Wolf Eagle Environmental

"Advancing Industry while Protecting the Environment"

Dispersion Modeling of Emissions from Natural Gas Compressor Stations

Town of DISH
Texas

Wolf Eagle Environmental

December 2009

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INTRODUCTION

Gaussian dispersion modeling is a widely used method for estimating atmospheric concentrations of air pollutants, given source emission rate information, meteorological data, and terrain data. The objective of this project was to conduct Gaussian dispersion modeling to estimate concentrations of air pollutants surrounding natural gas compressor stations located near Dish, Texas (see Fig. 1), to determine whether the potential exists for adverse impacts on human health. The compressor stations are not actually shown in Fig. 1, since they were installed after the aerial photo below was taken, but are located in the vicinity of the white rectangle. Pictures of the compressor stations have been published previously (Wolf Eagle Environmental, Sept. 2009).

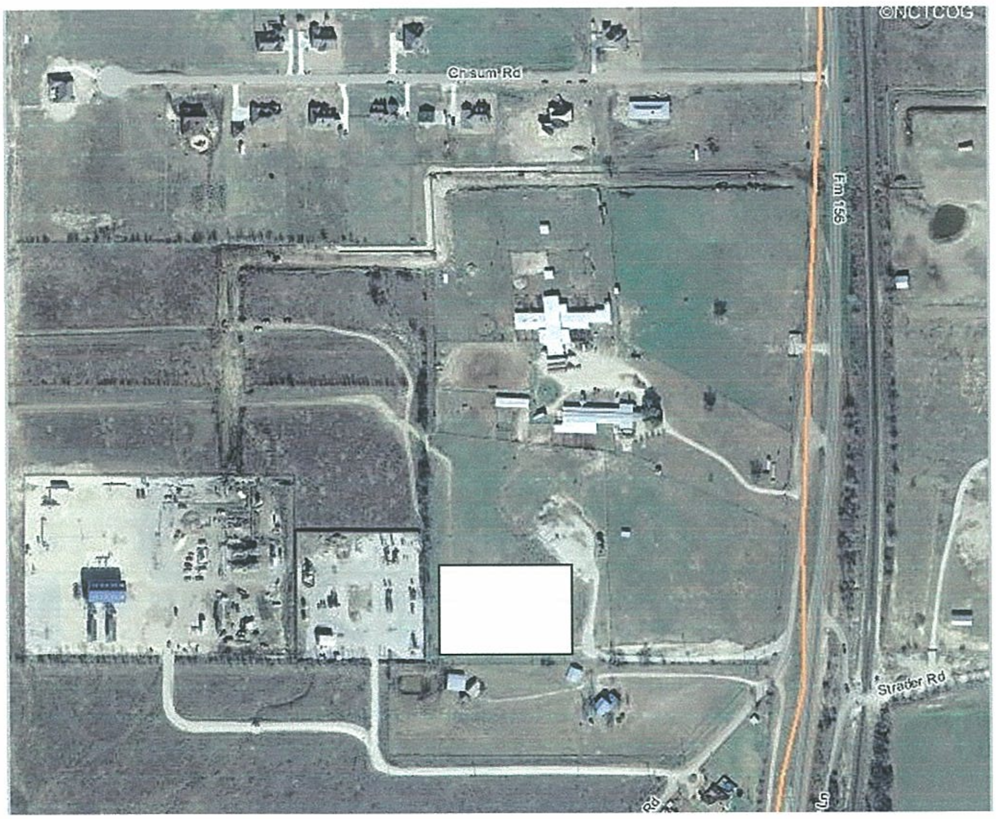

Fig. 1. Location modeled near Dish, Texas

The compressor stations are owned by 5 different entities (Crosstex, Chesapeake, Atmos, Energy Transfer, and Enbridge). The stations contain multiple compressor engines ranging in size from 1231 to 3500 hp, as well as support equipment that emits fugitive emissions (condensate tanks, truck rack, site fugitive, and compressor blowdown emissions).

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Field measurements of concentrations represent snapshots in time and space. A field measurement provides the pollutant concentration at a given time, but does not tell how that concentration is likely to vary as meteorological conditions vary (atmospheric concentrations of pollutants vary depending on meteorological conditions). In addition, a field measurement provides the pollutant concentration at the given location sampled, but does not provide concentrations at other locations. Collecting samples at a wide variety of locations is often cost-prohibitive.

Dispersion modeling can supplement field measurements of concentrations in order to provide a more complete picture of how concentrations vary as a function of time and space. For this project, a year's worth of hourly meteorological data was processed through the dispersion model software to predict how pollutant concentrations would be likely to change as meteorological conditions change. In addition, pollutant concentrations were estimated at 5688 locations surrounding the compressor stations (at points 50m apart covering a grid approximately 3900 m x 3550 m), to provide a more complete picture of how concentrations vary as a function of location.

