National Nuclear Security Administration
Nevada Site Office

DEFENSE THREAT REDUCTION AGENCY PROPOSED EXPLOSIVE EXPERIMENT AT THE NEVADA TEST SITE

Introduction

The Defense Threat Reduction Agency (DTRA) plans to conduct an experiment at the U16b Tunnel in Area 16 of the Nevada Test Site (NTS). The experiment, called Divine Strake, is scheduled to be conducted in early June, 2006. In April, 2005, the Nevada Division of Environmental Protection, Bureau of Air Pollution Control (BAPC) determined that prior to the experiment, the National Nuclear Security Administration Nevada Site Office (NNSA/NSO) must demonstrate that the resultant air pollutant emissions would not cause the NTS to exceed Title V permitting thresholds. The BAPC requested the following information:

- The expected criteria and hazardous air pollutant (HAP) emissions
- A demonstration that the Nevada Ambient Air Quality Standards (NV AAQS) will not be exceeded as a result of the test
- Documentation that the Title V thresholds, in conjunction with all currently permitted NTS activities, will not be exceeded as a result of the test
- Information as to whether DTRA anticipates any future experiments

This paper addresses the items listed above in the order of their appearance.

1. Expected Criteria and HAP Emissions

The proposed Divine Strake experiment will consist of one explosive detonation that will use up to 700 tons of ammonium nitrate fuel-oil explosive (ANFO) emulsion, detonated by approximately 30 lbs of Composition C4. The ANFO will be placed in an excavated pit approximately 32 feet deep, located above the U16b tunnel. There will be no overburden placed on top of the ANFO. Expected criteria pollutants from the detonation include nitrogen oxides (NOx), carbon monoxide (CO), and particulate matter. The HAP emissions expected from the detonation are shown in Tables 3 and 4.

2. Demonstration that NV AAQS Will Not Be Exceeded

Concentrations of air pollutants are determined through dispersion modeling to demonstrate compliance with the National Ambient Air Quality Standards and the NV AAQS. In order to estimate pollutant concentrations from Divine Strake, the POLU4WN model was used to derive the potential emissions of criteria and hazardous air pollutants. Total particulates and total PM10 emissions were determined using Combined Obscuration Model for Battlefield-Induced Contaminants (COMBIC). COMBIC and POLU4WN results are reported in units of pounds of pollutant per pound of material detonated as well as the total pounds of emissions (based on EPA compounds of interest) for the entire amount detonated. These data were input into Open Burn/Open Detonation Model (OBODM), an EPA-approved dispersion model to determine concentrations in micrograms per meter cubed (μ/m^3) at the nearest boundary, so that a direct comparison could be made with the federal and state of Nevada concentrations.

By projecting the plume direction generated by OBODM, it was determined that the northern boundary of the NTS, in the vicinity of the border between Areas 19 and 20 (in the northwest portion of the NTS) would be the point of direct intersection. The highest concentrations reported by OBODM along a line approximately even with the NTS northern boundary were used in this analysis. Results of running these models, shown in Table 1, indicate that very low levels of the criteria pollutants would be expected to reach the NTS boundary from the proposed detonation. Copies of OBODM-generated plume plots, showing concentration of various pollutants are in Appendix A of this report.

Meteorological data used in OBODM for Divine Strake were based on extensive NTS-specific data accumulated by the National Oceanographic and Atmospheric Administration, Air Resources Laboratory/Special Operations and Research Division. Divine Strake is scheduled to be detonated at about 10:00 a.m. (Pacific Daylight Time), between June 2 and 4, 2006. Therefore, average meteorological conditions for June 3 were selected to be used for the OBODM modeling. In general, on June 3, it is anticipated that any temperature inversions will dissipate during the early morning and winds will be moderate from the southeast. During the afternoon, the winds will likely change from the southeast to the southwest. All emissions from Divine Strake will be transported in a northerly direction, toward the Nevada Test and Training Range, rather than toward populated areas, such as Amargosa Springs or Indian Springs (to the southwest and southeast of the Divine Strake test bed, respectively).

3. Documentation that Title V Thresholds Will Not Be Exceeded

Potential emissions from the Divine Strake test were calculated using emission factors from the POLU4WN program, which was previously approved by BAPC. The results of these calculations for criteria and HAP emissions are summarized in Tables 2 and 3, respectively. A more detailed tabulation of the results is shown in Table 4.

As Table 2 indicates, these emissions, when added to the total NTS potential to emit for each criteria pollutant, except particulate matter larger than 10 microns, would still be well below the 100-ton per pollutant threshold for Title V permitting. Particulate matter was included but is not used in determining whether a source is Title V. Particulate matter resulting from the explosives was estimated by summing all of the solids reported by POLU4WM. It was then assumed that one-half of the particulate matter from the explosives would be assigned to PM10 and one-half to PM. It should be noted that particulate matter from the explosives would result in the 100 ton per 12 month period being exceeded by just over one ton; however, the contribution of particulate matter from the crater that would result from Divine Strake is considerable. HAP emissions at the NTS have two limits: an individual limit of any one HAP of 8 tons/yr, and a limit of 20 tons/yr for any combination of HAPs. As shown in Table 3, none of the individual HAP emissions exceed the 8 ton/yr limit, nor does any combination or the total quantity of HAP emissions exceed the 20 ton/yr limit.

Table 1 Air Dispersion Modeling Results

Pollutant	Averaging Period	Maximum Modeled NTS Sources[f] (μ/m^3)[a]	Background Concen-tration[f] (μ/m^3)[a]	Modeled Divine Strake Test (μ/m^3)[a]	Total NTS Concentration (μ/m^3)[a]	NAAQS[g] Standard (μ/m^3)[a]	NV AAQS[g] Standard (μ/m^3)[a]
Nitrogen Oxides	Annual	2.5	0	0.00001	2.50001	100	100
Carbon Monoxide	8-hour	42.2	0	0	42.2	10,000[b]	10,000[c]
	1-hour	222.5	0	0.00010	222.50010	40,000[b]	40,000
PM10[d]	Annual	0.6	9.0			50	50
	24-hour	17.4	10.2	0.01673	27.61673	150[b]	150
Ozone	1-hour	204.7[e]	0	0.10094	204.80094	235[b]	235

a μ/m^3 = micrograms per cubic meter
b Not to be exceeded more than once per calendar year
c 6,670 μ/m^3 at areas equal to or greater than 5,000 feet above Mean Sea Level
d Particulate matter with aerodynamic diameter less than or equal to 10 microns
e Ozone concentrations were conservatively assumed to be equal to VOC concentrations
f Source: Appendix 7, NTS Air Quality Operating Permit Renewal Application Package, March, 2002
g Source: NAC 445B.22097

Table 2 Estimated Emissions of Criteria Pollutants

Criteria Pollutant	DIVINE STRAKE[a] (tons/yr)	NTS[b] (tons/yr)	Total (tons/yr)
Carbon Monoxide	0.2173	23.47	23.69
Nitrogen Oxide	3.7870	72.33	76.83
Particulates from Explosives[c]	12.7	89.24	101.94
PM10[d] from Explosives	12.7	61.96	65.57
Total Particulates[e]	1,102.13	89.24	1,191.37
Total PM10[e]	17.55	61.96	79.51

[a] POLU4WN program
[b] NTS Emissions Inventory, May 2005
[c] Particulates and PM10 from explosives includes all emissions reported by POLU4WN as "solids."
[d] Particulate matter with aerodynamic diameter less than or equal to 10 microns
[e] Total Particulates and Total PM10 were determined using COMBIC and are based on the calculated volume of the post-detonation crater. Total particulates includes particles between 10 and 100 microns in size.

Table 3 Estimated Emissions of Hazardous Air Pollutants

HAP	DIVINE STRAKE[a] (tons/yr)	NTS[b] (tons/yr)	Total (tons/yr)
Chlorine	0.8235	8 tons/yr per any individual HAP or 20 tons/yr of any combination of HAPs	Total for all HAPs combined is 10.1282 tons/yr
Chloromethane	0.3918		
Cyanide Compounds	2.1695		
Formaldehyde	0.2330		
Hexachloroethane	1.8370		
Hydrazine	0.4973		
Phosgene	0.7675		
Tetrachloroethene	1.2868		
Tetrachloromethane	1.1936		
Trichloromethane	0.9263		

[a]POLU4WN program
[b]NTS Class II Air Quality Operating Permit, Facility-wide HAP Emissions Cap, June, 2004

Table 4 Detailed Estimated Emissions Using the POLU4WN Model

CRITERIA POLLUTANTS	Chemical Formula	Emissions (lbs.)	Total Emissions (lbs.)	Total Emissions (tons)
Carbon Monoxide	CO	434.6639	434.6839	**0.21733195**
Nitrogen Oxides (NOX)				
	N_2O_4	2855.7378		
	N_2O_5	1676.1508		
	N_2O_3	1179.5870		
	NO_2	713.9344		
	NO	465.6526		
	N_2O	683.0234		
Total NOX			7,574.0860	**3.78704300**
Particulates[1]				
Calcium Hydroxide	CaH_2O_2	24,872.6330		
Calcium Chloride	$CaCl_2$	18,712.6800		
Ammonium Chloride-II	NH_4Cl	1660.2928		
Ammonium Perchlorite	NH_4O_4Cl	1,823.2733		
Calcium Oxide	CaO	870.2280		
Nitrogen Oxide	N_2O_4	1,427.8689		
Calcium, Alpha	Ca	1243.8920		
Carbon	C	186.3821		
Total Particulates			50,797.2491	**25.39862400**
Chlorine Compounds				
Chlorine	Cl & CL_2	1,650.6244	1,650.6244	**0.82531220**
Chloromethane (Methyl Chloride)	CH_3Cl	783.5154	783.5154	**0.39175770**
Dichloromethane (Methyl Chloride)	CH_2Cl_2	1318.0818	1318.0818	**0.65904090**
Hexachloraethane	C_2Cl_6	3,674.0129	3,674.0129	**1.83700645**
Phosgene (Carbonic Dichloride)	$COCl_2$	1,535.0802	1,535.0802	**0.76754010**
Tetrachloroethene (Tetrachloroethylene)	C_2Cl_4	2,573.5967	2,573.5967	**1.28679835**
Tetrachloromethane (Carbon Tetrachloride)	CCl_4	2,387.2146	2,387.2146	**1.19360730**
Trichloromethane (Chloroform)	$CHCl_3$	1,852.6481	1,852.6481	**0.92632405**
Total Chlorine Compounds			15,774.8330	**7.88741650**
Cyanide Compounds				
Cyanogen Chloride	CNCl	953.9609		
CNN Radical Cyanogen	CN_2	1242.2472		
Cyanide	CN	403.7529		
CNO Radical	CNO	652.0347		
Hydrogen Cyanide	CNH	419.3946		
Hydrogen Isocyanate (Cyanic Acid)	CNHO	667.6765		
Total Cyanide Coumpounds			4,339.0668	**2.16953340**
Formaldehyde	CH_2O	465.9475	465.9475	**0.23297375**
Hydrazine	N_2H_4	497.3086		
	N_2H_4	497.3086		
			994.6172	**0.49730860**
TOTAL HAZARDOUS AIR POLLUTANTS				**10.7872028**

1 Particulates from explosives includes all emissions reported by POLU4WN as "solids."

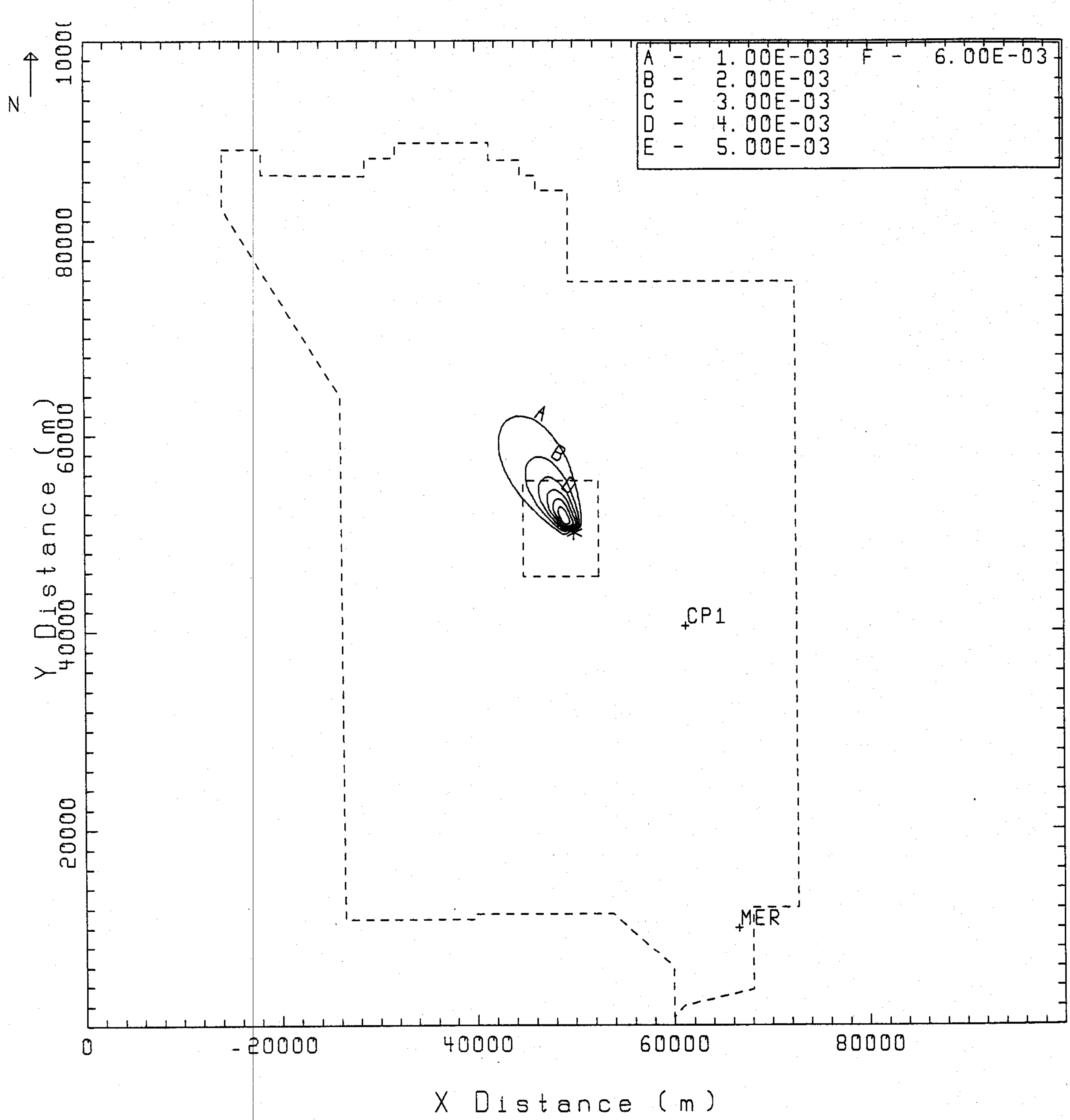
3. Information as to whether DTRA plans any future tests

At this time there are no plans to conduct future tests at the U16b Tunnel in Area 16 of the NTS.

