMALIZED CONC
1	.576E-05	2481	.575E-05	3228	.562E-05	2281	.592E-05
2	.836E-04	19850	.804E-04	21296	.826E-04	21299	.878E-04
3	.241E-03	58401	.246E-03	56361	.232E-03	57442	.244E-03
4	.299E-03	72310	.306E-03	69744	.289E-03	71026	.302E-03
5	.334E-03	79741	.338E-03	79831	.332E-03	77885	.332E-03
6	.562E-03	130503	.556E-03	138820	.584E-03	127517	.545E-03
7	.428E-03	101268	.430E-03	108096	.453E-03	94347	.403E-03
8	.304E-04	5402	.183E-04	14089	.519E-04	5810	.211E-04
9	.705E-06	1271	.554E-06	2226	.135E-05	956	.213E-06
14	.216E-04	6103	.213E-04	5915	.171E-04	7014	.263E-04
15	.411E-03	98059	.416E-03	95412	.399E-03	98054	.419E-03
16	.441E-03	104518	.444E-03	103135	.431E-03	104453	.446E-03
17	.455E-03	107256	.456E-03	111166	.466E-03	104109	.445E-03
18	.375E-03	87740	.372E-03	94257	.394E-03	84292	.359E-03
19	.204E-03	48035	.201E-03	54725	.225E-03	43674	.184E-03
20	.143E-03	33747	.140E-03	40860	.166E-03	29728	.124E-03
21	.111E-03	27851	.115E-03	31886	.128E-03	22202	.917E-04
22	.925E-05	3553	.104E-04	4346	.104E-04	2536	.702E-05
103	.382E-05	2063	.396E-05	2728	.349E-05	1839	.402E-05
101	.736E-04	18446	.742E-04	17567	.667E-04	19402	.797E-04
98	.115E-03	30334	.125E-03	27729	.110E-03	26461	.110E-03
97	.369E-03	87160	.370E-03	91678	.383E-03	83114	.354E-03
96	.280E-03	67756	.286E-03	71711	.298E-03	60404	.256E-03
94	.101E-03	25143	.103E-03	29876	.119E-03	19711	.810E-04
93	.477E-04	13283	.522E-04	13387	.489E-04	10637	.419E-04
92	.277E-04	7598	.277E-04	9488	.323E-04	6294	.232E-04
109	.456E-04	14066	.555E-04	9630	.329E-04	12127	.483E-04
110	.152E-03	37273	.155E-03	35115	.142E-03	38042	.160E-03
111	.292E-03	68741	.290E-03	69983	.290E-03	69593	.296E-03
112	.243E-03	56911	.240E-03	61724	.255E-03	55062	.233E-03
113	.218E-03	54128	.228E-03	56580	.233E-03	45897	.194E-03
114	.148E-03	36179	.151E-03	40663	.165E-03	30630	.128E-03
115	.786E-04	19900	.806E-04	23166	.906E-04	15873	.645E-04
116	.514E-04	14464	.572E-04	16340	.615E-04	9159	.356E-04
117	.204E-04	6798	.243E-04	7856	.253E-04	3555	.114E-04
30	.154E-03	37690	.157E-03	36159	.146E-03	37965	.160E-03
31	.196E-03	47493	.199E-03	46877	.192E-03	46335	.196E-03
32	.226E-03	53851	.226E-03	55065	.227E-03	53251	.225E-03
33	.188E-03	45573	.191E-03	48995	.201E-03	41136	.173E-03
34	.134E-03	33168	.138E-03	36413	.147E-03	27999	.117E-03
36	.483E-04	14501	.574E-04	15234	.560E-04	8056	.308E-04
37	.511E-05	2300	.497E-05	3404	.637E-05	1835	.400E-05
38	.174E-05	1329	.803E-06	2342	.184E-05	1505	.258E-05
39	.507E-06	1195	.228E-06	2051	.601E-06	1067	.691E-06

RUN # 11

	MODEL	PROTOTYPE
FREE STREAM VEL.	2.09 M/S	20.00 M/S
EXIT VEL.	1.71 M/S	7.60 M/S
VOL. FLOW	.26E-03M3/S	.43E+04M3/S
SOURCE STRENGTH	.69E+05	.10E+01
BACKGROUND	.61E+03	
CALIBRATION FACTOR	.19E-02	
RANGE	10	
STACK HEIGHT	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M

SAMPLE PT.	RAW (AREA)	NORMALIZED CONCENTRATION
1	161804	.699E-03
4	120456	.520E-03
7	69172	.298E-03
8	56457	.242E-03
12	14392	.598E-04
15	2289	.731E-05
18	1053	.194E-05
21	818	.922E-06

RUN # 12

	MODEL	PROTOTYPE
FREE STREAM VEL.	2.09 M/S	20.00 M/S
EXIT VEL.	1.71 M/S	7.60 M/S
VOL. FLOW	.26E-03M3/S	.43E+04M3/S
SOURCE STRENGTH	.69E+05	.10E+01
BACKGROUND	.18E+04	
CALIBRATION FACTOR	.19E-02	
RANGE	10	
STACK HEIGHT	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M

SAMPLE PT.	RAW (AREA)	NORMALIZED CONCENTRATION
1	88139	.375E-03
4	88136	.375E-03
7	84134	.357E-03
8	80527	.342E-03
12	60386	.254E-03
15	23426	.939E-04
18	22391	.894E-04
21	13593	.512E-04
25	6145	.188E-04
30	2261	.197E-05

RUN # 13

	MODEL	PROTOTYPE
FREE STREAM VEL.	2.09 M/S	20.00 M/S
EXIT VEL.	1.71 M/S	7.60 M/S
VOL. FLOW	.26E-03M3/S	.43E+04M3/S
SOURCE STRENGTH	.69E+05	.10E+01
BACKGROUND	.37E+04	
CALIBRATION FACTOR	.19E-02	
RANGE	10	
STACK HEIGHT	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M

SAMPLE PT.	RAW (AREA)	NORMALIZED CONCENTRATION
1	61777	.252E-03
3	60667	.247E-03
4	59958	.244E-03
8	57812	.235E-03
12	53597	.217E-03
18	31988	.123E-03
25	17220	.586E-04
30	7645	.170E-04
35	3479	.0
39	4015	.125E-05
52	3492	.0

UNIT 20B

Ground Concentration Measurement

Runs 6, 7, 8, 9 & 10

Vertical Concentration Measurement

Runs 14, 15 & 16

Run # 6

	MODEL	PROTOTYPE
FREE STREAM VEL.	2.88 M/S	27.56 M/S
EXIT VEL.	1.71 M/S	7.60 M/S
VOL. FLOW	.26E-03M3/S	.43E+04M3/S
SOURCE STRENGTH	.44E+05	.10E+01
BACKGROUND	.13E+04	
CALIBRATION FACTOR	.13E-02	
RANGE	10	
STACK HEIGHT	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M

SAMPLE PT.	RAW (AREA)	NORMALIZED CONCENTRATION
1	3458	.135E-04
2	23687	.140E-03
3	58380	.357E-03
4	72926	.448E-03
5	50635	.309E-03
6	33960	.204E-03
7	10347	.566E-04
8	3848	.160E-04
9	1297	.0
14	5823	.283E-04
15	71603	.440E-03
16	67304	.413E-03
17	46661	.284E-03
18	25536	.152E-03
19	8391	.444E-04
20	3286	.124E-04
21	2047	.469E-05
22	965	.0
103	2784	.930E-05
101	20159	.118E-03
98	19043	.111E-03
97	38433	.232E-03
96	19432	.113E-03
95	3577	.143E-04
94	2867	.982E-05
93	2183	.554E-05
92	1640	.214E-05
109	13789	.781E-04
110	33185	.199E-03
111	50342	.307E-03
112	31199	.187E-03
113	17546	.102E-03
114	9373	.505E-04
115	3623	.145E-04
116	2519	.764E-05
117	1840	.340E-05
118	2340	.652E-05
30	33037	.198E-03
31	37409	.226E-03
32	37176	.224E-03
33	20056	.117E-03
34	9521	.514E-04
36	3436	.134E-04
37	1651	.221E-05
38	2393	.685E-05
39	1522	.141E-05