Dispersion model outputs included the highest 1-hour averages of pollutant concentrations (worst case of the 8760 hours of data analyzed), as well as annual averages, for each receptor location. The 1-hour average concentrations and annual average concentrations were compared to Texas Commission on Environmental Quality Effect Screening Levels (ESLs) to determine whether there was a potential for adverse health impacts.

METHODOLOGY

Software. The Gaussian dispersion model AERMOD was used to predict pollutant concentrations and impact areas. Modeling was conducted using ISC-AERMOD View (Lakes Environmental Version 5.9).

Source Data. Wolf Eagle Environmental collected 24-hour field samples of pollutants near the compressor stations on Aug.17-18, 2008. The samples were analyzed by GD Air Testing, Richardson, TX. Measured concentrations of pollutants selected for modeling are shown in Table 1. Compounds were modeled only if they were identified in at least 3 of the sampling canisters.

The compressor stations were modeled as a single large area source, since specific compressor engine and condensate tank information was not available. If information were to be provided concerning specific compressor engine stack heights, stack diameters, stack flow rates, stack temperatures, as well as dimensions for condensate tanks, then the compressor engines could be modeled individually as point sources, and the condensate tanks as volume sources. Emission rates from the single large area source were set to replicate ambient concentrations measured on Aug. 17-18 at the Dish site as closely as possible by minimizing the sum of the squares of the residuals between the measured and modeled concentrations at the various sampling locations, given meteorological conditions on those days, which were obtained from Lakes Environmental.

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Table 1. Measured field concentrations, used to determine source emission rates

	Measured 24-hour Average Concentration, µg/m³					
Pollutant ↓/Receptor→	**1**	**2**	**3**	**4**	**5**	**6**
Benzene	2.2	34.1	39.2	247.9	3.3	1.9
Carbon disulfide		320.2	303.4	22.8		
Carbonyl sulfide			90.1	72.4	10.4	
Dimethyl disulfide		768.9			75	201.8
Styrene		1.6	3.9	5.5		
Toluene	11.7	126.8	232.2	523	11.6	2.8
1,2,4-Trimethylbenzene		94.4	296.9	231.6		9.7

Compounds that were identified in the field samples, but with concentrations not anticipated to exceed ESLs, were not modeled. For a few species identified in the field samples, no ESL has been designated; these species also were not modeled. The laboratory analysis did not separate out m & p xylenes, but reported a lumped number. However, the ESLs for these are separate. Since separate concentration numbers were not available, these compounds were not modeled, either.

Meteorological Data. Hourly surface meteorological data from Dallas-Fort Worth International Airport (station number 03927) was obtained from Lakes Environmental web site (www.weblakes.com) for 1990. Hourly upper air meteorological data was obtained for the Stephenville weather station, the closest station to DFW with upper air data. The surface and upper air data is part of the Texas Commission on Environmental Quality (TCEQ) quality-controlled data currently used for air quality permit application modeling in Texas. For DFW, corresponding surface and upper air data sets are available from the TCEQ data set only for 1984-1992. The implicit assumption is that meteorology has not changed significantly in the region since 1992.

The data included hourly values of temperature, wind speed, wind direction, and cloud cover. AERMET was used to preprocess the meteorological data for AERMOD.

Terrain Elevations. Terrain/receptor elevations were obtained from 7.5 minute digital elevation model [DEM] data from the Lakes website [www.weblakes.com]. Terrain/receptor elevations were processed using the terrain preprocessor AERMAP. Simple+complex and elevated terrain options were selected.

Receptor Grid. A 50 m x 50 m Cartesian grid receptor network was used to cover a 3900 m x 3550 m area surrounding the release location.

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Averaging Time. A 1-hour averaging time was selected for short-term concentrations, to facilitate comparison with TCEQ short-term Effects Screening Levels (ESLs), which are based on a 1-hour averaging time. An annual averaging time was selected for long-term concentrations, to facilitate comparison with TCEQ long-term ESLs, which are based on an annual averaging time.

Other Model Options. Regulatory default mode, rural dispersion coefficients, elevated terrain, and simple+complex terrain were used. No significant removal was assumed due to wet deposition, dry deposition, chemical reaction (exponential decay), or gravitational setting.

Output. Output included highest 1-hour average concentration, and annual average concentration, for each pollutant at each receptor location. Concentrations exceeding TCEQ ESLs were plotted.

RESULTS

Table 2 shows the highest 1-hour average concentration (over all receptor locations and all hours modeled) and the highest annual average concentration (over all receptor locations) for each pollutant. TCEQ short-term (1-hour) and long-term (annual) ESLs are also shown (the most up-to-date ESL list dated October 2009 was obtained from the TCEQ web site at http://www.tceq.state.tx.us/implementation/tox/esl/list_main.html). The basis of an ESL is health impacts, unless noted with an * as an odor basis. In cases where the basis is odor, the compound also causes health impacts, but at higher concentrations.