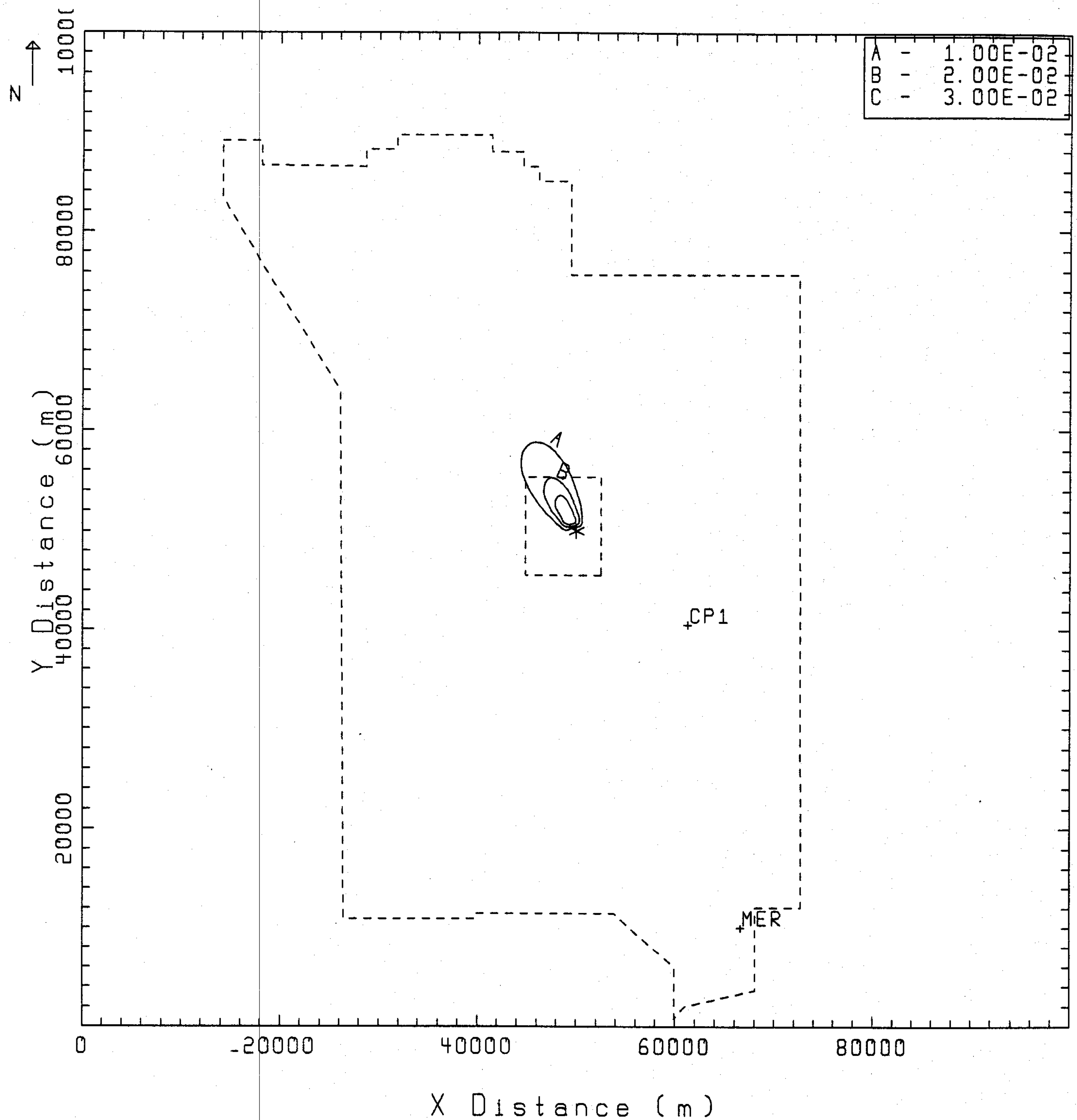
APPENDIX A

PLUME PLOTS GENERATED BY OPEN BURN/OPEN DETONATION MODEL

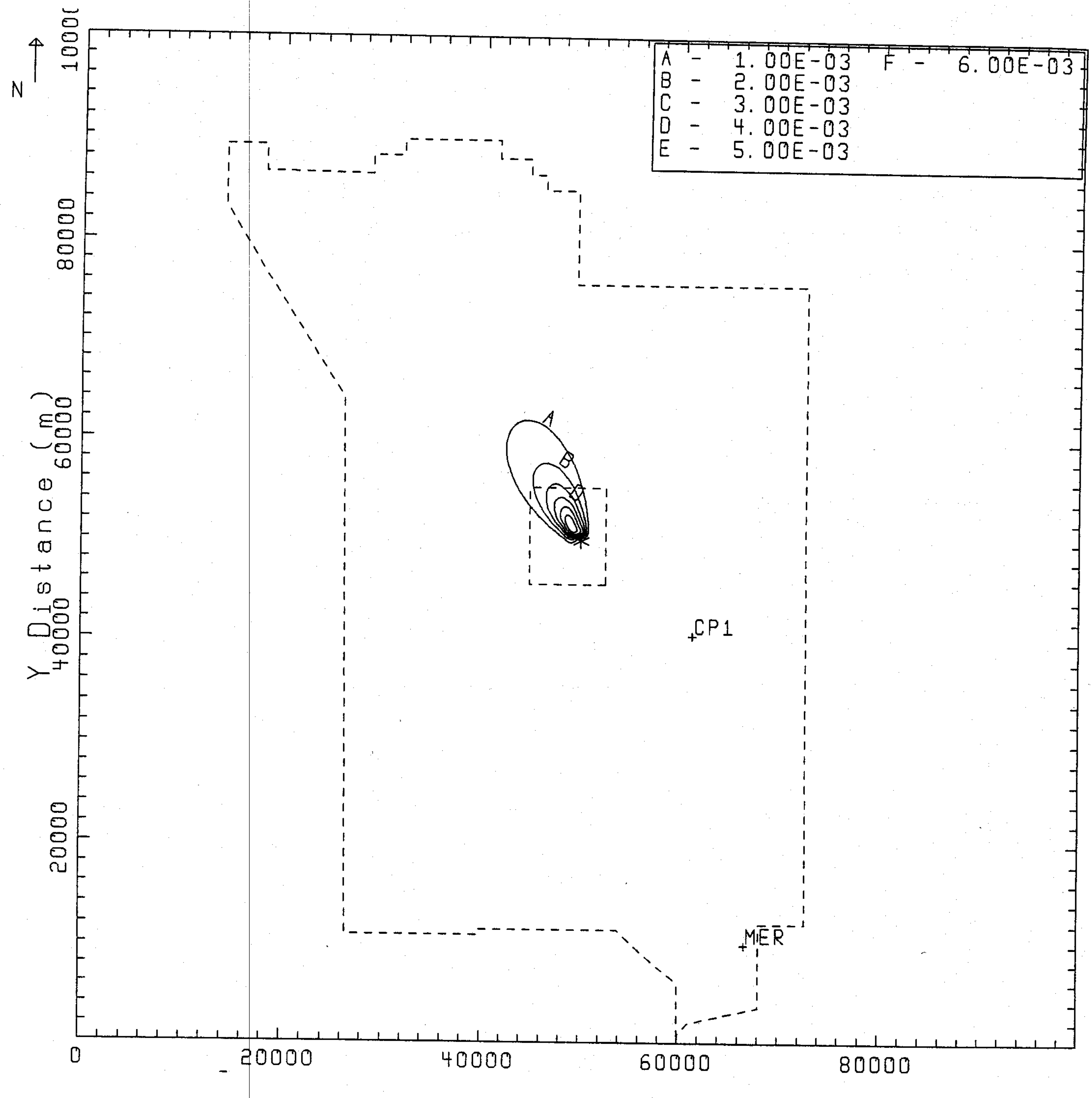
CRITERIA POLLUTANTS



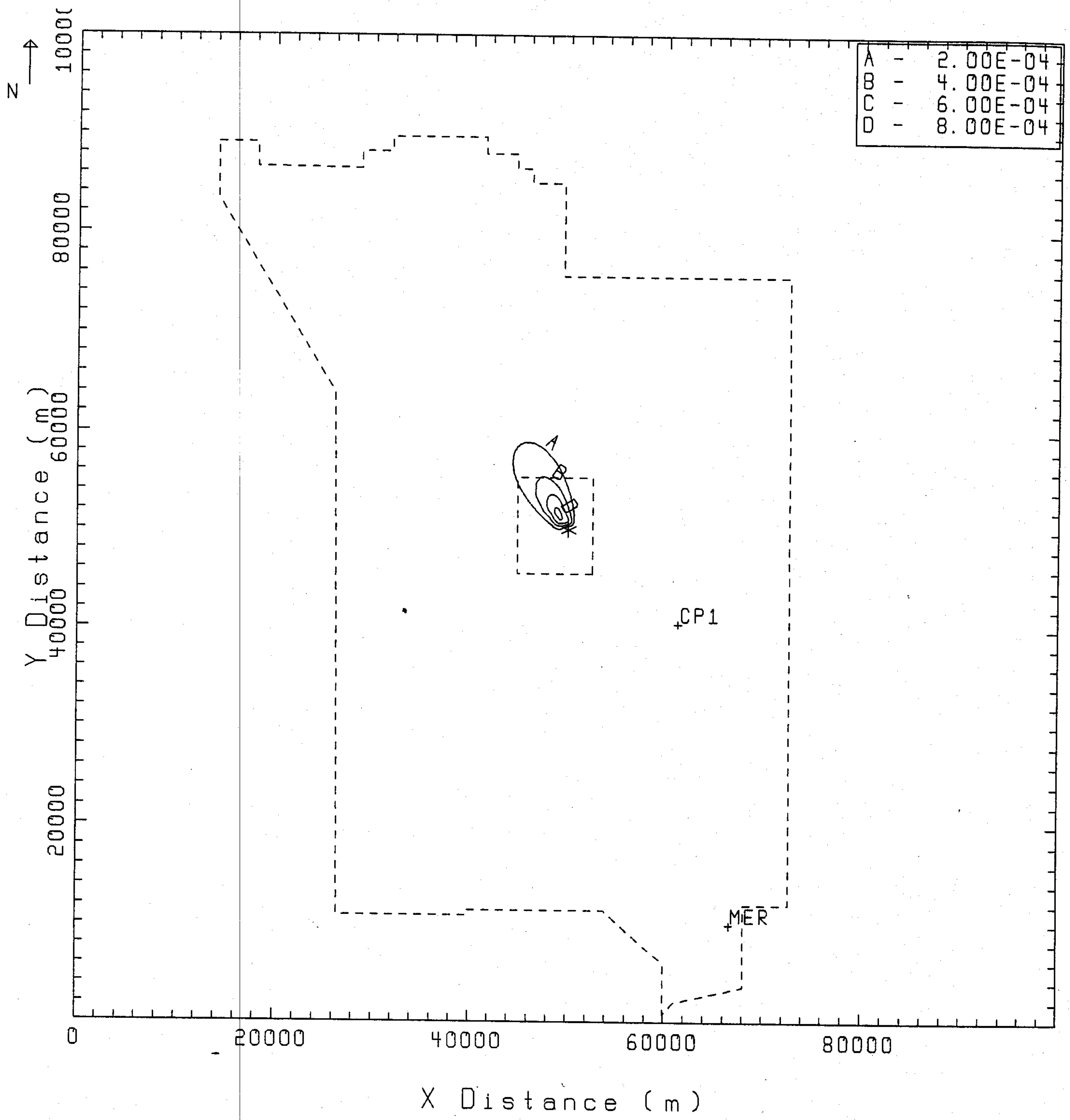
Divine Strake - June 3 Climatology
Highest 1-hr Nitrogen Dioxide (NO2)
Concentration (ppm)