Run # 7

	MODEL	PROTOTYPE
FREE STREAM VEL.	.79 M/S	7.50 M/S
EXIT VEL.	1.71 M/S	7.60 M/S
VOL. FLOW	.26E-03M3/S	.43E+04M3/S
SOURCE STRENGTH	.44E+05	.10E+01
BACKGROUND	.82E+03	
CALIBRATION FACTOR	.13E-02	
RANGE	10	
STACK HEIGHT	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M

SAMPLE PT.	RAW (AREA)	NORMALIZED CONCENTRATION
1	1017	.333E-06
2	7160	.109E-04
3	22151	.367E-04
4	18758	.308E-04
5	26073	.434E-04
6	22595	.374E-04
7	3477	.456E-05
8	2173	.232E-05
9	770	.0
14	3267	.420E-05
15	37001	.622E-04
16	46546	.786E-04
17	34407	.577E-04
18	14042	.227E-04
19	2962	.368E-05
20	1191	.633E-06
21	920	.167E-06
22	121	.0
103	870	.808E-07
101	4092	.562E-05
98	11080	.176E-04
97	21706	.359E-04
96	7405	.113E-04
95	1909	.187E-05
94	1202	.651E-06
92	1104	.483E-06
109	3323	.430E-05
110	10479	.166E-04
111	25543	.425E-04
112	16112	.263E-04
113	1398	.988E-06
114	2930	.362E-05
115	1257	.746E-06
116	919	.165E-06
117	861	.653E-07
118	833	.172E-07
30	11239	.179E-04
31	13904	.225E-04
32	17018	.278E-04
33	10363	.164E-04
34	3152	.400E-05
35	1758	.161E-05
36	980	.270E-06
37	946	.211E-06
38	1261	.753E-06
39	855	.550E-07

Run # 8

	MODEL	PROTOTYPE
FREE STREAM VEL.	1.05 M/S	10.00 M/S
EXIT VEL.	1.71 M/S	7.60 M/S
VOL. FLOW	.26E-03M3/S	.43E+04M3/S
SOURCE STRENGTH	.44E+05	.10E+01
BACKGROUND	.14E+04	
CALIBRATION FACTOR	.13E-02	
RANGE	10	
STACK HEIGHT	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M

SAMPLE PT.	RAW (AREA)	NORMALIZED CONCENTRATION
1	1545	.440E-06
2	9213	.179E-04
3	28435	.617E-04
4	28970	.630E-04
5	37439	.823E-04
6	44683	.988E-04
7	9084	.176E-04
8	2283	.212E-05
9	1344	.0
14	4067	.619E-05
15	47637	.106E-03
16	60551	.135E-03
17	59857	.133E-03
18	33999	.744E-04
19	11365	.228E-04
20	3996	.603E-05
21	2177	.188E-05
22	1079	.0
103	1377	.570E-07
101	6159	.110E-04
98	17995	.379E-04
97	50638	.112E-03
96	24468	.527E-04
95	3206	.423E-05
94	3969	.597E-05
93	1918	.129E-05
92	1571	.499E-06
109	4877	.804E-05
110	14027	.289E-04
111	32599	.712E-04
112	33065	.723E-04
113	27186	.589E-04
114	9090	.176E-04
115	3920	.585E-05
116	3573	.506E-05
117	2093	.169E-05
118	1453	.230E-06
30	16237	.339E-04
31	21377	.456E-04
32	25592	.553E-04
33	18943	.401E-04
34	9250	.180E-04
36	4745	.773E-05
37	1977	.142E-05
38	1518	.378E-06
39	1461	.248E-06

RUN # 9

	MODEL	PROTOTYPE	MODEL	PROTOTYPE	MODEL	PROTOTYPE
FREE STREAM VEL.	1.57 M/S	15.00 M/S	1.57 M/S	15.00 M/S	1.57 M/S	15.00 M/S
EXIT VEL.	1.71 M/S	7.60 M/S	1.71 M/S	7.60 M/S	1.71 M/S	7.60 M/S
VOL. FLOW	.26E-03M3/S	.43E+04M3/S	.26E-03M3/S	.43E+04M3/S	.26E-03M3/S	.43E+04M3/S
SOURCE STRENGTH	.44E+05	.10E+01	.44E+05	.10E+01	.44E+05	.10E+01
BACKGROUND	.15E+04		.12E+04		.14E+04	
CALIBRATION FACTOR	.13E-02		.13E-02		.13E-02	
RANGE	10		10		10	
STACK HEIGHT	1.04 CM	19.97 M	1.04 CM	19.97 M	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M	0.44 CM	8.45 M	0.44 CM	8.45 M

SAMPLE PT.	AVE	RAW (AREA)	NORMALIZED CONC	RAW (AREA)	NORMALIZED CONC	RAW (AREA)	NORMALIZED CONC
1	.304E-05	2168	.221E-05	2354	.397E-05	2232	.293E-05
2	.517E-04	15538	.478E-04	17852	.569E-04	16134	.504E-04
3	.161E-03	45140	.149E-03	50726	.169E-03	49753	.165E-03
4	.127E-03	52082	.172E-03	5934	.162E-04	57339	.191E-03
5	.202E-03	60741	.202E-03	60119	.201E-03	60734	.203E-03
6	.160E-03	52914	.175E-03	44578	.148E-03	47206	.157E-03
7	.418E-04	15134	.464E-04	12272	.378E-04	13445	.412E-04
8	.539E-05	2164	.219E-05	3838	.904E-05	2821	.494E-05
9	.185E-05	2415	.305E-05	1892	.239E-05	1406	.111E-06
14	.164E-04	5466	.134E-04	6443	.179E-04	6603	.179E-04
15	.277E-03	79861	.267E-03	83832	.282E-03	83615	.281E-03
16	.294E-03	88329	.296E-03	86153	.290E-03	88367	.297E-03
17	.226E-03	72863	.243E-03	64650	.217E-03	64989	.217E-03
18	.126E-03	44497	.146E-03	34957	.115E-03	35789	.118E-03
19	.386E-04	14929	.457E-04	10725	.326E-04	12366	.375E-04
20	.121E-04	5544	.137E-04	4224	.104E-04	4958	.122E-04
21	.384E-05	2877	.462E-05	2221	.351E-05	2362	.338E-05
22	0.	1100	.0	855	.0	1076	.0
103	.201E-05	1924	.137E-05	1968	.265E-05	*******	********
101	.440E-04	13537	.410E-04	15565	.491E-04	13682	.420E-04
98	.677E-04	23163	.738E-04	20154	.648E-04	20311	.647E-04
97	.176E-03	59234	.197E-03	48626	.162E-03	50859	.169E-03
96	.865E-04	31668	.103E-03	23750	.771E-04	24696	.797E-04
94	.675E-05	4246	.929E-05	2633	.492E-05	3144	.605E-05
93	.244E-05	2258	.251E-05	2011	.280E-05	1963	.201E-05
92	.119E-05	1868	.118E-05	1621	.146E-05	1647	.934E-06
109	.262E-04	8749	.246E-04	11554	.354E-04	6779	.185E-04
110	.989E-04	27865	.898E-04	33513	.110E-03	29627	.965E-04
111	.194E-03	57044	.189E-03	59037	.198E-03	58157	.194E-03
112	.134E-03	44203	.145E-03	38471	.127E-03	38950	.129E-03
113	.114E-03	43689	.144E-03	38499	.127E-03	22152	.710E-04
114	.332E-04	13681	.415E-04	9339	.278E-04	10285	.304E-04
115	.869E-05	5541	.137E-04	4077	.985E-05	2105	.250E-05
116	.536E-05	3808	.780E-05	2296	.377E-05	2691	.450E-05
117	.171E-05	2268	.255E-05	1553	.123E-05	1768	.135E-05
118	.216E-06	1626	.358E-06	1275	.282E-06	1376	.854E-08
30	.977E-04	27395	.882E-04	32599	.107E-03	29965	.977E-04
31	.123E-03	36154	.118E-03	38990	.129E-03	36862	.121E-03
32	.139E-03	41515	.136E-03	42282	.140E-03	42106	.139E-03
33	.145E-03	82615	.276E-03	23972	.778E-04	24865	.802E-04
34	.361E-04	14655	.448E-04	10078	.304E-04	11126	.333E-04
36	.818E-05	5174	.125E-04	2584	.475E-05	3522	.734E-05
37	.896E-06	1883	.123E-05	1451	.883E-06	1541	.572E-06
38	.892E-06	1667	.498E-06	1667	.162E-05	1537	.559E-06
39	.970E-06	1580	.201E-06	1728	.183E-05	1631	.880E-06