Table 2. Modeled maximum 1-hour and annual average concentrations, compared with TCEQ Effect Screening Levels

Pollutant	Max. 1-hour Average Modeled Concentration, µg/m^3	TCEQ 1-hour ESL, µg/m^3	1-hour ESL exceeded ?	Max. Annual Average Modeled Concentration, µg/m^3	TCEQ Annual ESL, µg/m^3	Annual ESL exceeded ?
Benzene	472.8	170	Yes	39.8	4.5	Yes
Carbon disulfide	35,942	30	Yes	3025	3	Yes
Carbonyl sulfide	10,404	135*	Yes	875.7	2.6*	Yes
Dimethyl disulfide	7661	20	Yes	644.8	2	Yes
Styrene	454.0	110*	Yes	38.2	140*	No
Toluene	2081	640*	Yes	175.1	1200*	No
1,2,4-Trimethylbenzene	2743	1250	Yes	230.9	125	Yes

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According to Table 2, short-term and long-term ESLs were exceeded for all pollutants, with the exception of long-term ESLs for styrene and toluene.

Figures 2-13 show the spatial extent of the exceedances of the ESLs. The lowest concentration shown on the scale of each plot is the ESL for that pollutant. In other words, anywhere a color is shown, the ESL is exceeded.

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Emission Dispersion Maps

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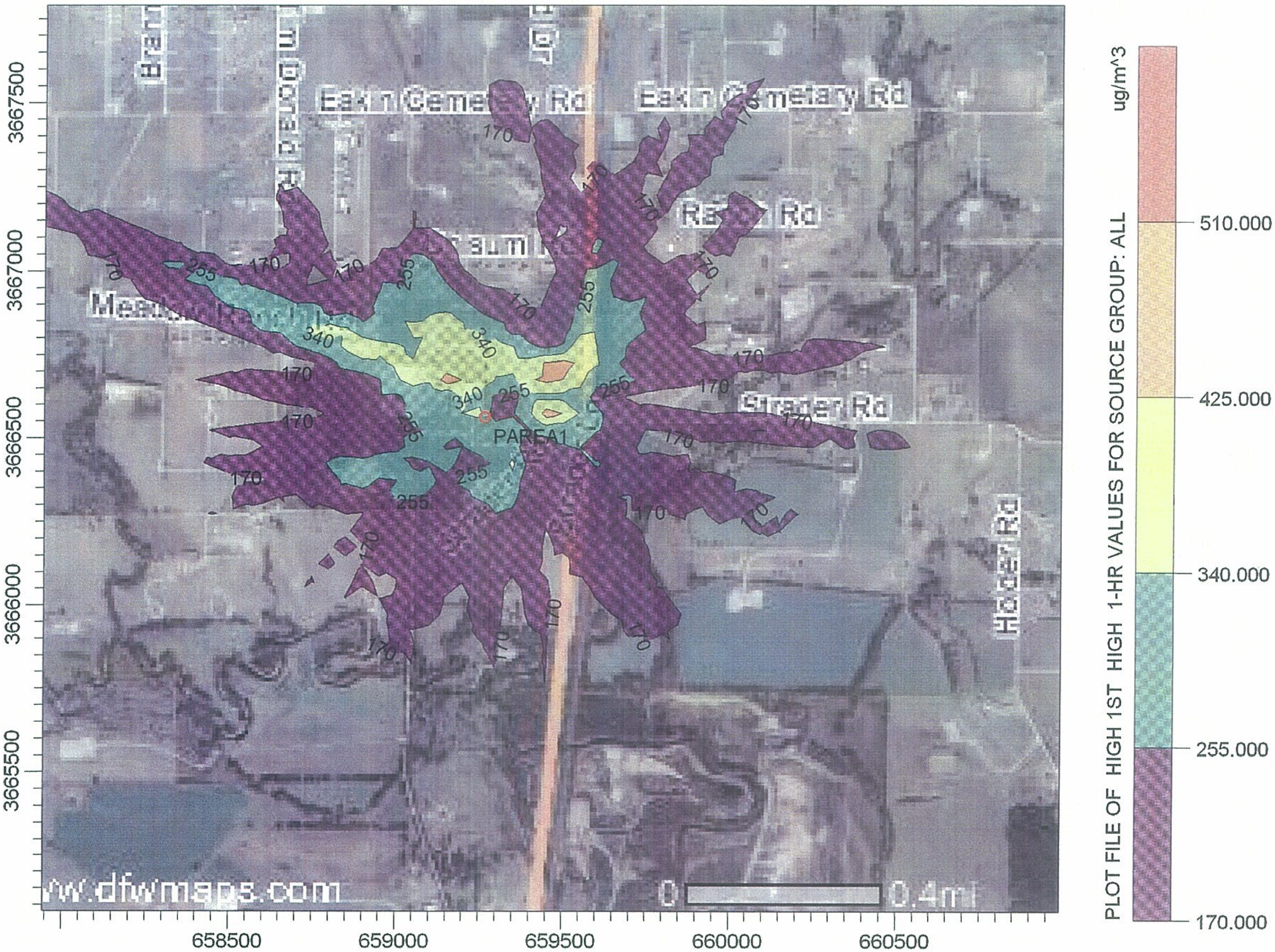
Benzene ST