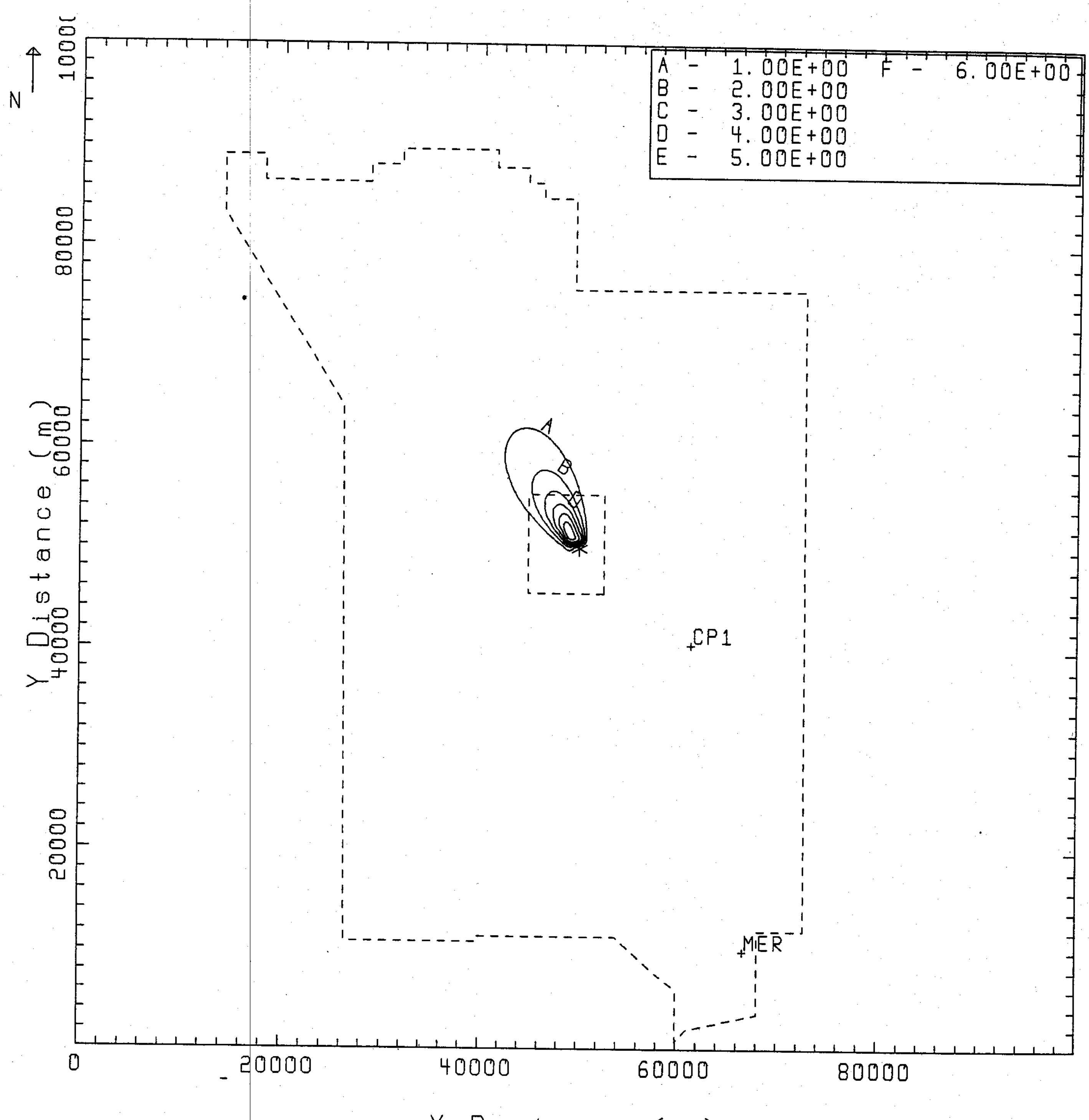
Divine Strake - June 3 Climatology
Highest 1-hr Nitrogen Oxide (NOX)
Concentration (ppm)



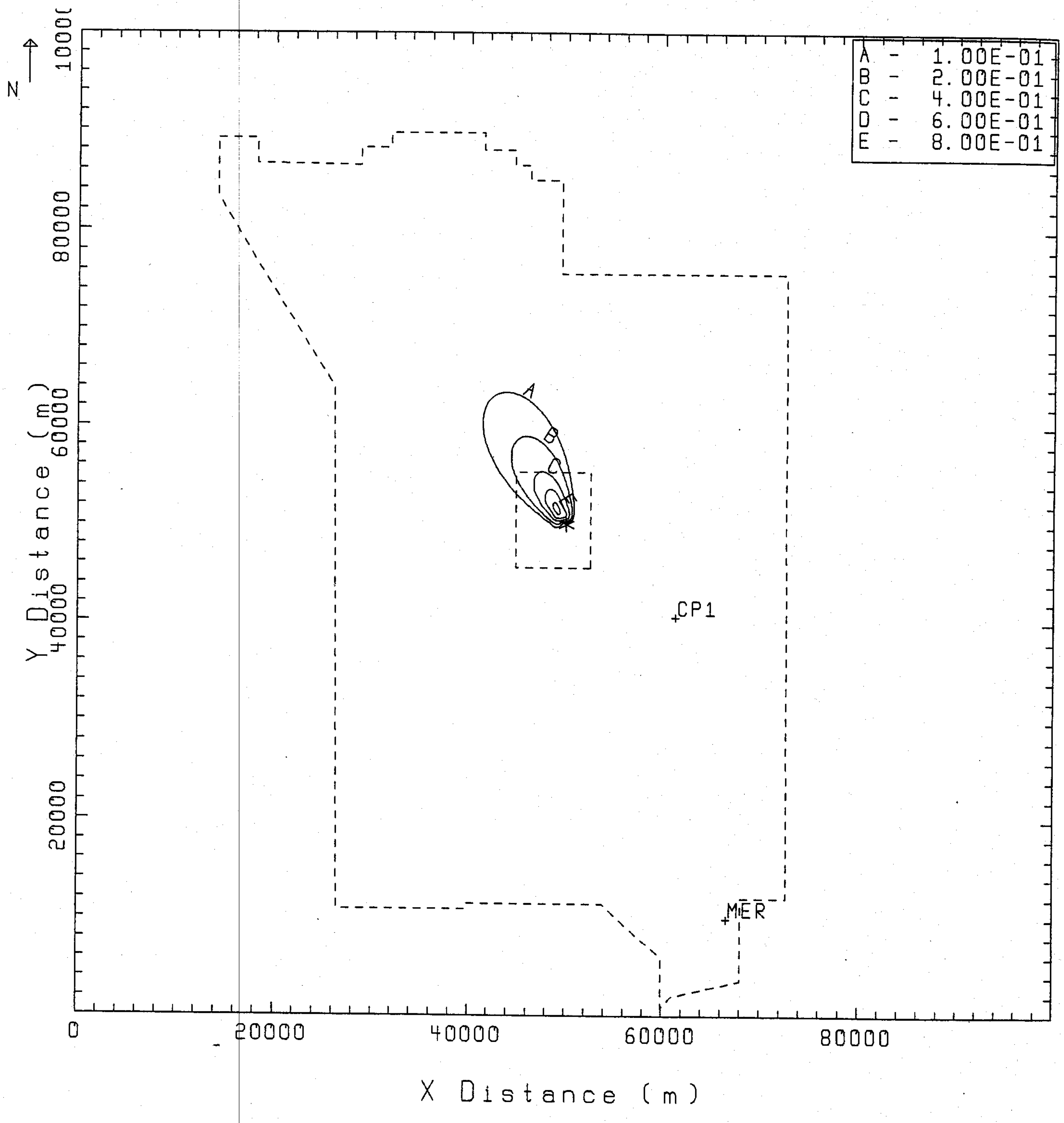
Divine Strake - June 3 Climatology
Highest 1-hr Carbon Monoxide (CO)
Concentration (ppm)



Divine Strake - June 3 Climatology
Highest 8-hr Average Carbon Monoxide (CO)
Concentration (ppm)

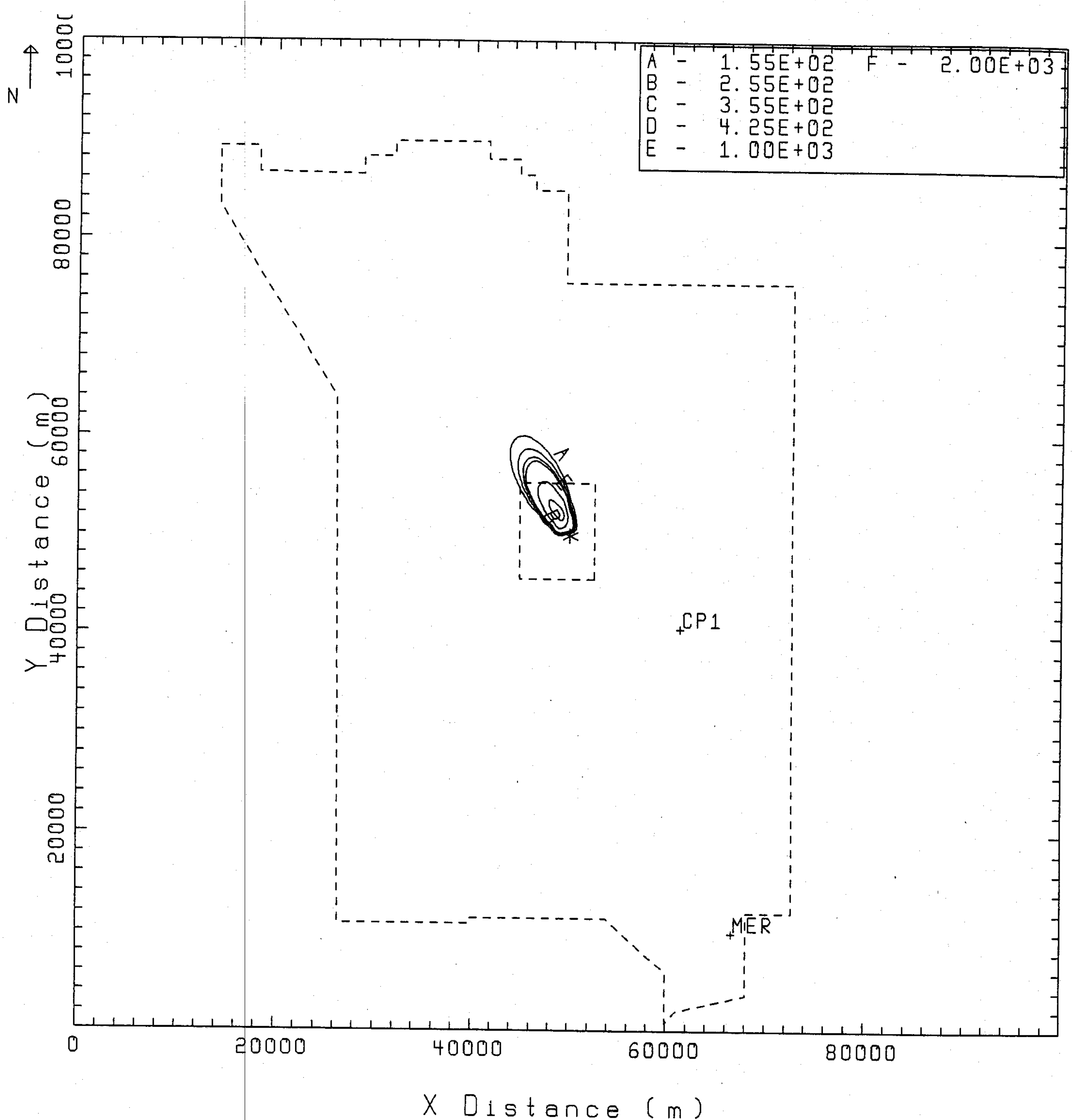


Divine Strake - June 3 Climatology
Highest 1-hr Ozone (O3) Concentration (ppb)

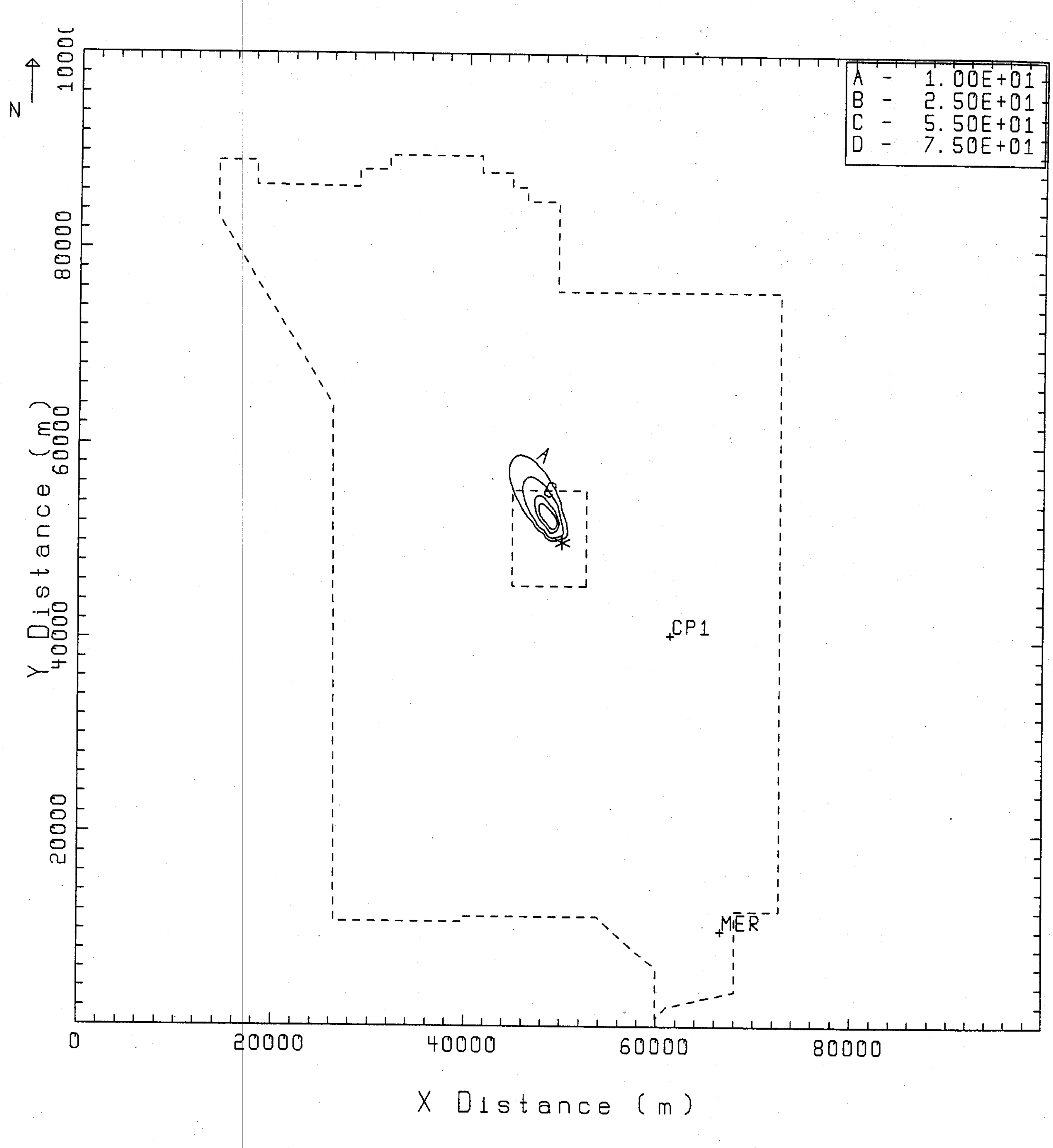


Divine Strake - June 3 Climatology
Highest 8-hr Average Ozone (O3) Concentration
(ppb)