RUN # 10

	MODEL	PROTOTYPE
FREE STREAM VEL.	2.09 M/S	20.00 M/S
EXIT VEL.	1.71 M/S	7.60 M/S
VOL. FLOW	.26E-03M3/S	.43E+04M3/S
SOURCE STRENGTH	.44E+05	.10E+01
BACKGROUND	.13E+04	
CALIBRATION FACTOR	.13E-02	
RANGE	10	
STACK HEIGHT	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M

SAMPLE PT.	RAW (AREA)	NORMALIZED CONCENTRATION
1	2860	.702E-05
2	22416	.958E-04
3	60132	.267E-03
4	76154	.340E-03
5	63883	.284E-03
6	41628	.183E-03
7	10720	.427E-04
8	2848	.697E-05
9	1417	.472E-06
14	6177	.221E-04
15	85990	.384E-03
16	85980	.384E-03
17	60899	.270E-03
18	33103	.144E-03
19	10541	.419E-04
20	3491	.988E-05
21	2034	.327E-05
22	887	.0
103	2873	.708E-05
101	18567	.783E-04
98	22639	.968E-04
97	49639	.219E-03
96	25570	.110E-03
95	3903	.118E-04
94	2951	.743E-05
93	1827	.233E-05
92	1541	.103E-05
109	13452	.551E-04
110	34694	.151E-03
111	60204	.267E-03
112	39301	.172E-03
113	23800	.102E-03
114	11132	.446E-04
115	3879	.116E-04
116	2585	.577E-05
117	1776	.210E-05
118	1439	.572E-06
30	34870	.152E-03
31	41964	.184E-03
32	44083	.194E-03
33	24982	.107E-03
34	11542	.464E-04
36	3644	.106E-04
37	1554	.109E-05
38	1441	.581E-06
39	1400	.395E-06

Run # 14

	MODEL	PROTOTYPE
FREE STREAM VEL.	1.57 M/S	15.00 M/S
EXIT VEL.	1.71 M/S	7.60 M/S
VOL. FLOW	.26E-03M3/S	.43E+04M3/S
SOURCE STRENGTH	.44E+05	.10E+01
BACKGROUND	.26E+04	
CALIBRATION FACTOR	.13E-02	
RANGE	10	
STACK HEIGHT	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M

SAMPLE PT.	RAW (AREA)	NORMALIZED CONCENTRATION
1	42900	.140E-03
3	116423	.394E-03
4	140508	.478E-03
6	89575	.301E-03
7	145060	.494E-03
8	138033	.469E-03
12	83268	.279E-03
15	21281	.647E-04
18	12758	.352E-04
21	5180	.894E-05
25	3288	.238E-05

Run # 15

	MODEL	PROTOTYPE
FREE STREAM VEL.	1.57 M/S	15.00 M/S
EXIT VEL.	1.71 M/S	7.60 M/S
VOL. FLOW	.26E-03M3/S	.43E+04M3/S
SOURCE STRENGTH	.44E+05	.10E+01
BACKGROUND	.23E+04	
CALIBRATION FACTOR	.13E-02	
RANGE	10	
STACK HEIGHT	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M

SAMPLE PT.	RAW (AREA)	NORMALIZED CONCENTRATION
1	49272	.164E-03
3	50804	.169E-03
4	56745	.190E-03
7	64288	.216E-03
8	66206	.223E-03
10	56946	.190E-03
12	71634	.241E-03
15	38430	.126E-03
18	52148	.174E-03
21	49651	.165E-03
25	35379	.115E-03
35	13302	.384E-04
39	2775	.181E-05
52	2590	.117E-05

Run # 16

	MODEL	PROTOTYPE
FREE STREAM VEL.	1.57 M/S	15.00 M/S
EXIT VEL.	1.71 M/S	7.60 M/S
VOL. FLOW	.26E-03M3/S	.43E+04M3/S
SOURCE STRENGTH	.44E+05	.10E+01
BACKGROUND	.28E+04	
CALIBRATION FACTOR	.13E-02	
RANGE	10	
STACK HEIGHT	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M

SAMPLE PT.	RAW (AREA)	NORMALIZED CONCENTRATION
1	50471	.164E-03
3	48576	.158E-03
4	43617	.141E-03
8	46899	.152E-03
12	49355	.160E-03
18	44629	.144E-03
21	49355	.160E-03
25	42925	.138E-03
30	24372	.743E-04
35	18830	.552E-04
39	6574	.130E-04
52	2767	.0

UNIT 18

Ground Concentration Measurement

Runs 1, 5, 6, 7, 8, 9 & 10

Vertical Concentration Measurement

Runs 11, 12, 13, 14, 15 & 16

Run # 1

	MODEL	PROTOTYPE
FREE STREAM VEL.	2.88 M/S	27.56 M/S
EXIT VEL.	1.71 M/S	7.60 M/S
VOL. FLOW	.26E-03M3/S	.43E+04M3/S
SOURCE STRENGTH	.44E+05	.10E+01
BACKGROUND	.16E+04	
CALIBRATION FACTOR	.13E-02	
RANGE	10	
STACK HEIGHT	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M

SAMPLE PT.	RAW (AREA)	NORMALIZED CONCENTRATION
1	1668	.378E-06
2	1938	.207E-05
3	7323	.357E-04
4	5344	.234E-04
5	76688	.470E-03
6	330952	.206E-02
7	208679	.129E-02
8	15537	.871E-04
9	1870	.164E-05
14	3976	.148E-04
15	93059	.572E-03
16	123341	.761E-03
17	181631	.113E-02
18	167505	.104E-02
19	74849	.458E-03
20	33792	.201E-03
21	15302	.856E-04
22	702	.0
103	1309	.0
101	4107	.156E-04
98	37809	.226E-03
97	136832	.846E-03
96	103708	.638E-03
95	20262	.117E-03
94	16921	.958E-04
93	7716	.382E-04
92	4501	.181E-04
110	24481	.143E-03
111	75193	.460E-03
112	76856	.471E-03
113	67406	.411E-03
114	41591	.250E-03
115	17308	.982E-04
116	11213	.601E-04
117	5612	.250E-04
119	4241	.165E-04
30	33524	.200E-03
31	49304	.298E-03
32	59728	.363E-03
33	51893	.314E-03
34	36778	.220E-03
36	12841	.702E-04
37	3332	.108E-04
38	3109	.939E-05
39	1699	.572E-06

RUN # 5

	MODEL	PROTOTYPE	MODEL	PROTOTYPE	MODEL	PROTOTYPE
FREE STREAM VEL.	2.09 M/S	20.00 M/S	2.09 M/S	20.00 M/S	2.09 M/S	20.00 M/S
EXIT VEL.	1.71 M/S	7.60 M/S	1.71 M/S	7.60 M/S	1.71 M/S	7.60 M/S
VOL. FLOW	.26E-03M3/S	.43E+04M3/S	.26E-03M3/S	.43E+04M3/S	.26E-03M3/S	.43E+04M3/S
SOURCE STRENGTH	.44E+05	.10E+01	.44E+05	.10E+01	.44E+05	.10E+01
BACKGROUND	.10E+04		.19E+04		.98E+03	
CALIBRATION FACTOR	.13E-02		.13E-02		.13E-02	
RANGE	10		10		10	
STACK HEIGHT	1.04 CM	19.97 M	1.04 CM	19.97 M	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M	0.44 CM	8.45 M	0.44 CM	8.45 M