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3666000
3665500
658500
659000
659500
660000
660500
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ww.dfwmaps.com
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PLOT FILE OF HIGH 1ST HIGH 1-HR VALUES FOR SOURCE GROUP: ALL
510.000
425.000
340.000
255.000
170.000

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Benzene LT

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Carbon Disulfide ST

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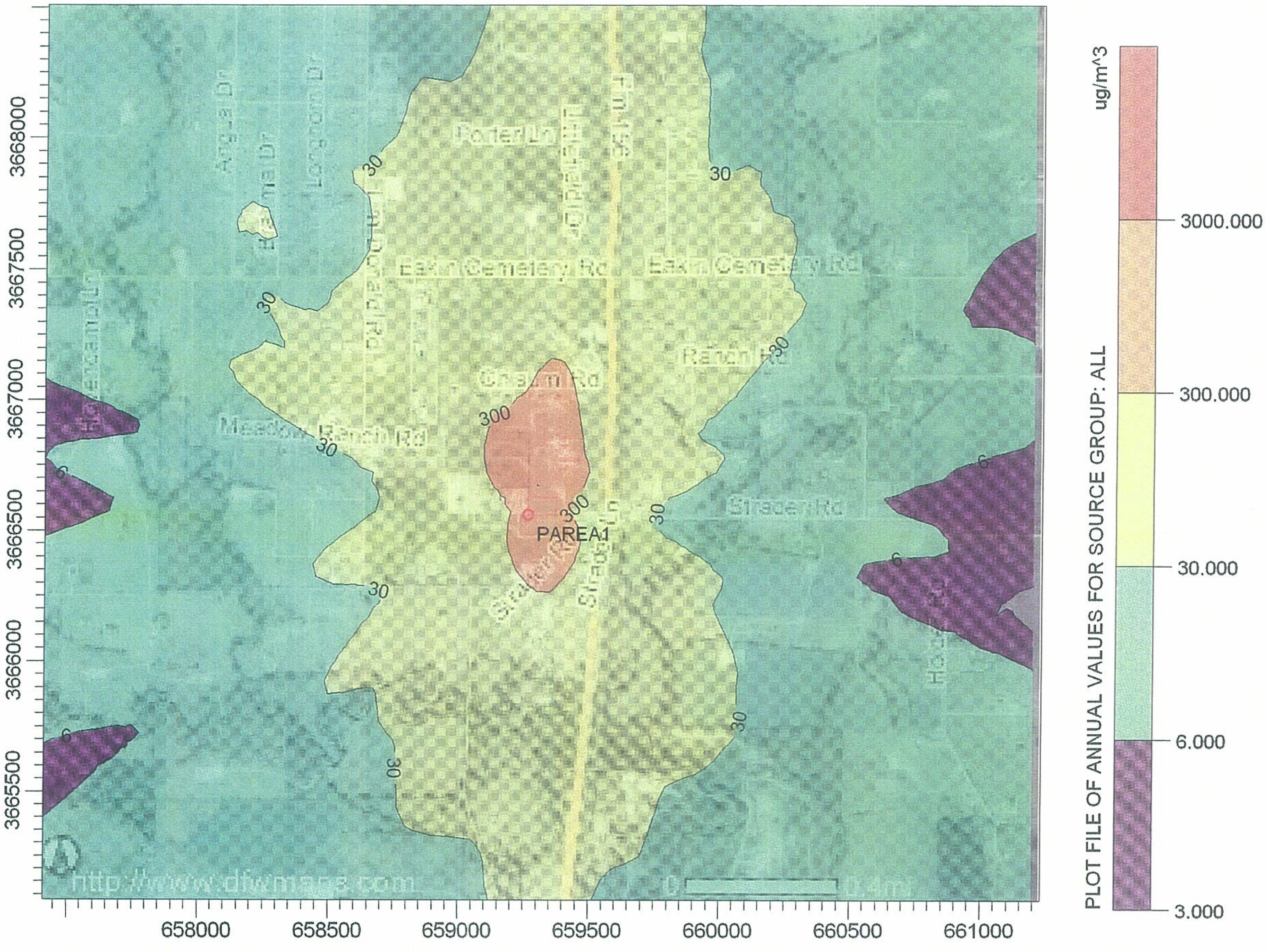