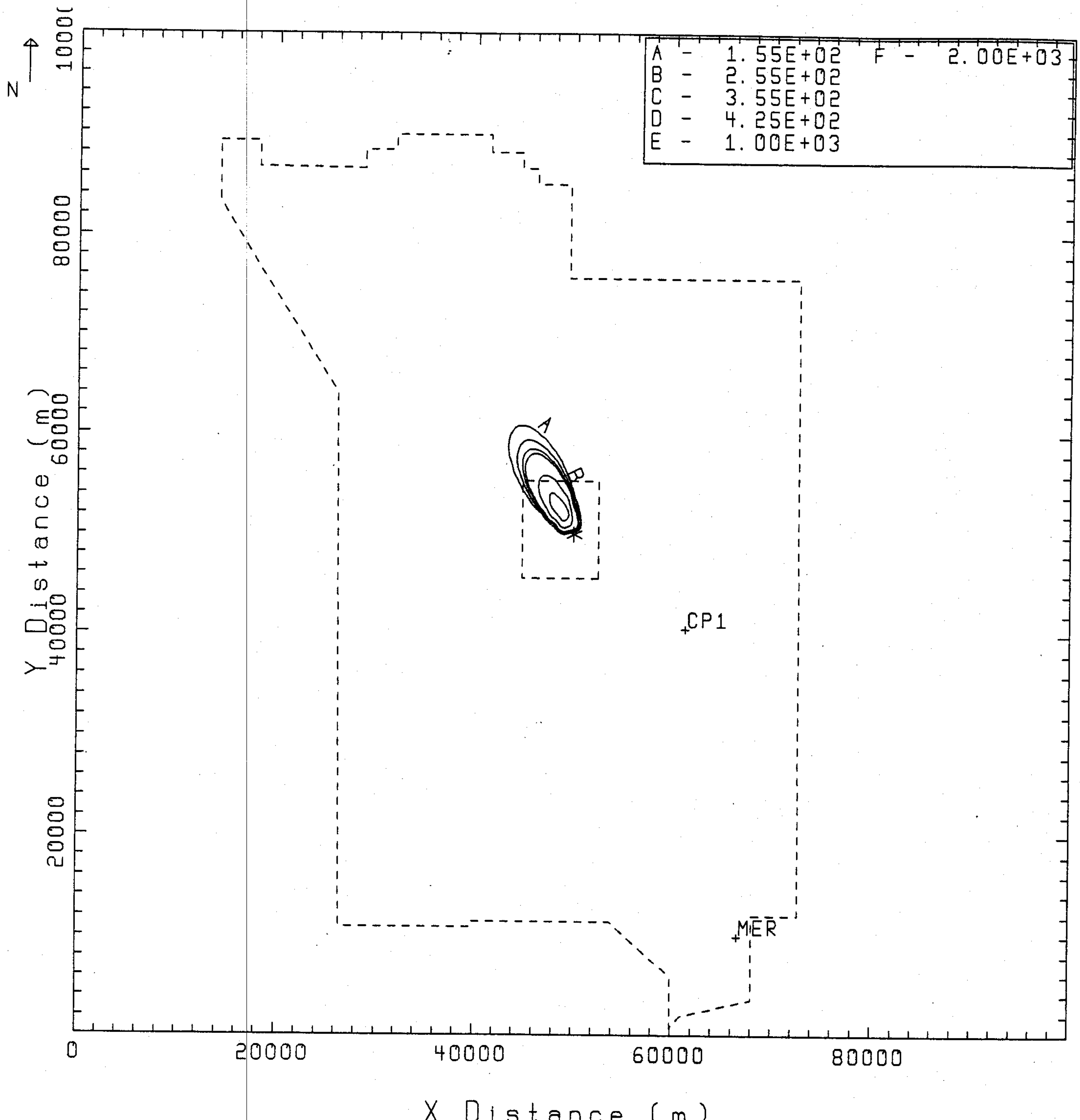
Note: The following four plume plots are for PM10 and for total particulates. The two plots identified with "PM10 (exp) are the one hour and 24 hour plots for PM10 from the detonation. The two plots labeled "PM10 (exp+dirt)" are the one hour and 24 hour plots for total particulates.



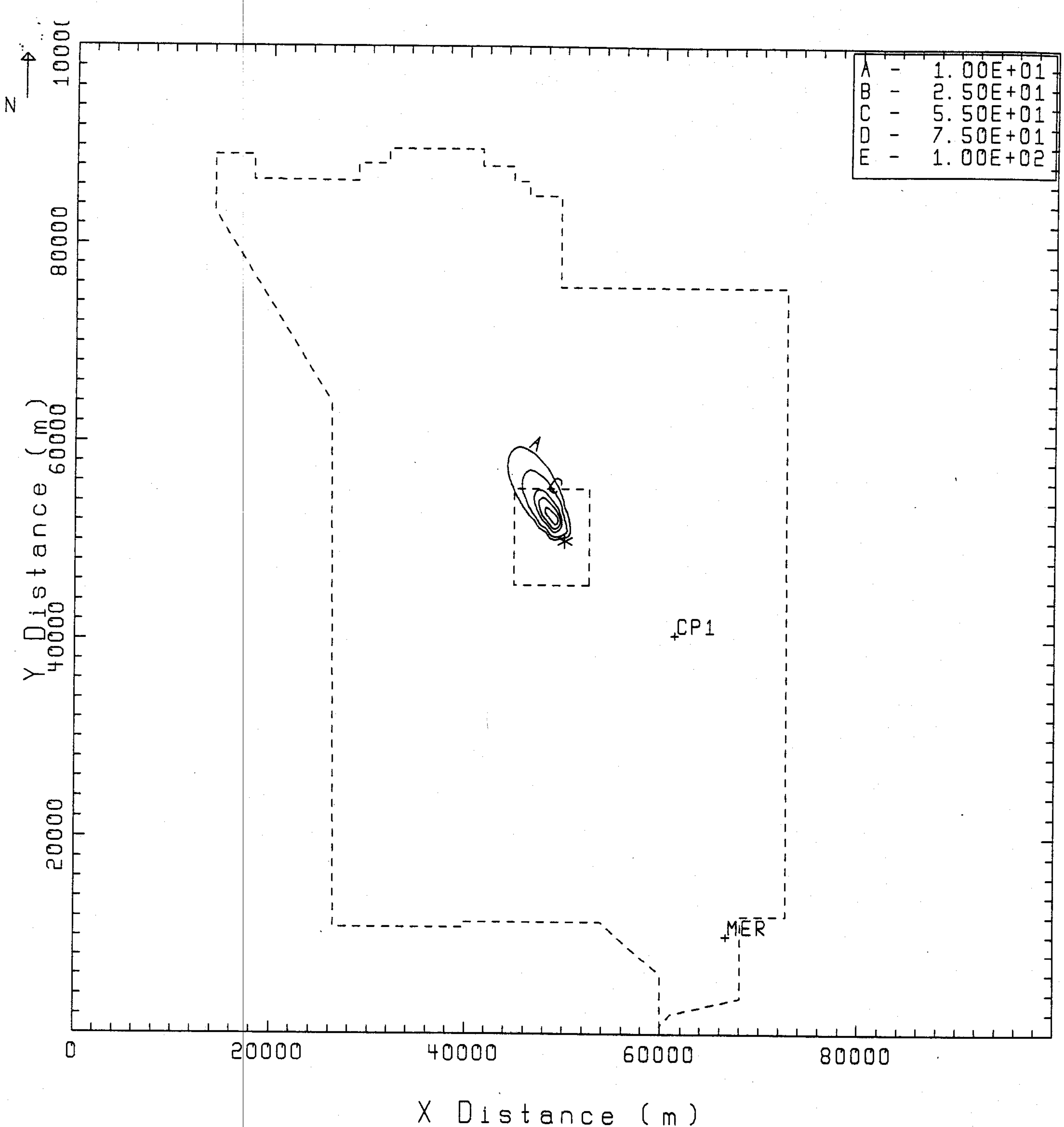
Divine Strake - June 3 Climatology
Highest 1-hr PM10 (exp) Concentration (ug/m3)



Divine Strake - June 3 Climatology
Highest 24-hr Average PM10 (exp) Concentration
(ug/m3)

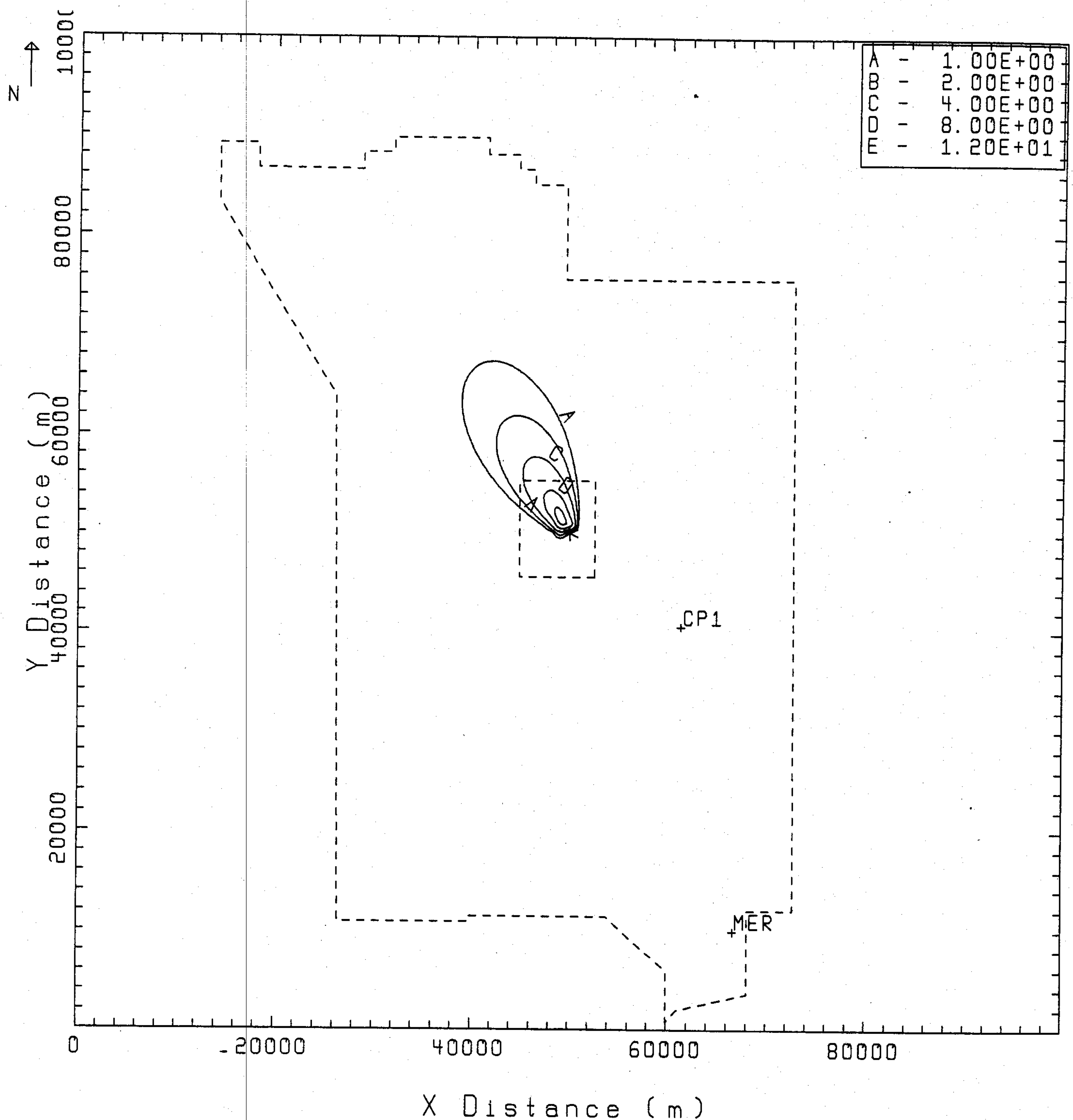


Divine Strake - June 3 Climatology
Highest 1-hr PM10 (exp+dirt) Concentration
(ug/m3)