SAMPLE PT.	AVE	RAW (AREA)	NORMALIZED CONC	RAW (AREA)	NORMALIZED CONC	RAW (AREA)	NORMALIZED CONC
1	.398E-06	1039	.962E-07	2049	.816E-06	1043	.280E-06
2	.315E-05	1391	.171E-05	2934	.484E-05	1613	.290E-05
3	.292E-04	7009	.275E-04	8356	.295E-04	7659	.307E-04
4	.119E-04	3119	.963E-05	4561	.122E-04	3973	.137E-04
5	.299E-03	64145	.289E-03	66595	.294E-03	69461	.315E-03
6	.165E-02	362929	.166E-02	357851	.162E-02	365571	.168E-02
7	.102E-02	221012	.101E-02	215246	.970E-03	234079	.107E-02
8	.791E-04	13697	.581E-04	26668	.113E-03	15418	.663E-04
9	.174E-05	956	.0	2494	.284E-05	1502	.239E-05
14	.110E-04	2796	.815E-05	4202	.106E-04	4060	.141E-04
15	.423E-03	91058	.413E-03	91255	.406E-03	99157	.451E-03
16	.594E-03	129477	.589E-03	126013	.565E-03	138012	.630E-03
17	.921E-03	201498	.919E-03	199600	.899E-03	206891	.946E-03
18	.838E-03	185996	.848E-03	181348	.816E-03	185910	.850E-03
19	.353E-03	77593	.351E-03	80760	.359E-03	77298	.351E-03
20	.137E-03	29173	.129E-03	33340	.143E-03	31229	.139E-03
21	.584E-04	13006	.549E-04	15000	.597E-04	14156	.605E-04
22	.245E-05	1135	.536E-06	2701	.378E-05	1643	.304E-05
103	.216E-05	2195	.539E-05	1978	.493E-06	1113	.602E-06
101	.137E-04	3541	.116E-04	4444	.117E-04	4830	.177E-04
98	.190E-03	47016	.211E-03	38235	.165E-03	43178	.194E-03
97	.603E-03	105175	.477E-03	145301	.652E-03	148748	.679E-03
96	.473E-03	107617	.489E-03	103612	.463E-03	102526	.467E-03
94	.685E-04	14976	.640E-04	18095	.738E-04	15729	.678E-04
93	.285E-04	7632	.303E-04	7377	.250E-04	7537	.301E-04
92	.106E-04	2857	.843E-05	4023	.979E-05	3942	.136E-04
109	.148E-04	4150	.144E-04	4444	.117E-04	4954	.183E-04
110	.112E-03	25114	.110E-03	24224	.102E-03	28165	.125E-03
111	.368E-03	78714	.356E-03	79969	.355E-03	86559	.393E-03
112	.371E-03	80852	.366E-03	82865	.368E-03	83287	.378E-03
113	.320E-03	75215	.340E-03	69509	.308E-03	68771	.312E-03
114	.183E-03	43024	.193E-03	42117	.183E-03	38939	.174E-03
115	.719E-04	17859	.772E-04	18283	.746E-04	14884	.639E-04
116	.353E-04	10161	.419E-04	10077	.373E-04	6814	.268E-04
117	.103E-04	3384	.108E-04	4133	.103E-04	3121	.983E-05
118	.156E-05	1061	.197E-06	2586	.326E-05	1249	.123E-05
30	.141E-03	31213	.138E-03	30395	.130E-03	34630	.155E-03
31	.212E-03	47221	.212E-03	45703	.199E-03	50091	.226E-03
32	.284E-03	63066	.284E-03	62055	.274E-03	65156	.295E-03
33	.254E-03	58061	.261E-03	57148	.251E-03	54967	.248E-03
34	.165E-03	38001	.169E-03	38735	.168E-03	35079	.157E-03
36	.373E-04	11353	.474E-04	10322	.384E-04	6691	.262E-04
37	.257E-05	1498	.220E-05	2464	.270E-05	1591	.280E-05
38	.188E-05	1053	.160E-06	2346	.217E-05	1700	.330E-05
39	.669E-06	941	.0	2047	.807E-06	1243	.120E-05

RUN # 6

	MODEL	PROTOTYPE
FREE STREAM VEL.	2.88 M/S	27.56 M/S
EXIT VEL.	1.71 M/S	7.60 M/S
VOL. FLOW	.26E-03M3/S	.43E+04M3/S
SOURCE STRENGTH	.69E+05	.10E+01
BACKGROUND	.14E+04	
CALIBRATION FACTOR	.19E-02	
RANGE	10	
STACK HEIGHT	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M

SAMPLE PT.	RAW (AREA)	NORMALIZED CONCENTRATION
1	1421	.149E-06
2	2370	.571E-05
3	10358	.525E-04
4	8758	.432E-04
5	91246	.527E-03
6	383163	.224E-02
7	257597	.150E-02
8	61887	.355E-03
9	1385	.0
14	3278	.110E-04
15	112029	.649E-03
16	144825	.841E-03
17	213213	.124E-02
18	196462	.114E-02
19	91140	.526E-03
20	37966	.214E-03
21	17294	.932E-04
22	1496	.589E-06
103	1405	.557E-07
101	5347	.232E-04
98	46715	.266E-03
97	161873	.941E-03
96	121389	.703E-03
95	20836	.114E-03
94	21236	.116E-03
93	9311	.464E-04
92	5102	.217E-04
109	5309	.229E-04
110	30497	.171E-03
111	94189	.544E-03
112	89883	.519E-03
113	11890	.615E-04
114	51114	.291E-03
115	20630	.113E-03
116	12550	.654E-04
117	5477	.239E-04
118	1662	.156E-05
30	40613	.230E-03
31	60010	.344E-03
32	73138	.421E-03
33	62934	.361E-03
34	43457	.247E-03
36	14358	.760E-04
37	2609	.711E-05
38	1665	.158E-05
39	1566	.999E-06

RUN # 7

	MODEL	PROTOTYPE
FREE STREAM VEL.	.79 M/S	7.50 M/S
EXIT VEL.	1.71 M/S	7.60 M/S
VOL. FLOW	.26E-03M3/S	.43E+04M3/S
SOURCE STRENGTH	.69E+05	.10E+01
BACKGROUND	.86E+03	
CALIBRATION FACTOR	.19E-02	
RANGE	10	
STACK HEIGHT	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M

SAMPLE PT.	RAW (AREA)	NORMALIZED CONCENTRATION
1	1024	.261E-06
2	2911	.330E-05
3	16690	.255E-04
4	2065	.194E-05
5	62919	.100E-03
6	306589	.493E-03
7	136641	.219E-03
8	40619	.641E-04
9	967	.169E-06
14	2772	.308E-05
15	69231	.110E-03
16	136701	.219E-03
17	197349	.317E-03
18	156986	.252E-03
19	54875	.870E-04
20	21816	.338E-04
21	9729	.143E-04
22	405	.0
103	851	.0
101	1487	.101E-05
98	36480	.574E-04
97	130972	.210E-03
96	74389	.118E-03
95	9446	.138E-04
94	15296	.233E-04
92	3315	.395E-05
109	1750	.143E-05
110	7928	.114E-04
111	44639	.705E-04
112	24469	.380E-04
113	2611	.282E-05
114	32200	.505E-04
115	14096	.213E-04
116	6107	.845E-05
117	2230	.220E-05
118	1028	.267E-06
30	10756	.159E-04
31	17150	.262E-04
32	31596	.495E-04
33	43960	.694E-04
34	29786	.466E-04
35	2290	.230E-05
36	4467	.581E-05
37	1333	.759E-06
38	1604	.120E-05
39	1019	.253E-06

RUN # 8

	MODEL	PROTOTYPE
FREE STREAM VEL.	1.05 M/S	10.00 M/S
EXIT VEL.	1.71 M/S	7.60 M/S
VOL. FLOW	.26E-03M3/S	.43E+04M3/S
SOURCE STRENGTH	.69E+05	.10E+01
BACKGROUND	.16E+04	
CALIBRATION FACTOR	.19E-02	
RANGE	10	
STACK HEIGHT	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M

SAMPLE PT.	RAW (AREA)	NORMALIZED CONCENTRATION
1	1633	.812E-07
2	2578	.210E-05
3	11536	.212E-04
4	2636	.222E-05
5	61477	.128E-03
6	390059	.830E-03
7	184990	.392E-03
8	18575	.363E-04
9	1646	.109E-06
14	3074	.316E-05
15	64363	.134E-03
16	123969	.261E-03
17	234872	.498E-03
18	223602	.474E-03
19	106566	.224E-03
20	42313	.870E-04
21	16376	.316E-04
22	1759	.350E-06
103	1535	.0
101	2058	.989E-06
98	50252	.104E-03
97	177955	.377E-03
96	138470	.292E-03
95	17698	.344E-04
94	24208	.483E-04
93	9625	.172E-04
92	5028	.734E-05
109	2443	.181E-05
110	8338	.144E-04
111	42846	.881E-04
112	81343	.170E-03
113	66792	.139E-03
114	43177	.889E-04
115	21852	.433E-04
116	14954	.285E-04
117	8300	.143E-04
118	2539	.202E-05
30	13214	.248E-04
31	22844	.454E-04
32	38550	.790E-04
33	56115	.117E-03
34	43434	.894E-04
36	18090	.352E-04
37	5481	.830E-05
38	2197	.129E-05
39	1731	.291E-06