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Carbon Disulfide LT

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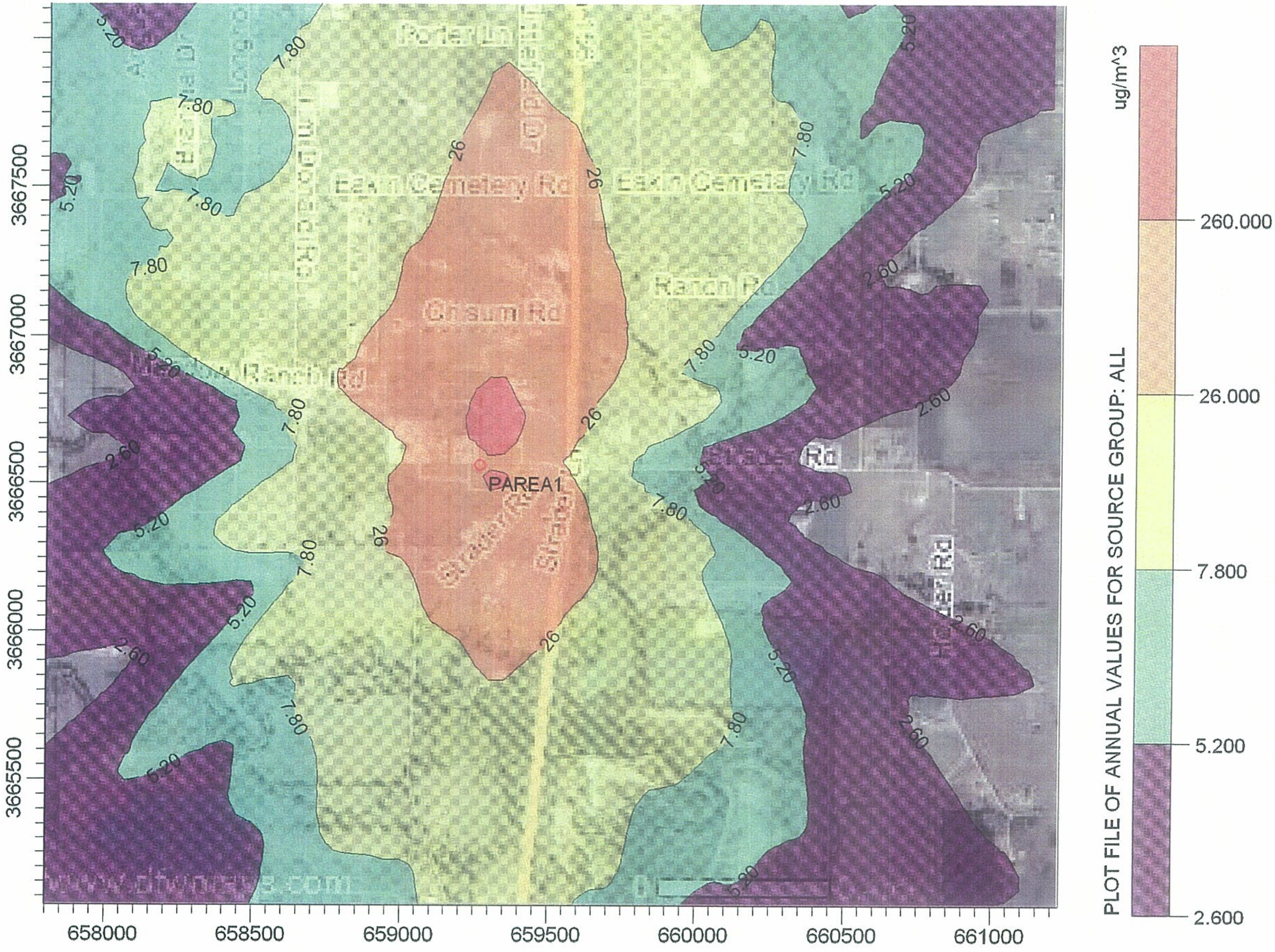