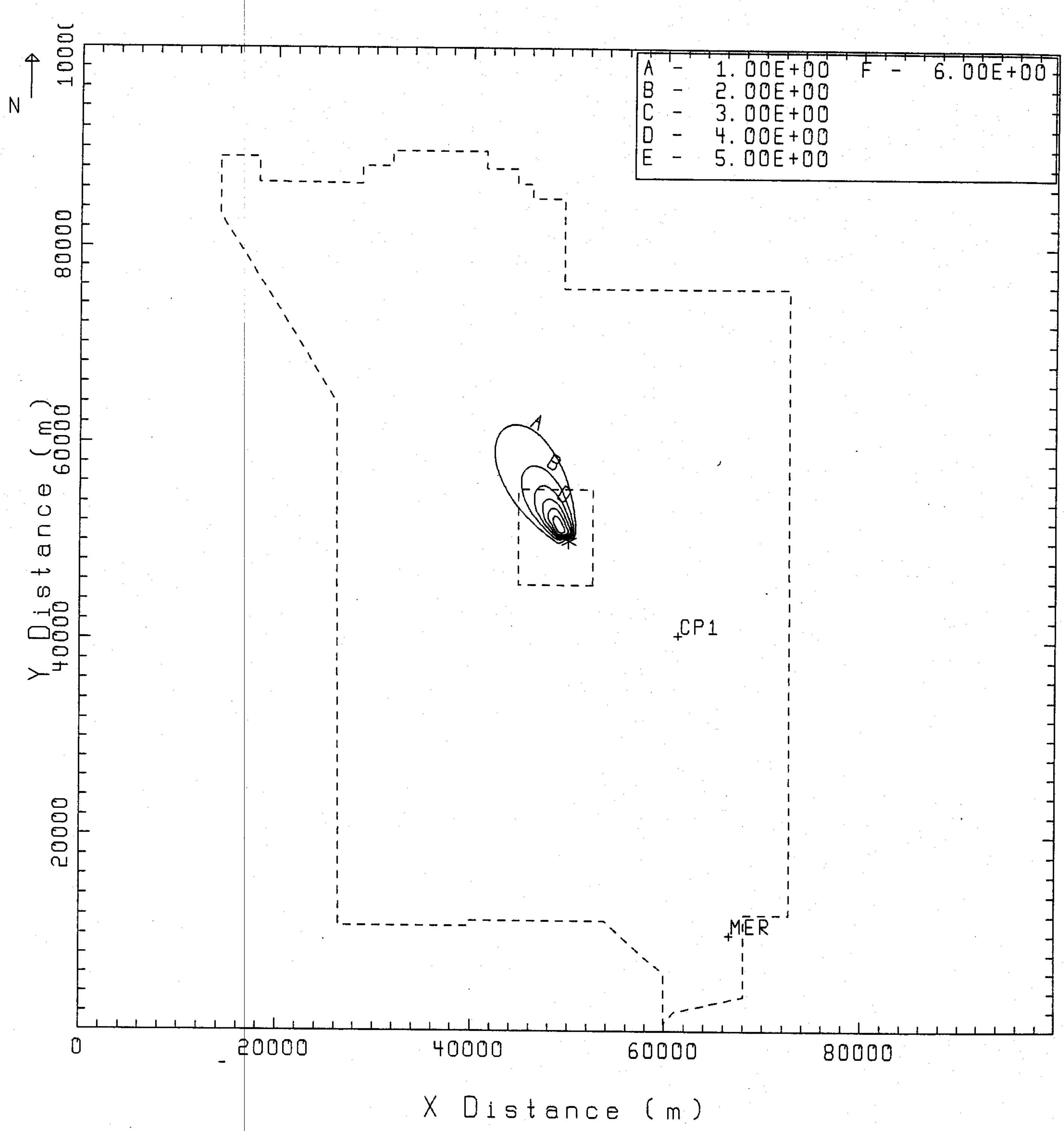


Divine Strake - June 3 Climatology
Highest 24-hr Average PM10 (exp+dirt)
Concentration (ug/m3)

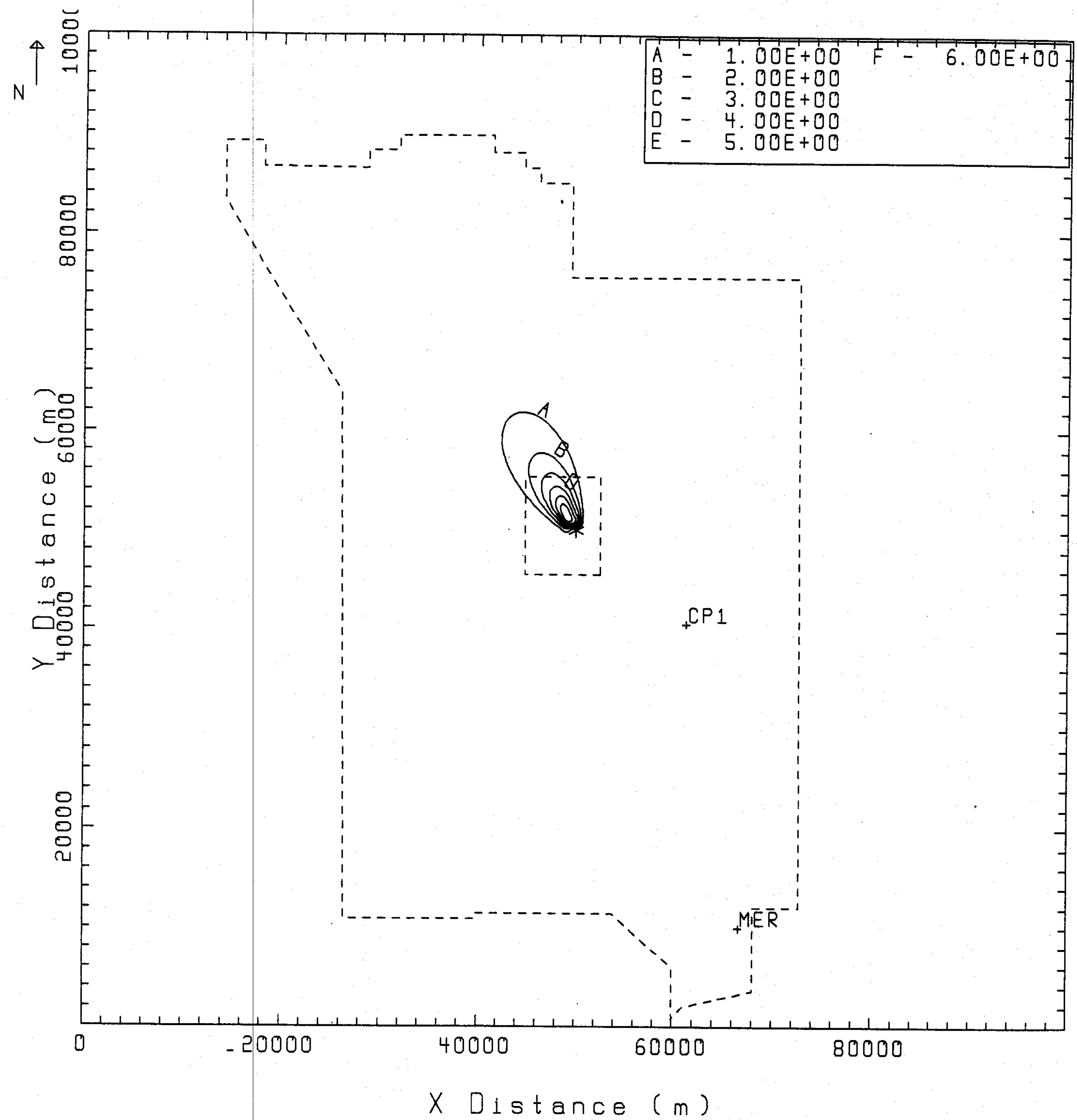
HAZARDOUS AIR POLLUTANTS



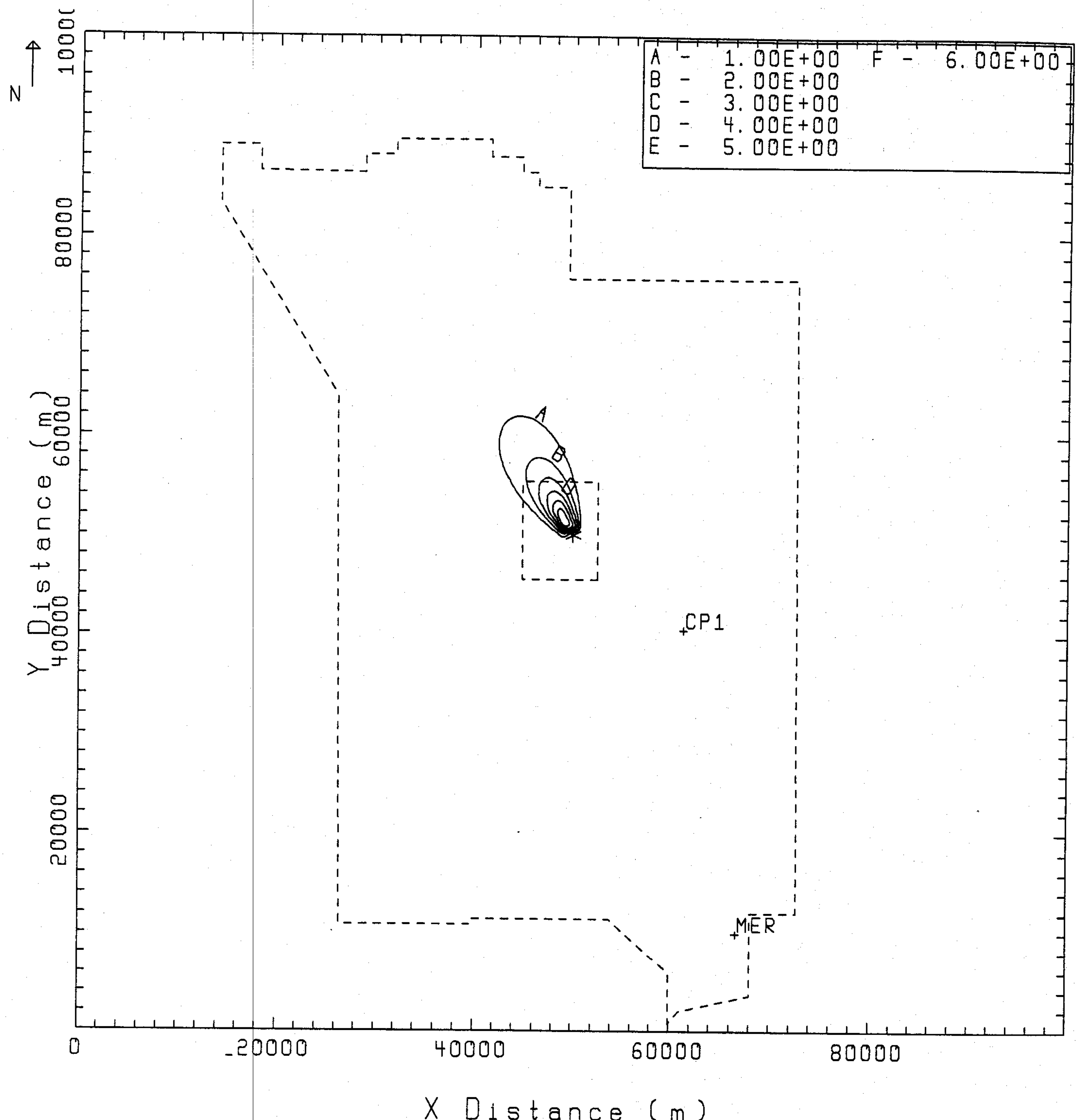
Divine Strake - June 3 Climatology
Highest 1-hr Chlorine (Cl2, Cl) Concentration
(ppb)



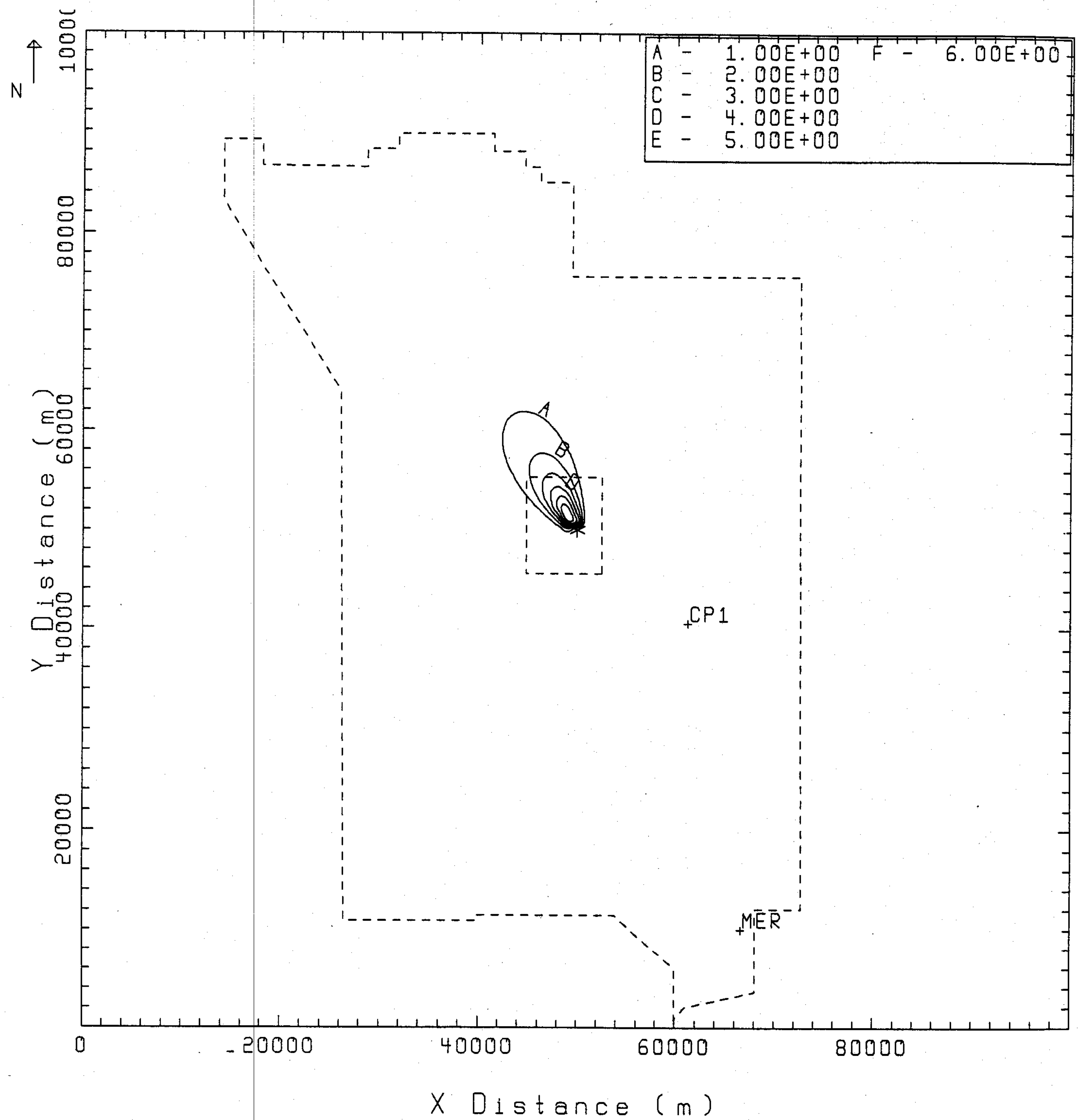
Divine Strake - June 3 Climatology
Highest 1-hr Methyl Chloride (CH3Cl)
Concentration (ppb)