RUN # 9

	MODEL	PROTOTYPE	MODEL	PROTOTYPE	MODEL	PROTOTYPE
FREE STREAM VEL.	1.57 M/S	15.00 M/S	1.57 M/S	15.00 M/S	1.57 M/S	15.00 M/S
EXIT VEL.	1.71 M/S	7.60 M/S	1.71 M/S	7.60 M/S	1.71 M/S	7.60 M/S
VOL. FLOW	.26E-03M3/S	.43E+04M3/S	.26E-03M3/S	.43E+04M3/S	.26E-03M3/S	.43E+04M3/S
SOURCE STRENGTH	.69E+05	.10E+01	.69E+05	.10E+01	.69E+05	.10E+01
BACKGROUND	.18E+04		.14E+04		.16E+04	
CALIBRATION FACTOR	.19E-02		.19E-02		.19E-02	
RANGE	10		10		10	
STACK HEIGHT	1.04 CM	19.97 M	1.04 CM	19.97 M	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M	0.44 CM	8.45 M	0.44 CM	8.45 M

SAMPLE PT.	AVE	RAW (AREA)	NORMALIZED CONC	RAW (AREA)	NORMALIZED CONC	RAW (AREA)	NORMALIZED CONC
1	.284E-06	1811	.767E-07	1593	.677E-06	1618	.993E-07
2	.439E-05	3010	.391E-05	2999	.518E-05	2862	.408E-05
3	.391E-04	14638	.411E-04	13644	.393E-04	13124	.369E-04
4	.812E-05	4312	.807E-05	4064	.859E-05	3997	.772E-05
5	.318E-03	113730	.358E-03	97493	.308E-03	91627	.288E-03
6	.147E-02	458722	.146E-02	464830	.148E-02	458750	.146E-02
7	.955E-03	291627	.926E-03	307443	.980E-03	301339	.960E-03
8	.133E-03	15917	.452E-04	60075	.188E-03	52987	.165E-03
9	.157E-05	2161	.126E-05	2354	.311E-05	1711	.397E-06
14	.103E-04	4266	.792E-05	5061	.118E-04	5098	.112E-04
15	.401E-03	130098	.416E-03	130378	.413E-03	120682	.381E-03
16	.604E-03	198751	.629E-03	188964	.601E-03	183392	.582E-03
17	.896E-03	287941	.914E-03	277292	.883E-03	279620	.890E-03
18	.820E-03	260642	.827E-03	257454	.820E-03	255785	.814E-03
19	.381E-03	127146	.401E-03	115534	.366E-03	119612	.378E-03
20	.167E-03	60072	.186E-03	48764	.152E-03	52264	.162E-03
21	.670E-04	25451	.756E-04	20030	.597E-04	22072	.656E-04
22	.171E-05	2502	.228E-05	1953	.183E-05	1902	.101E-05
103	.148E-06	1704	.0	1474	.296E-06	*******	********
101	.878E-05	4049	.723E-05	4816	.110E-04	4122	.812E-05
98	.174E-03	59919	.186E-03	53356	.166E-03	54339	.169E-03
97	.685E-03	224213	.711E-03	213020	.678E-03	209407	.665E-03
96	.482E-03	163307	.516E-03	150188	.476E-03	143510	.454E-03
94	.822E-04	31091	.936E-04	24253	.732E-04	26500	.798E-04
93	.276E-04	11466	.309E-04	9748	.268E-04	9406	.250E-04
92	.134E-04	7167	.172E-04	4979	.115E-04	5149	.114E-04
109	.976E-05	4429	.844E-05	5734	.139E-04	3746	.691E-05
110	.847E-04	24418	.723E-04	33609	.103E-03	26129	.786E-04
111	.353E-03	107410	.338E-03	116815	.370E-03	111120	.351E-03
112	.386E-03	126004	.397E-03	121222	.384E-03	119517	.378E-03
113	.358E-03	123870	.390E-03	120323	.381E-03	96456	.304E-03
114	.183E-03	65018	.202E-03	54505	.170E-03	56555	.176E-03
115	.564E-04	29973	.901E-04	23315	.702E-04	4375	.893E-05
116	.408E-04	17559	.504E-04	12078	.343E-04	13340	.376E-04
117	.135E-04	8110	.202E-04	4184	.897E-05	5092	.112E-04
118	.727E-06	2121	.107E-05	1625	.780E-06	1691	.333E-06
30	.103E-03	30878	.930E-04	37978	.117E-03	32858	.100E-03
31	.173E-03	53040	.164E-03	59812	.187E-03	54082	.168E-03
32	.254E-03	79667	.249E-03	84182	.265E-03	79010	.248E-03
33	.189E-03	28587	.856E-04	77304	.243E-03	76384	.240E-03
34	.164E-03	58872	.182E-03	49174	.153E-03	50548	.157E-03
36	.442E-04	20745	.606E-04	11152	.313E-04	14293	.407E-04
37	.372E-05	3639	.592E-05	2190	.259E-05	2418	.266E-05
38	.154E-05	2168	.122E-05	2029	.207E-05	1998	.132E-05
39	.419E-06	1887	.320E-06	1607	.722E-06	1654	.215E-06

RUN # 10

	MODEL	PROTOTYPE
FREE STREAM VEL.	2.09 M/S	20.00 M/S
EXIT VEL.	1.71 M/S	7.60 M/S
VOL. FLOW	.26E-03M3/S	.43E+04M3/S
SOURCE STRENGTH	.69E+05	.10E+01
BACKGROUND	.16E+04	
CALIBRATION FACTOR	.19E-02	
RANGE	10	
STACK HEIGHT	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M

SAMPLE PT.	RAW (AREA)	NORMALIZED CONCENTRATION
1	1585	.851E-07
2	2644	.459E-05
3	11498	.423E-04
4	6891	.227E-04
5	106995	.448E-03
6	447135	.190E-02
7	299564	.127E-02
8	71507	.298E-03
9	1825	.111E-05
14	4129	.109E-04
15	129890	.546E-03
16	175973	.742E-03
17	261700	.111E-02
18	239753	.101E-02
19	114088	.479E-03
20	50407	.208E-03
21	21564	.851E-04
22	1835	.115E-05
103	1461	.0
101	4957	.144E-04
98	57724	.239E-03
97	201334	.850E-03
96	149793	.631E-03
95	25555	.102E-03
94	26977	.108E-03
93	10589	.384E-04
92	6107	.193E-04
109	5537	.169E-04
110	31014	.125E-03
111	113183	.475E-03
112	113252	.475E-03
113	102298	.428E-03
114	62613	.260E-03
115	25201	.101E-03
116	14433	.547E-04
117	6274	.200E-04
118	1887	.137E-05
30	42115	.172E-03
31	64870	.269E-03
32	85076	.355E-03
33	78225	.326E-03
34	53816	.222E-03
36	17194	.665E-04
37	2994	.608E-05
38	1872	.131E-05
39	1744	.761E-06

Run # 11

	MODEL	PROTOTYPE
FREE STREAM VEL.	2.09 M/S	20.00 M/S
EXIT VEL.	1.71 M/S	7.60 M/S
VOL. FLOW	.26E-03M3/S	.43E+04M3/S
SOURCE STRENGTH	.44E+05	.10E+01
BACKGROUND	.76E+03	
CALIBRATION FACTOR	.13E-02	
RANGE	10	
STACK HEIGHT	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M

SAMPLE PT.	RAW (AREA)	NORMALIZED CONCENTRATION
1	368157	.170E-02
4	204859	.945E-03
7	55604	.254E-03
8	36214	.164E-03
12	2389	.754E-05
15	1249	.226E-05
18	956	.905E-06
21	987	.105E-05