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Carbonyl Sulfide ST

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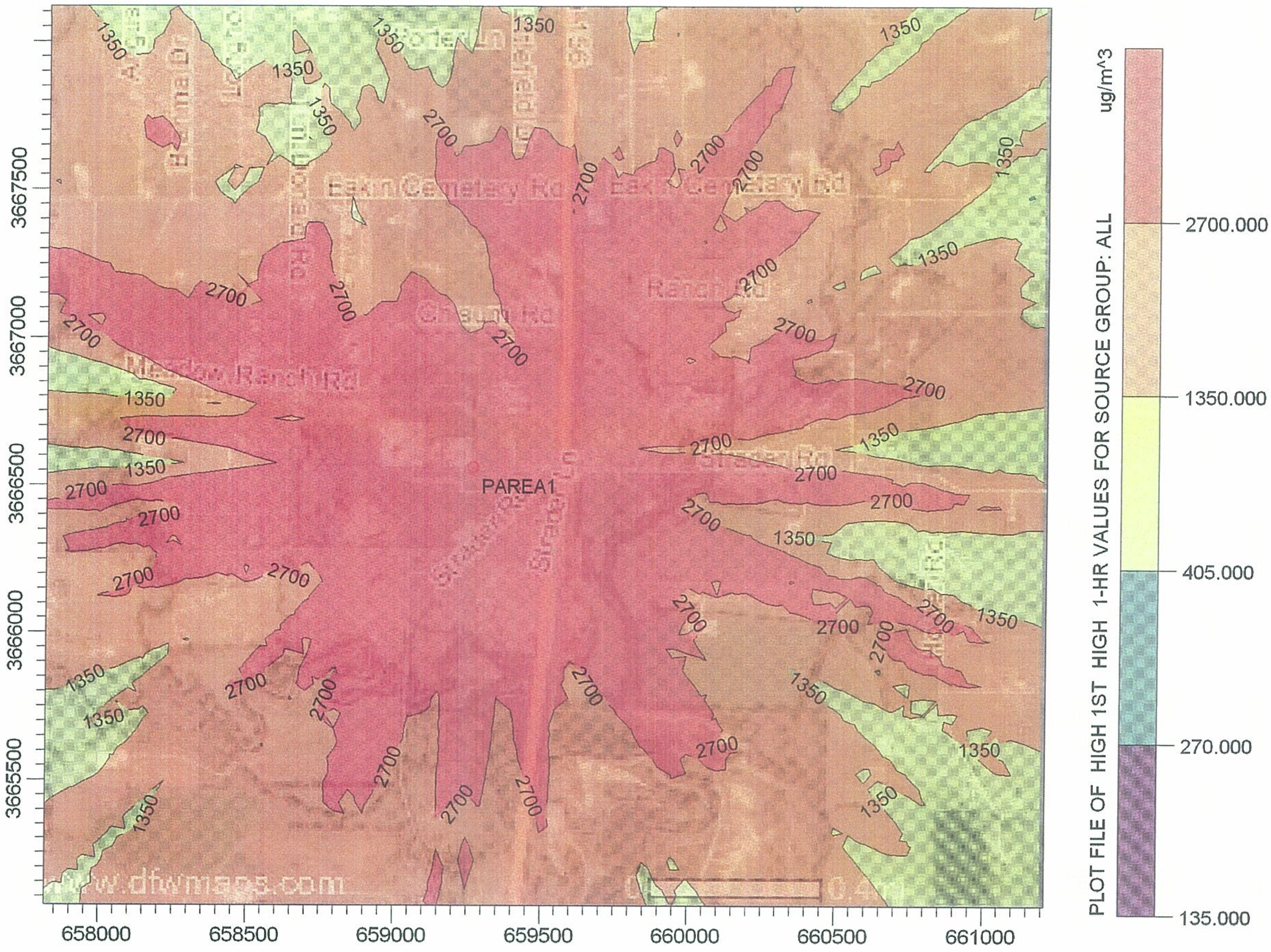

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Carbonyl Sulfide LT

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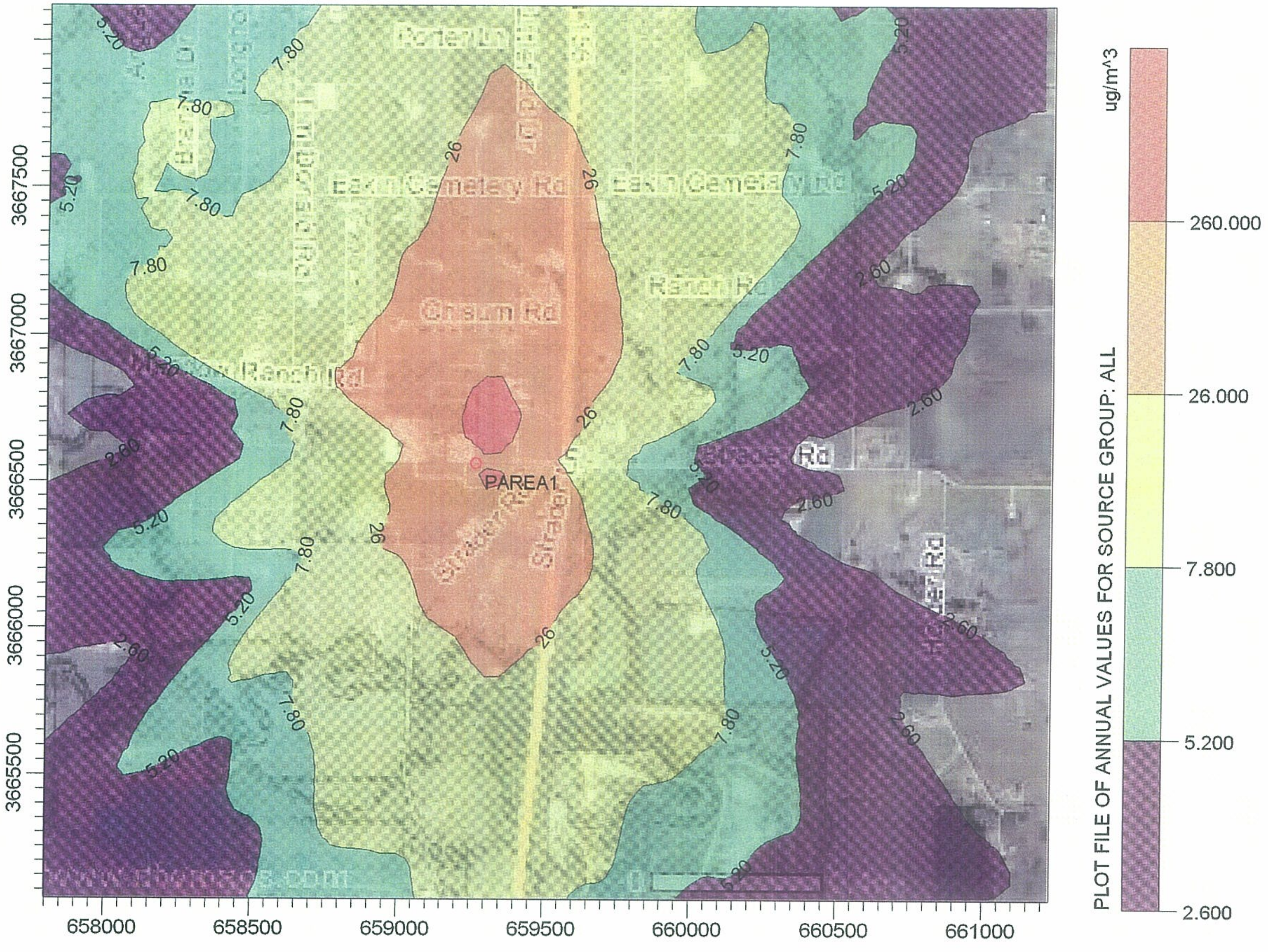