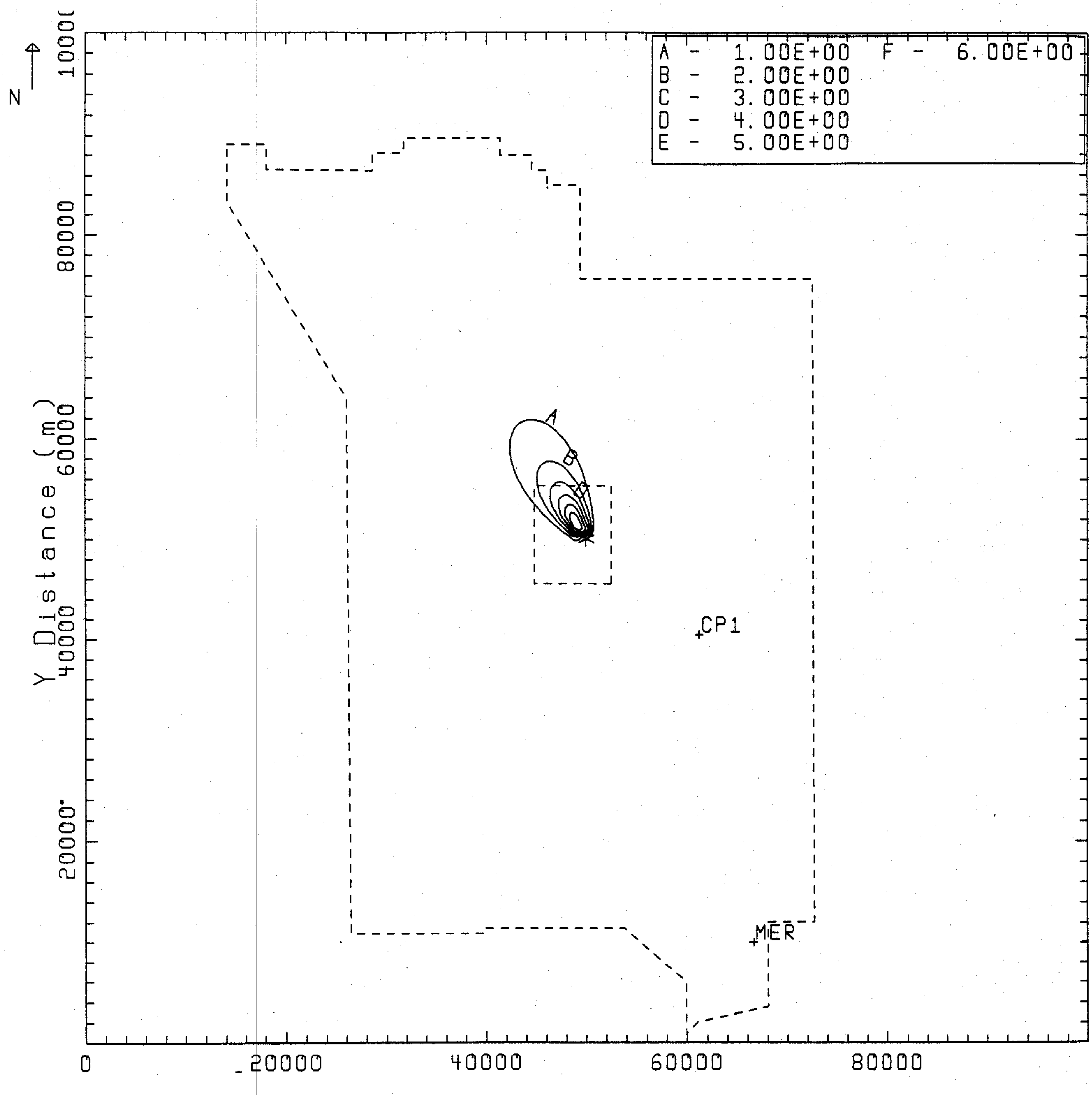
Divine Strake - June 3 Climatology
Highest 1-hr Cyanogen Chloride (CNCl)
Concentration (ppb)



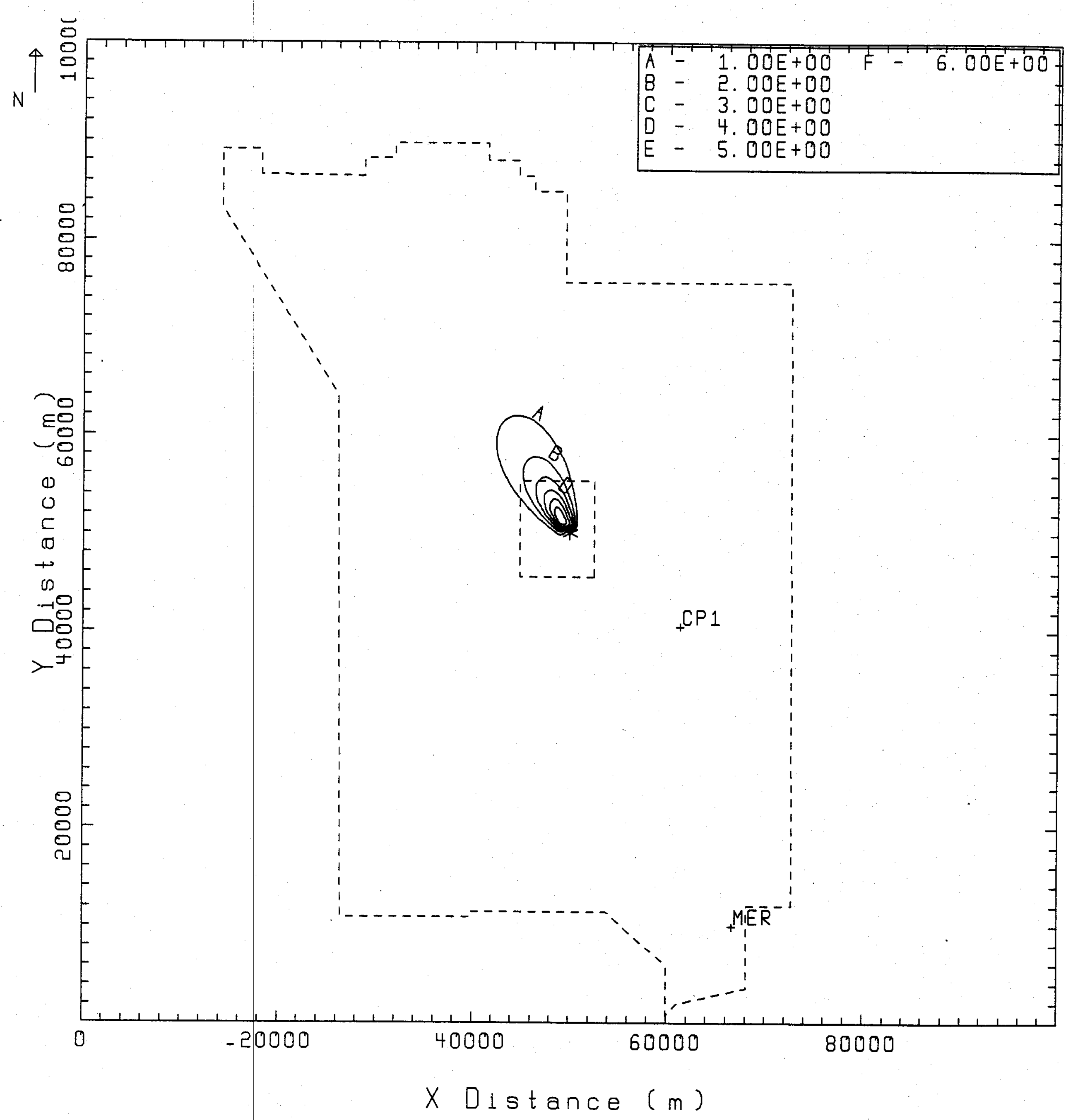
Divine Strake - June 3 Climatology
Highest 1-hr Hydrogen Isocyanate (HNCO)
Concentration (ppb)



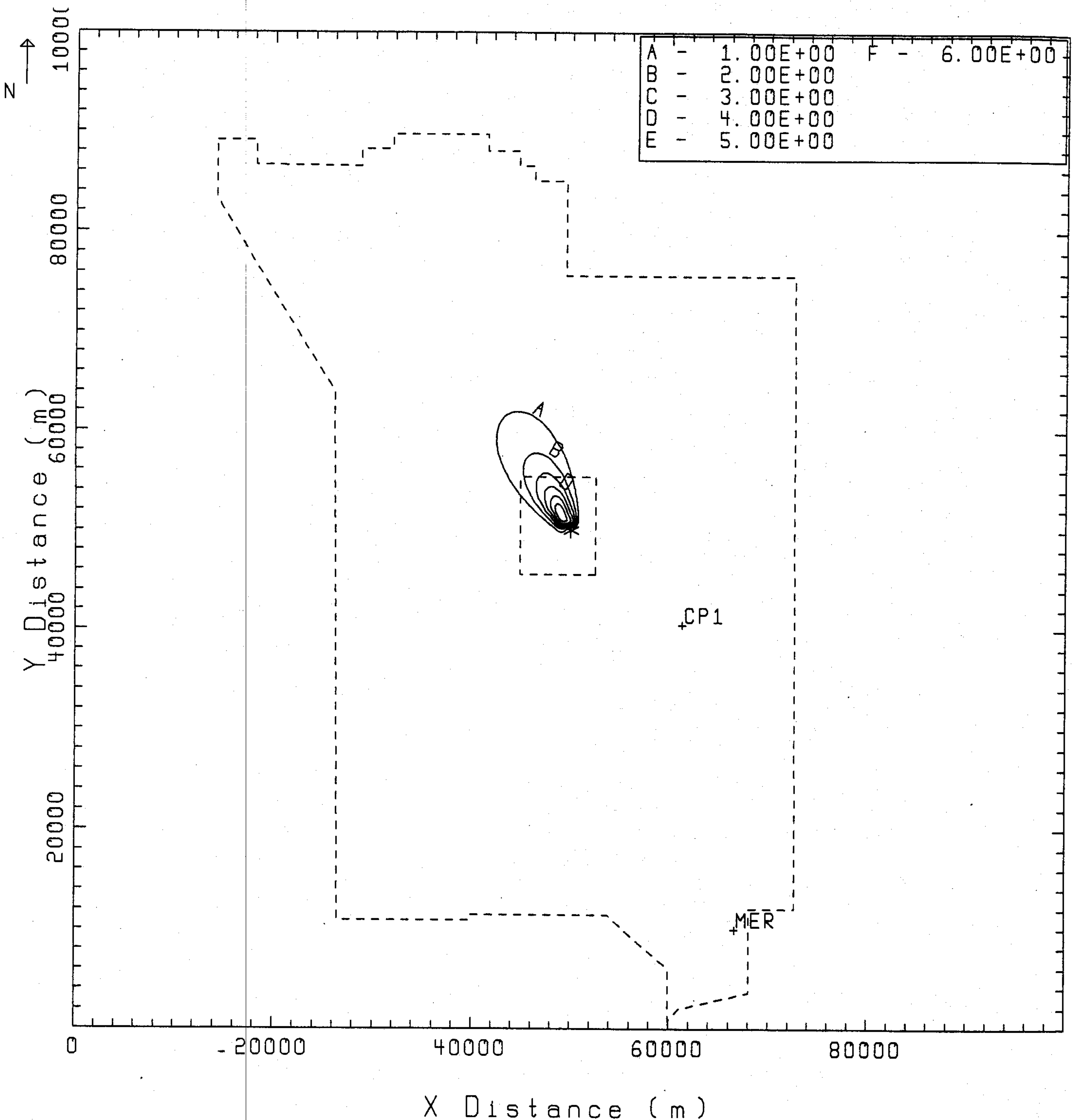
Divine Strake - June 3 Climatology
Highest 1-hr CNN Radical Cyanogen (CN2)
Concentration (ppb)