Run # 12

	MODEL	PROTOTYPE
FREE STREAM VEL.	2.09 M/S	20.00 M/S
EXIT VEL.	1.71 M/S	7.60 M/S
VOL. FLOW	.26E-03M3/S	.43E+04M3/S
SOURCE STRENGTH	.44E+05	.10E+01
BACKGROUND	.17E+04	
CALIBRATION FACTOR	.13E-02	
RANGE	10	
STACK HEIGHT	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M

SAMPLE PT.	RAW (AREA)	NORMALIZED CONCENTRATION
1	145022	.664E-03
4	142468	.652E-03
7	141168	.646E-03
8	125209	.572E-03
12	82712	.375E-03
15	26367	.114E-03
18	21304	.909E-04
21	10566	.411E-04
25	4395	.125E-04
30	1995	.142E-05

Run # 13

	MODEL	PROTOTYPE
FREE STREAM VEL.	2.09 M/S	20.00 M/S
EXIT VEL.	1.71 M/S	7.60 M/S
VOL. FLOW	.26E-03M3/S	.43E+04M3/S
SOURCE STRENGTH	.44E+05	.10E+01
BACKGROUND	.33E+04	
CALIBRATION FACTOR	.13E-02	
RANGE	10	
STACK HEIGHT	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M

SAMPLE PT.	RAW (AREA)	NORMALIZED CONCENTRATION
1	71831	.318E-03
3	73230	.324E-03
4	75242	.333E-03
8	73262	.324E-03
12	65392	.288E-03
18	34527	.145E-03
25	14339	.510E-04
30	6140	.130E-04
35	5072	.808E-05
39	3409	.373E-06
52	3125	.0

RUN # 14

	MODEL	PROTOTYPE
FREE STREAM VEL.	1.57 M/S	15.00 M/S
EXIT VEL.	1.71 M/S	7.60 M/S
VOL. FLOW	.26E-03M3/S	.43E+04M3/S
SOURCE STRENGTH	.69E+05	.10E+01
BACKGROUND	.29E+04	
CALIBRATION FACTOR	.19E-02	
RANGE	10	
STACK HEIGHT	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M

SAMPLE PT.	RAW (AREA)	NORMALIZED CONCENTRATION
1	69455	.216E-03
3	72147	.225E-03
4	43187	.131E-03
6	13520	.344E-04
7	13230	.335E-04
8	10353	.241E-04
12	5359	.789E-05
15	4404	.479E-05
18	3432	.163E-05
21	3015	.276E-06
25	3021	.296E-06

RUN # 15

	MODEL	PROTOTYPE
FREE STREAM VEL.	1.57 M/S	15.00 M/S
EXIT VEL.	1.71 M/S	7.60 M/S
VOL. FLOW	.26E-03M3/S	.43E+04M3/S
SOURCE STRENGTH	.69E+05	.10E+01
BACKGROUND	.25E+04	
CALIBRATION FACTOR	.19E-02	
RANGE	10	
STACK HEIGHT	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M

SAMPLE PT.	RAW (AREA)	NORMALIZED CONCENTRATION
1	197182	.635E-03
3	196082	.632E-03
4	195975	.631E-03
7	178111	.573E-03
8	169297	.544E-03
10	118124	.377E-03
12	110546	.353E-03
15	35751	.109E-03
18	33885	.102E-03
21	20209	.579E-04
25	9270	.222E-04
35	3923	.473E-05
39	2475	.652E-08
52	2315	.0

RUN # 16

	MODEL	PROTOTYPE
FREE STREAM VEL.	1.57 M/S	15.00 M/S
EXIT VEL.	1.71 M/S	7.60 M/S
VOL. FLOW	.26E-03M3/S	.43E+04M3/S
SOURCE STRENGTH	.69E+05	.10E+01
BACKGROUND	.31E+04	
CALIBRATION FACTOR	.19E-02	
RANGE	10	
STACK HEIGHT	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M

SAMPLE PT.	RAW (AREA)	NORMALIZED CONCENTRATION
1	92121	.287E-03
3	96577	.302E-03
4	101871	.319E-03
8	98216	.307E-03
12	89336	.278E-03
18	44606	.134E-03
21	34652	.102E-03
25	20892	.575E-04
30	8035	.160E-04
35	7288	.135E-04
39	3749	.212E-05
52	3069	.0

APPENDIX C

Concentration Measurement Data

for Similarity Tests

Runs 9, 17, 18, 19 & 20

RUN # 9

	MODEL	PROTOTYPE	MODEL	PROTOTYPE	MODEL	PROTOTYPE
FREE STREAM VEL.	1.57 M/S	15.00 M/S	1.57 M/S	15.00 M/S	1.57 M/S	15.00 M/S
EXIT VEL.	1.71 M/S	7.60 M/S	1.71 M/S	7.60 M/S	1.71 M/S	7.60 M/S
VOL. FLOW	.26E-03M3/S	.43E+04M3/S	.26E-03M3/S	.43E+04M3/S	.26E-03M3/S	.43E+04M3/S
SOURCE STRENGTH	.69E+05	.10E+01	.69E+05	.10E+01	.69E+05	.10E+01
BACKGROUND	.18E+04		.14E+04		.16E+04	
CALIBRATION FACTOR	.19E-02		.19E-02		.19E-02	
RANGE	10		10		10	
STACK HEIGHT	1.04 CM	19.97 M	1.04 CM	19.97 M	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M	0.44 CM	8.45 M	0.44 CM	8.45 M

SAMPLE PT.	AVE	RAW (AREA)	NORMALIZED CONC	RAW (AREA)	NORMALIZED CONC	RAW (AREA)	NORMALIZED CONC
1	.284E-06	1811	.767E-07	1593	.677E-06	1618	.993E-07
2	.439E-05	3010	.391E-05	2999	.518E-05	2862	.408E-05
3	.391E-04	14638	.411E-04	13644	.393E-04	13124	.369E-04
4	.812E-05	4312	.807E-05	4064	.859E-05	3997	.772E-05
5	.318E-03	113730	.358E-03	97493	.308E-03	91627	.288E-03
6	.147E-02	458722	.146E-02	464830	.148E-02	458750	.146E-02
7	.955E-03	291627	.926E-03	307443	.980E-03	301339	.960E-03
8	.133E-03	15917	.452E-04	60075	.188E-03	52987	.165E-03
9	.157E-05	2161	.120E-05	2354	.311E-05	1711	.397E-06
14	.103E-04	4266	.792E-05	5061	.118E-04	5098	.112E-04
15	.401E-03	130098	.410E-03	130378	.413E-03	120682	.381E-03
16	.604E-03	198751	.629E-03	188964	.601E-03	183392	.582E-03
17	.896E-03	287941	.914E-03	277292	.883E-03	279620	.890E-03
18	.820E-03	260642	.827E-03	257454	.820E-03	255785	.814E-03
19	.381E-03	127146	.401E-03	115534	.366E-03	119612	.378E-03
20	.167E-03	60072	.186E-03	48764	.152E-03	52264	.162E-03
21	.670E-04	25451	.756E-04	20030	.597E-04	22072	.656E-04
22	.171E-05	2502	.228E-05	1953	.183E-05	1902	.101E-05
103	.148E-06	1704	.0	1474	.296E-06	*******	********
101	.878E-05	4049	.723E-05	4816	.110E-04	4122	.812E-05
98	.174E-03	59919	.186E-03	53356	.166E-03	54339	.169E-03
97	.685E-03	224213	.711E-03	213020	.678E-03	209407	.665E-03
96	.482E-03	163307	.516E-03	150188	.476E-03	143510	.454E-03
94	.822E-04	31091	.936E-04	24253	.732E-04	26500	.798E-04
93	.276E-04	11466	.309E-04	9748	.268E-04	9406	.250E-04
92	.134E-04	7167	.172E-04	4979	.115E-04	5149	.114E-04
109	.976E-05	4429	.844E-05	5734	.139E-04	3746	.691E-05
110	.847E-04	24418	.723E-04	33609	.103E-03	26129	.786E-04
111	.353E-03	107410	.338E-03	116815	.370E-03	111120	.351E-03
112	.386E-03	126004	.397E-03	121222	.384E-03	119517	.378E-03
113	.358E-03	123870	.390E-03	120323	.381E-03	96456	.304E-03
114	.183E-03	65018	.202E-03	54505	.170E-03	56555	.176E-03
115	.564E-04	29973	.901E-04	23315	.702E-04	4375	.893E-05
116	.408E-04	17559	.504E-04	12078	.343E-04	13340	.376E-04
117	.135E-04	8110	.202E-04	4184	.897E-05	5092	.112E-04
118	.727E-06	2121	.107E-05	1625	.780E-06	1691	.333E-06
30	.103E-03	30878	.930E-04	37978	.117E-03	32858	.100E-03
31	.173E-03	53040	.164E-03	59812	.187E-03	54082	.168E-03
32	.254E-03	79667	.249E-03	84182	.265E-03	79010	.248E-03
33	.189E-03	28587	.856E-04	77304	.243E-03	76384	.240E-03
34	.164E-03	58872	.182E-03	49174	.153E-03	50548	.157E-03
36	.442E-04	20745	.606E-04	11152	.313E-04	14293	.407E-04
37	.372E-05	3639	.592E-05	2190	.259E-05	2418	.266E-05
38	.154E-05	2168	.122E-05	2029	.207E-05	1998	.132E-05
39	.419E-06	1887	.320E-06	1607	.722E-06	1654	.215E-06