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Dimethyl Disulfide ST

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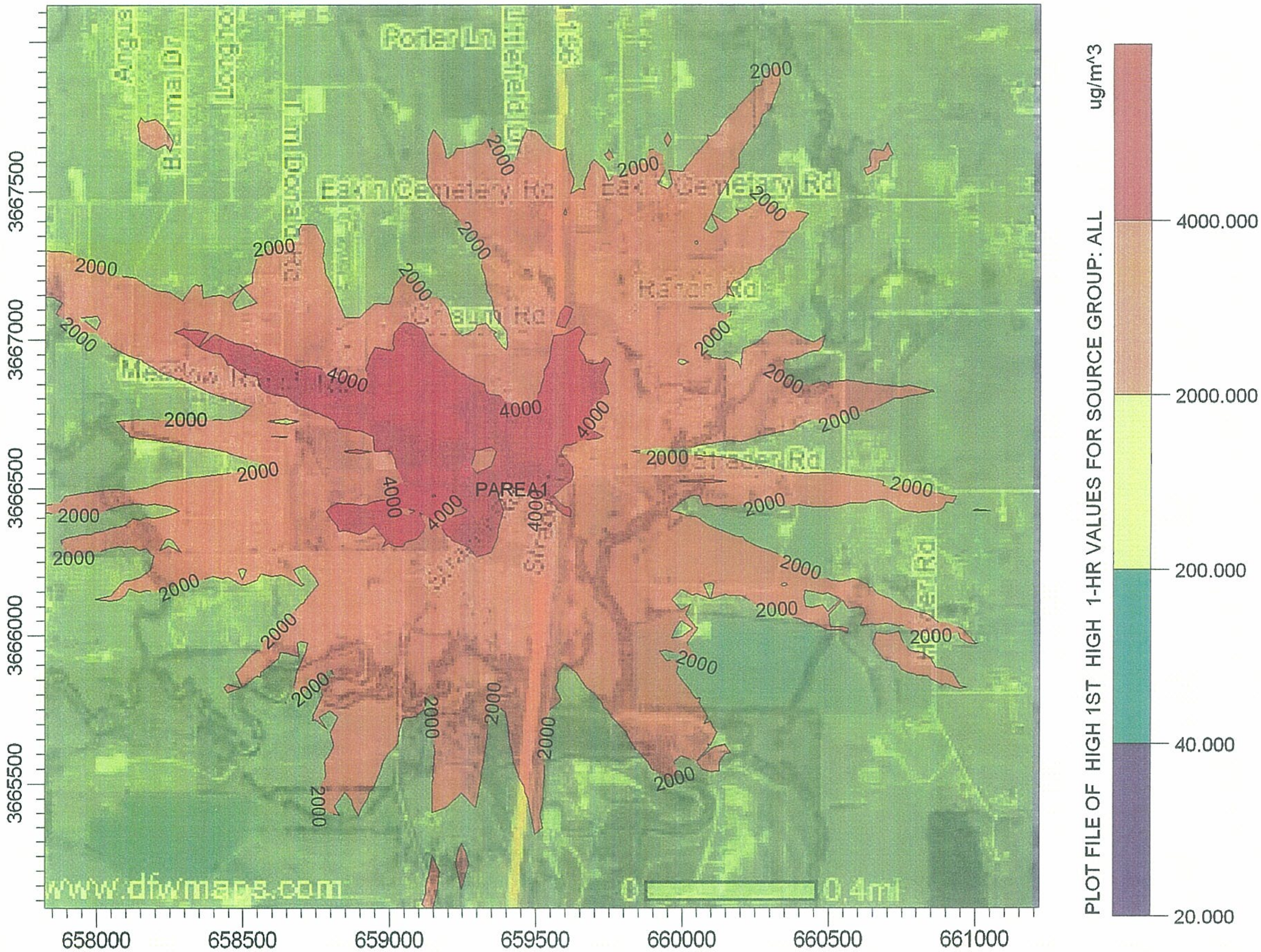