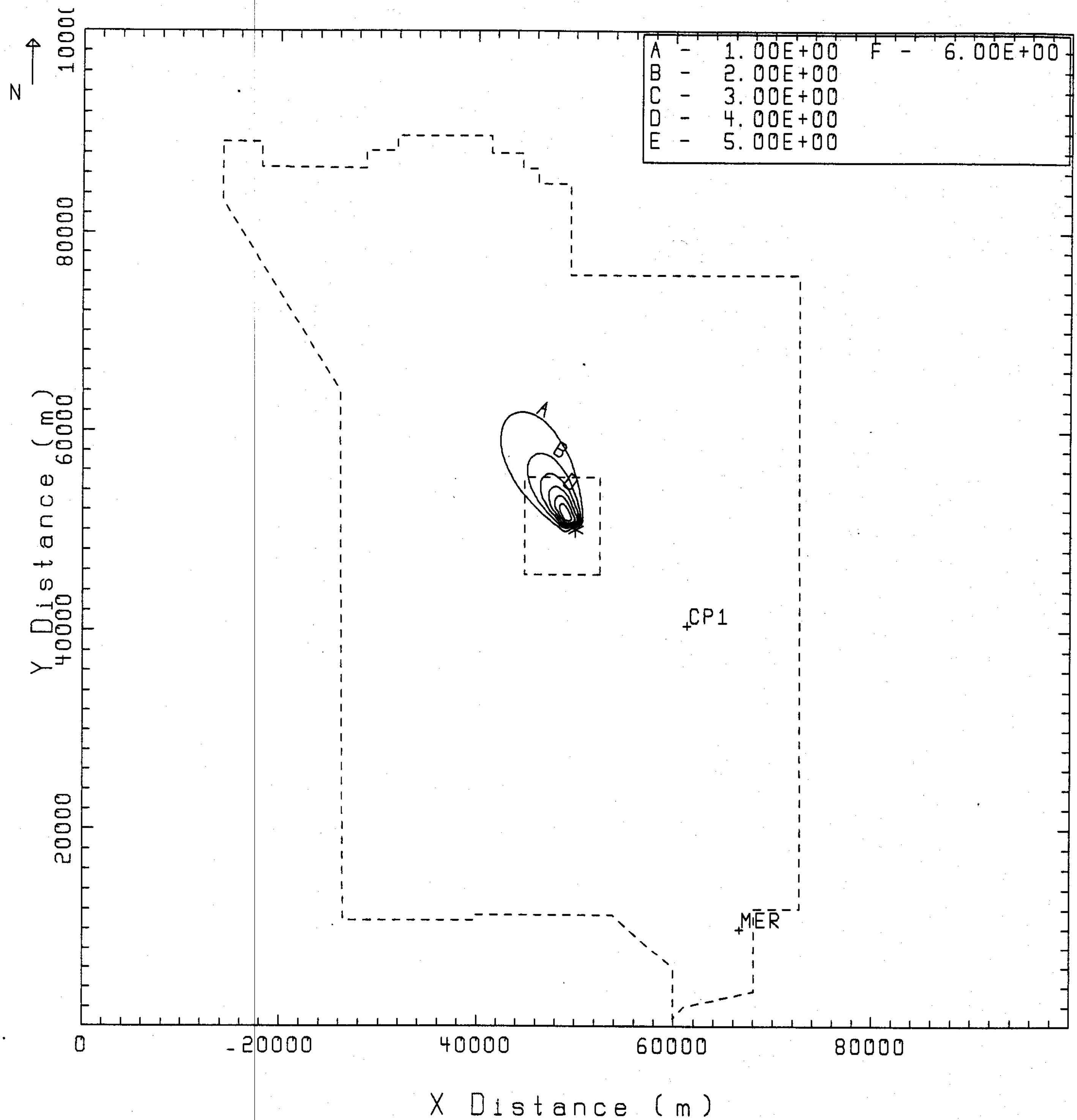
Divine Strake - June 3 Climatology
Highest 1-hr Hydrogen Cyanide (HCN)
Concentration (ppb)



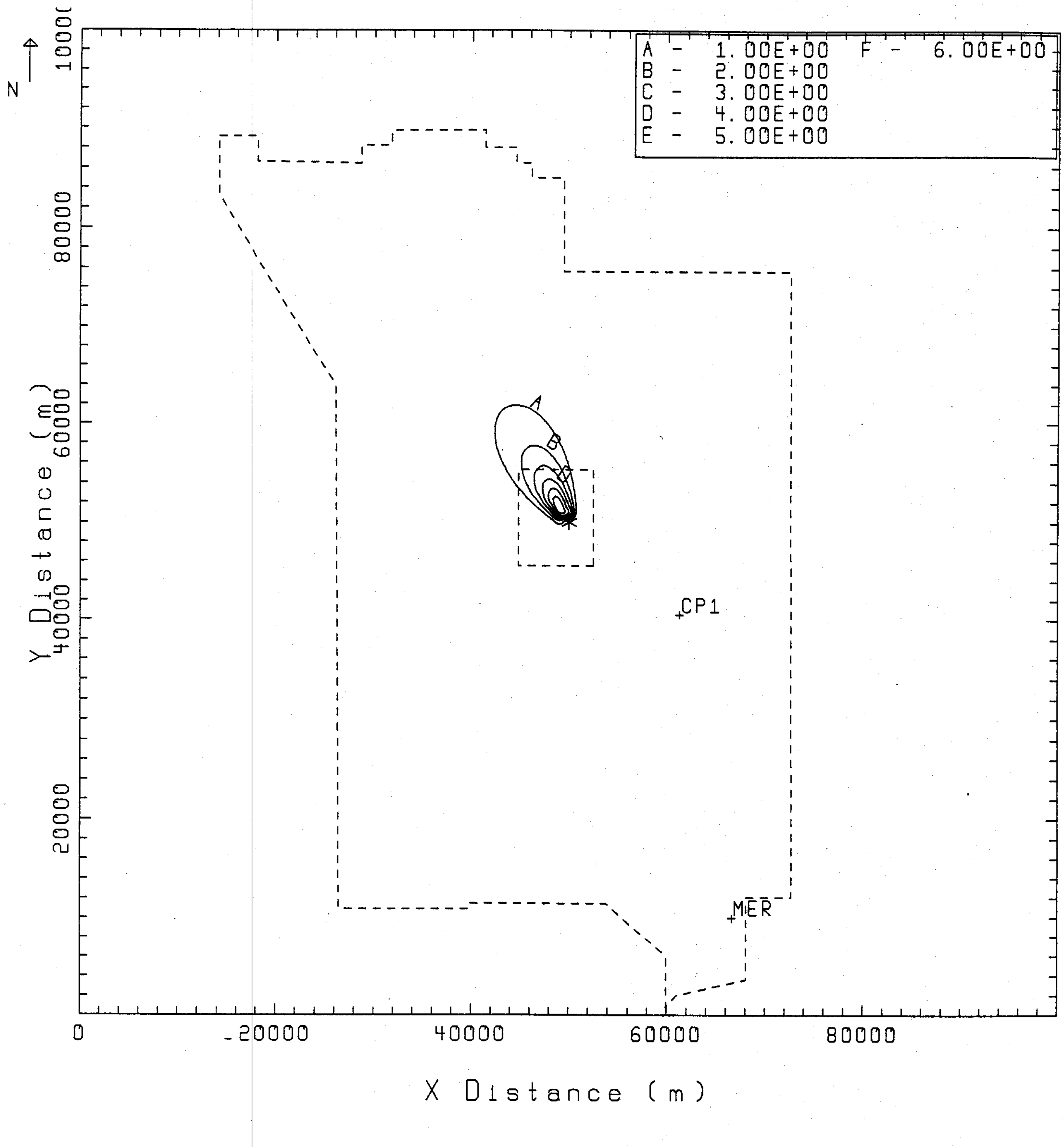
Divine Strake - June 3 Climatology
Highest 1-hr Cyanide (CN) Concentration (ppb)



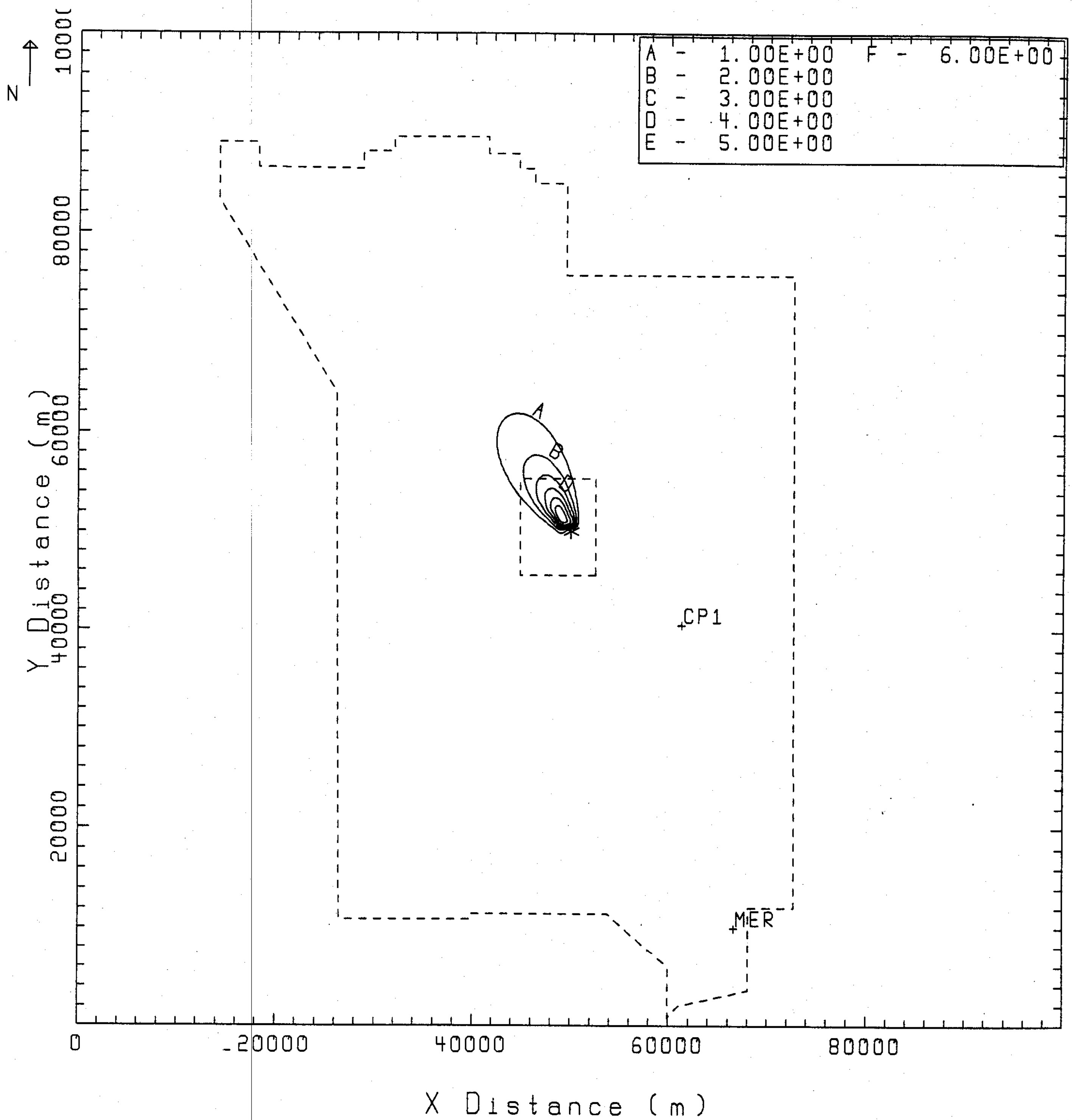
Divine Strake - June 3 Climatology
Highest 1-hr Hexachloroethane (C2Cl6)
Concentration (ppb)



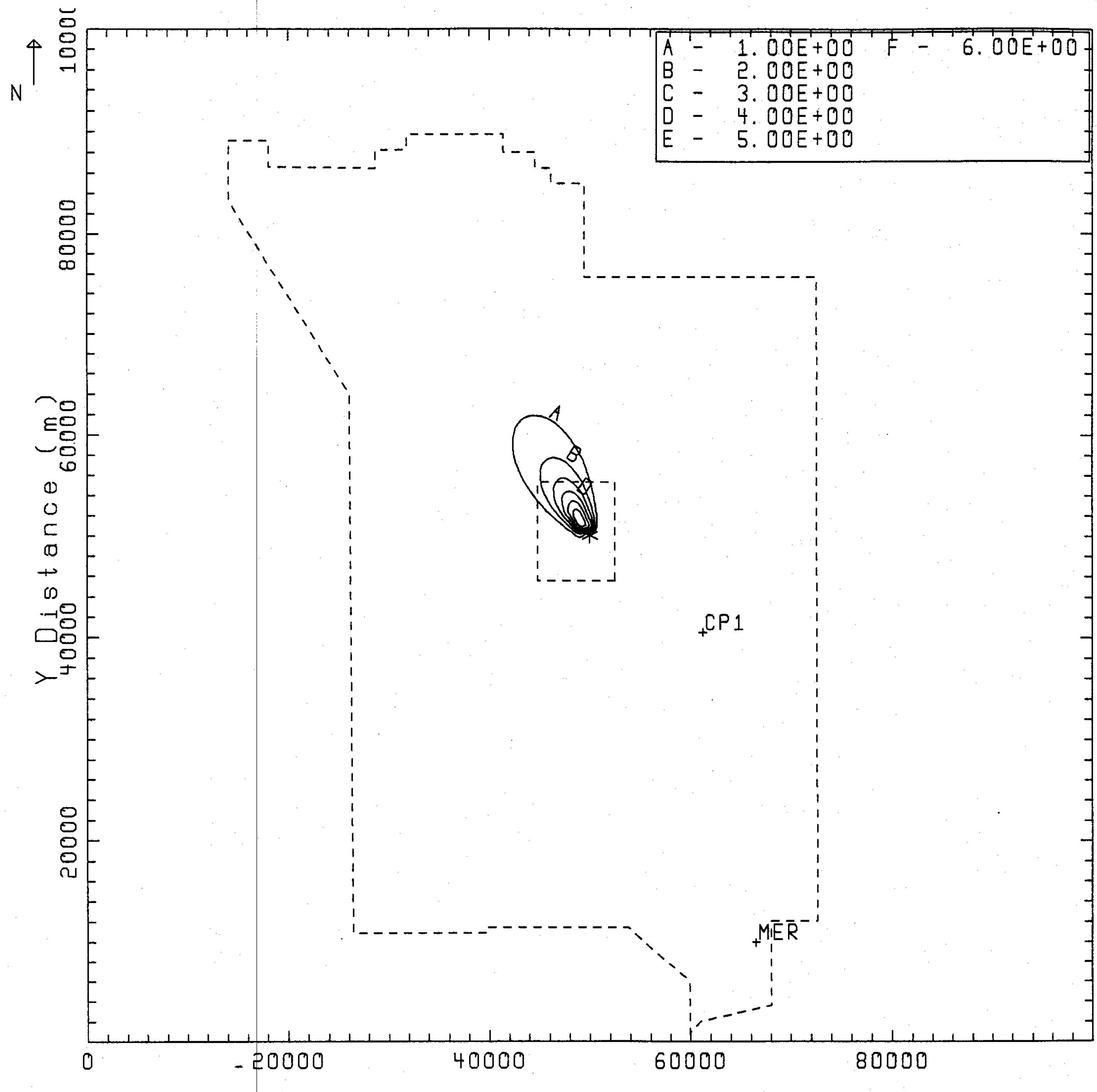
Divine Strake - June 3 Climatology
Highest 1-hr Tetrachloroethene (C2Cl4)
Concentration (ppb)