RUN # 17

	MODEL	PROTOTYPE	MODEL	PROTOTYPE
FREE STREAM VEL.	1.07 M/S	15.00 M/S	1.07 M/S	15.00 M/S
EXIT VEL.	.54 M/S	7.60 M/S	.54 M/S	7.60 M/S
VOL. FLOW	.84E-04M3/S	.43E+04M3/S	.84E-04M3/S	.43E+04M3/S
SOURCE STRENGTH	.69E+05	.10E+01	.69E+05	.10E+01
BACKGROUND	.47E+03		.65E+03	
CALIBRATION FACTOR	.19E-02		.19E-02	
RANGE	10		10	
STACK HEIGHT	1.04 CM	19.97 M	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M	0.44 CM	8;45 M

SAMPLE PT.	AVE	RAW (AREA)	NORMALIZED CONC	RAW (AREA)	NORMALIZED CONC
1	0.	312	.0	491	.0
2	.106E-04	1354	.600E-05	2889	.152E-04
3	.219E-04	5241	.324E-04	2339	.115E-04
4	.493E-05	727	.174E-05	1842	.812E-05
5	.892E-04	14547	.955E-04	12832	.829E-04
6	.117E-02	169634	.115E-02	177156	.120E-02
7	.128E-02	191448	.130E-02	186708	.127E-02
8	.364E-03	49224	.331E-03	59149	.398E-03
9	.217E-05	780	.210E-05	976	.223E-05
14	.269E-05	921	.306E-05	988	.231E-05
15	.136E-03	21299	.141E-03	19850	.131E-03
16	.255E-03	38200	.256E-03	38119	.255E-03
17	.672E-03	99834	.674E-03	99134	.670E-03
18	.759E-03	114531	.774E-03	110185	.745E-03
19	.500E-03	78369	.529E-03	70027	.472E-03
20	.197E-03	31776	.212E-03	27234	.181E-03
21	.682E-04	11327	.737E-04	9878	.628E-04
22	.476E-05	1210	.502E-05	1309	.450E-05
103	.781E-06	589	.807E-06	759	.755E-06
101	.910E-05	2228	.119E-04	1570	.627E-05
98	.941E-04	17076	.113E-03	11767	.756E-04
97	.511E-03	77965	.526E-03	73606	.496E-03
96	.506E-03	78835	.532E-03	71316	.481E-03
94	.917E-04	16578	.109E-03	11548	.741E-04
93	.255E-04	3934	.235E-04	4697	.275E-04
92	.147E-04	2812	.159E-04	2647	.136E-04
110	.427E-04	6451	.406E-04	7233	.448E-04
111	.201E-03	30074	.201E-03	30270	.201E-03
112	.286E-03	44674	.300E-03	40798	.273E-03
113	.248E-03	34610	.232E-03	39619	.265E-03
114	.199E-03	33385	.223E-03	26262	.174E-03
115	.363E-04	885	.282E-05	10904	.697E-04
116	.557E-04	10512	.681E-04	7011	.433E-04
117	.170E-04	3864	.230E-04	2270	.110E-04
118	.954E-06	657	.127E-05	742	.639E-06
119	.103E-05	620	.102E-05	801	.104E-05
30	.724E-04	11272	.733E-04	11163	.715E-04
31	.123E-03	18304	.121E-03	18964	.125E-03
32	.189E-03	29180	.195E-03	27485	.183E-03
33	.238E-03	38085	.255E-03	33148	.221E-03
34	.193E-03	31715	.212E-03	26268	.174E-03
36	.574E-04	12234	.798E-04	5794	.350E-04
37	.427E-05	1395	.628E-05	982	.227E-05
38	.161E-05	718	.168E-05	873	.153E-05
39	.635E-06	592	.760E-06	723	.510E-06

RUN # 18

	MODEL	PROTOTYPE	MODEL	PROTOTYPE
FREE STREAM VEL.	1.07 M/S	15.00 M/S	1.07 M/S	15.00 M/S
EXIT VEL.	.54 M/S	7.60 M/S	.54 M/S	7.60 M/S
VOL. FLOW	.84E-04M3/S	.43E+04M3/S	.84E-04M3/S	.43E+04M3/S
SOURCE STRENGTH	.10E+06	.10E+01	.10E+06	.10E+01
BACKGROUND	.31E+04		.29E+04	
CALIBRATION FACTOR	.19E-02		.19E-02	
RANGE	10		10	
STACK HEIGHT	1.04 CM	19.97 M	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M	0.44 CM	8.45 M

SAMPLE PT.	AVE	RAW (AREA)	NORMALIZED CONC	RAW (AREA)	NORMALIZED CONC
1	0.	3001	.0	2763	.0
2	.224E-04	7521	.211E-04	7842	.236E-04
3	.129E-03	29061	.123E-03	31350	.135E-03
4	.144E-04	6023	.140E-04	6000	.149E-04
5	.425E-03	94077	.432E-03	90883	.418E-03
6	.213E-02	450670	.219E-02	451978	.213E-02
7	.137E-02	295592	.139E-02	287882	.135E-02
8	.253E-03	66310	.300E-03	46063	.205E-03
9	.907E-06	3232	.731E-06	3097	.108E-05
14	.752E-05	5097	.559E-05	4018	.546E-05
15	.497E-03	105531	.486E-03	109862	.508E-03
16	.778E-03	163140	.760E-03	170439	.796E-03
17	.122E-02	260558	.122E-02	261015	.123E-02
18	.112E-02	243341	.114E-02	232415	.109E-02
19	.599E-03	132318	.614E-03	126084	.585E-03
20	.199E-03	48487	.216E-03	41319	.183E-03
21	.559E-04	15571	.593E-04	13905	.524E-04
22	.142E-05	3534	.217E-05	3012	.679E-06
103	.190E-07	3047	.0	2877	.380E-07
101	.211E-04	7153	.194E-04	7662	.228E-04
98	.221E-03	47876	.213E-03	50991	.229E-03
97	.924E-03	198344	.927E-03	196962	.922E-03
96	.708E-03	153993	.717E-03	150011	.699E-03
95	.974E-04	23757	.982E-04	23221	.966E-04
94	.878E-04	22713	.932E-04	20231	.824E-04
93	.189E-04	7327	.202E-04	6569	.176E-04
92	.144E-04	6354	.156E-04	5653	.132E-04
110	.141E-03	32571	.140E-03	32678	.142E-03
111	.514E-03	112068	.518E-03	110390	.511E-03
112	.554E-03	123056	.570E-03	116410	.539E-03
113	.551E-03	121089	.560E-03	116740	.541E-03
114	.246E-03	57702	.259E-03	51902	.233E-03
115	.935E-04	23698	.979E-04	21643	.891E-04
116	.517E-04	14147	.526E-04	13586	.509E-04
117	.193E-04	7328	.202E-04	6749	.184E-04
118	.164E-05	3515	.208E-05	3122	.120E-05
119	.186E-05	3769	.328E-05	2961	.437E-06
30	.237E-03	53454	.239E-03	52178	.234E-03
31	.336E-03	75224	.343E-03	72281	.330E-03
32	.414E-03	91750	.421E-03	88440	.406E-03
33	.352E-03	78790	.360E-03	75294	.344E-03
34	.212E-03	49328	.220E-03	46002	.205E-03
36	.648E-04	16049	.616E-04	17193	.680E-04
37	.750E-05	4428	.641E-05	4677	.859E-05
38	.207E-05	3741	.315E-05	3076	.983E-06
39	.283E-06	3127	.231E-06	2939	.332E-06

RUN # 19

	MODEL	PROTOTYPE	MODEL	PROTOTYPE
FREE STREAM VEL.	2.09 M/S	15.00 M/S	2.09 M/S	15.00 M/S
EXIT VEL.	1.09 M/S	7.60 M/S	1.09 M/S	7.60 M/S
VOL. FLOW	.17E-03M3/S	.43E+04M3/S	.17E-03M3/S	.43E+04M3/S
SOURCE STRENGTH	.10E+06	.10E+01	.10E+06	.10E+01
BACKGROUND	.23E+04		.24E+04	
CALIBRATION FACTOR	.19E-02		.19E-02	
RANGE	10		10	
STACK HEIGHT	1.04 CM	19.97 M	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M	0.44 CM	8.45 M

SAMPLE PT.	AVE	RAW (AREA)	NORMALIZED CONC	RAW (AREA)	NORMALIZED CONC
1	.671E-06	1987	.0	2644	.134E-05
2	.176E-04	6469	.192E-04	5799	.160E-04
3	.111E-03	27936	.119E-03	24689	.104E-03
4	.216E-04	6945	.214E-04	7059	.218E-04
5	.465E-03	108237	.491E-03	96652	.438E-03
6	.217E-02	468777	.216E-02	469769	.217E-02
7	.141E-02	305788	.141E-02	306318	.141E-02
8	.271E-03	73439	.330E-03	48183	.213E-03
9	.202E-06	2428	.404E-06	2277	.0
14	.110E-04	4869	.117E-04	4572	.103E-04
15	.590E-03	135141	.616E-03	123890	.564E-03
16	.838E-03	189499	.869E-03	176276	.807E-03
17	.123E-02	271239	.125E-02	264289	.122E-02
18	.110E-02	243080	.112E-02	236042	.108E-02
19	.562E-03	123274	.561E-03	123495	.562E-03
20	.166E-03	37261	.162E-03	38845	.169E-03
21	.541E-04	13546	.520E-04	14446	.561E-04
22	.638E-06	1560	.0	2630	.128E-05
103	.114E-05	2111	.0	2845	.227E-05
101	.254E-04	7934	.260E-04	7714	.249E-04
98	.222E-03	46797	.206E-03	53419	.237E-03
97	.918E-03	203610	.934E-03	196923	.903E-03
96	.704E-03	154635	.707E-03	153332	.701E-03
95	.913E-04	22467	.934E-04	21576	.892E-04
94	.934E-04	21654	.896E-04	23274	.971E-04
93	.144E-04	5539	.148E-04	5377	.140E-04
92	.122E-04	4989	.123E-04	4985	.122E-04
110	.149E-03	35857	.156E-03	32902	.142E-03
111	.527E-03	120228	.547E-03	111528	.507E-03
112	.567E-03	126719	.577E-03	122537	.558E-03
113	.385E-03	98440	.446E-03	72265	.324E-03
114	.276E-03	61310	.274E-03	62537	.279E-03
115	.617E-04	23296	.972E-04	8010	.262E-04
116	.544E-04	13567	.521E-04	14557	.566E-04
117	.196E-04	6484	.192E-04	6670	.200E-04
118	.173E-05	2720	.176E-05	2721	.170E-05
119	.281E-06	2458	.543E-06	2359	.186E-07
30	.227E-03	50980	.226E-03	51474	.228E-03
31	.344E-03	77737	.350E-03	75165	.338E-03
32	.434E-03	97700	.443E-03	94150	.426E-03
33	.375E-03	83081	.375E-03	83415	.376E-03
34	.234E-03	51771	.229E-03	53909	.239E-03
36	.670E-04	16341	.650E-04	17226	.690E-04
37	.746E-05	*******	********	3962	.746E-05
38	.970E-06	2675	.155E-05	2439	.390E-06
39	.104E-05	2620	.129E-05	2525	.789E-06

RUN # 20

	MODEL	PROTOTYPE	MODEL	PROTOTYPE
FREE STREAM VEL.	2.09 M/S	15.00 M/S	2.09 M/S	15.00 M/S
EXIT VEL.	1.03 M/S	7.60 M/S	1.03 M/S	7.60 M/S
VOL. FLOW	.16E-03M3/S	.43E+04M3/S	.16E-03M3/S	.43E+04M3/S
SOURCE STRENGTH	.10E+06	.10E+01	.10E+06	.10E+01
BACKGROUND	.55E+03		.12E+04	
CALIBRATION FACTOR	.19E-02		.19E-02	
RANGE	10		10	
STACK HEIGHT	1.04 CM	19.97 M	1.04 CM	19.97 M
CELL DIAMETER	0.44 CM	8.45 M	0.44 CM	8.45 M

SAMPLE PT.	AVE	RAW (AREA)	NORMALIZED CONC	RAW (AREA)	NORMALIZED CONC
1	0.	299	.0	989	.0
2	.188E-04	4434	.191E-04	4966	.186E-04
3	.108E-03	22139	.106E-03	23408	.109E-03
4	.199E-04	4486	.194E-04	5348	.205E-04
5	.442E-03	88411	.433E-03	92748	.451E-03
6	.221E-02	449227	.221E-02	451839	.222E-02
7	.153E-02	318291	.156E-02	306674	.150E-02
8	.270E-03	64189	.313E-03	47419	.228E-03
9	.805E-06	722	.837E-06	1349	.773E-06
14	.155E-04	4015	.170E-04	4031	.140E-04
15	.587E-03	119634	.586E-03	120723	.588E-03
16	.836E-03	170265	.835E-03	170946	.836E-03
17	.124E-02	251575	.124E-02	252693	.124E-02
18	.111E-02	231069	.113E-02	222913	.109E-02
19	.589E-03	122524	.600E-03	118324	.577E-03
20	.177E-03	37621	.182E-03	36208	.172E-03
21	.602E-04	12598	.593E-04	13600	.611E-04
22	.167E-05	616	.315E-06	1805	.302E-05
103	.106E-06	569	.837E-07	1218	.129E-06
101	.301E-04	6455	.291E-04	7501	.311E-04
98	.270E-03	57985	.283E-03	53265	.256E-03
97	.934E-03	189958	.932E-03	191325	.936E-03
96	.714E-03	148202	.727E-03	143654	.701E-03
95	.101E-03	23100	.111E-03	19602	.906E-04
94	.933E-04	19663	.941E-04	19968	.924E-04
93	.309E-04	7288	.332E-04	6995	.286E-04
92	.146E-04	3404	.140E-04	4272	.152E-04
110	.154E-03	32568	.150E-03	31836	.151E-03
111	.534E-03	108610	.532E-03	109951	.535E-03
112	.562E-03	114459	.561E-03	115780	.564E-03
113	.442E-03	80121	.392E-03	101271	.493E-03
114	.283E-03	60214	.294E-03	56367	.272E-03
115	.101E-03	22018	.106E-03	20719	.961E-04
116	.515E-04	10786	.504E-04	11884	.526E-04
117	.180E-04	3958	.168E-04	5089	.192E-04
118	.381E-05	1472	.453E-05	1818	.308E-05
119	.269E-05	1282	.359E-05	1556	.179E-05
30	.238E-03	49660	.242E-03	48778	.234E-03
31	.360E-03	74614	.365E-03	73569	.356E-03
32	.448E-03	92219	.451E-03	91660	.445E-03
33	.384E-03	79048	.386E-03	78686	.382E-03
34	.239E-03	50150	.244E-03	48749	.234E-03
36	.597E-04	12340	.580E-04	13677	.615E-04
37	.619E-05	1902	.665E-05	2357	.574E-05
38	.316E-05	1415	.425E-05	1612	.207E-05
39	.244E-05	1173	.306E-05	1563	.183E-05