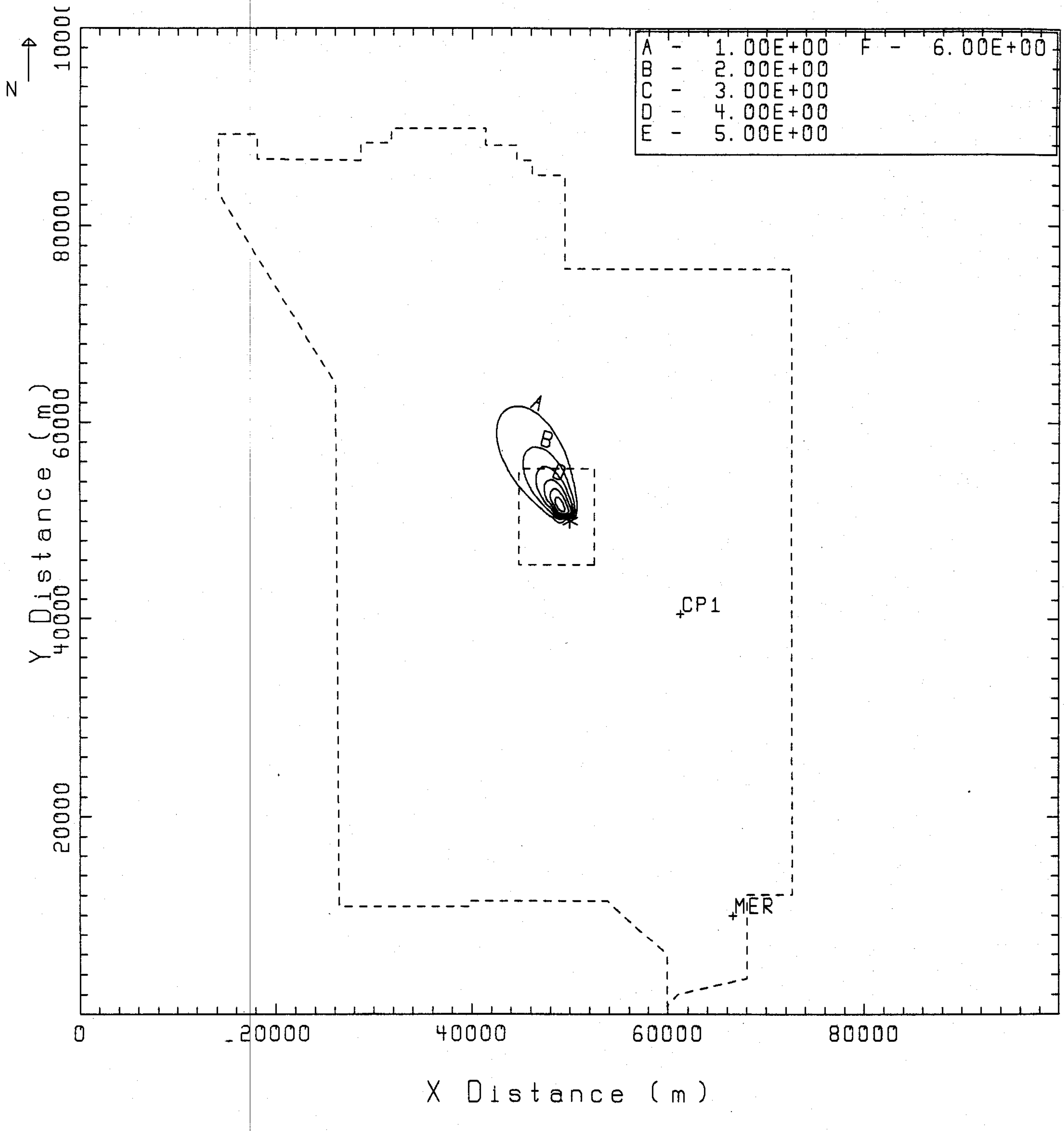
Divine Strake - June 3 Climatology
Highest 1-hr Carbon Tetrachloride (CCl4)
Concentration (ppb)



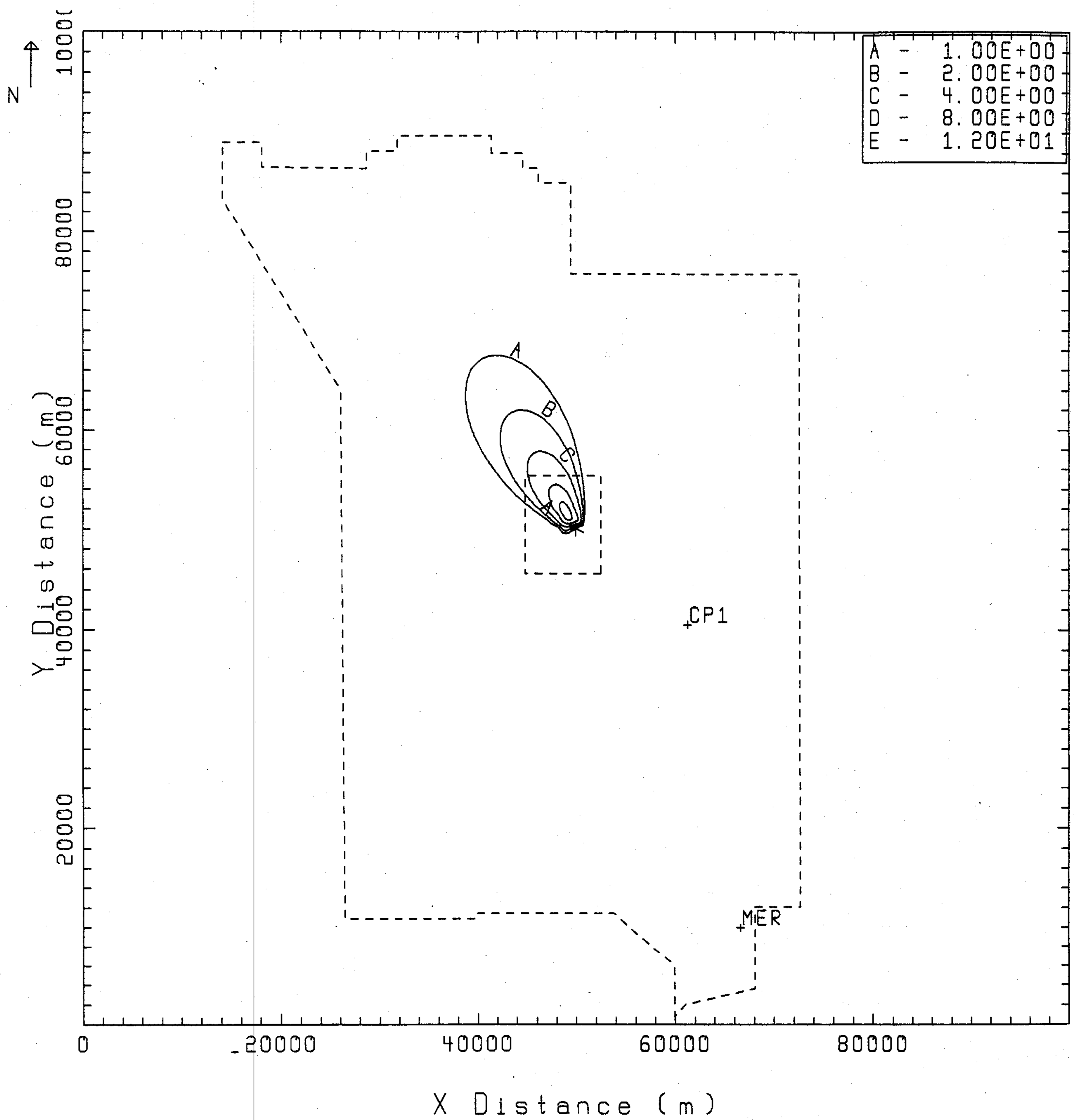
Divine Strake - June 3 Climatology
Highest 1-hr Chloroform (CHCl3) Concentration
(ppb)



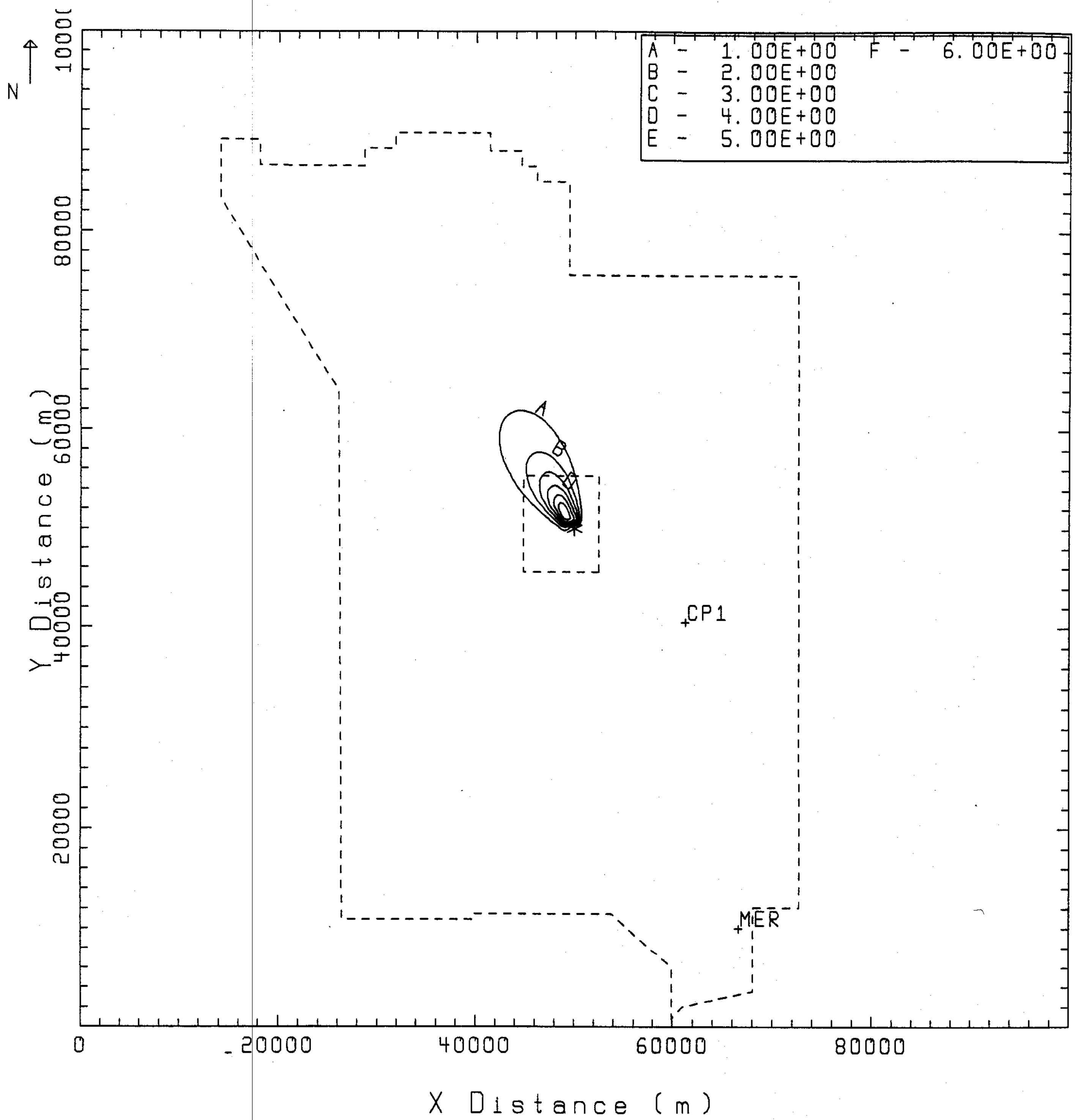
Divine Strake - June 3 Climatology
Highest 1-hr Phosgene (COCl2) Concentration
(ppb)



Divine Strake - June 3 Climatology
Highest 1-h Dichloromethane (CH2CL2)
Concentration (ppb)



Divine Strake - June 3 Climatology
Highest 1-hr Hydrazine (N2H4)t Concentration
(ppb)



Divine Strake - June 3 Climatology
Highest 1-hr Formaldehyde(HCHO) Concentration
(ppb)