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Dimethyl Disulfide LT

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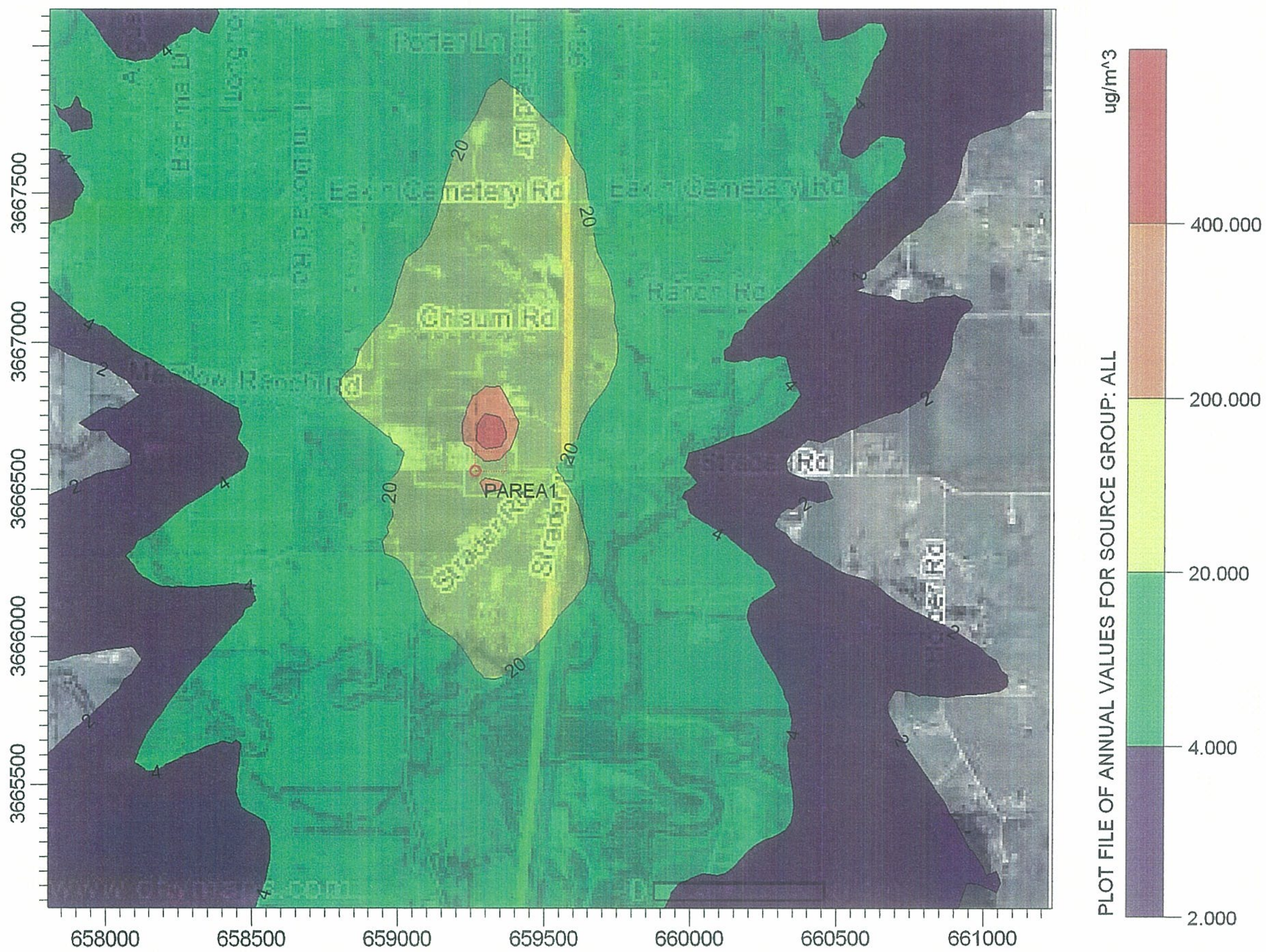

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Styrene ST

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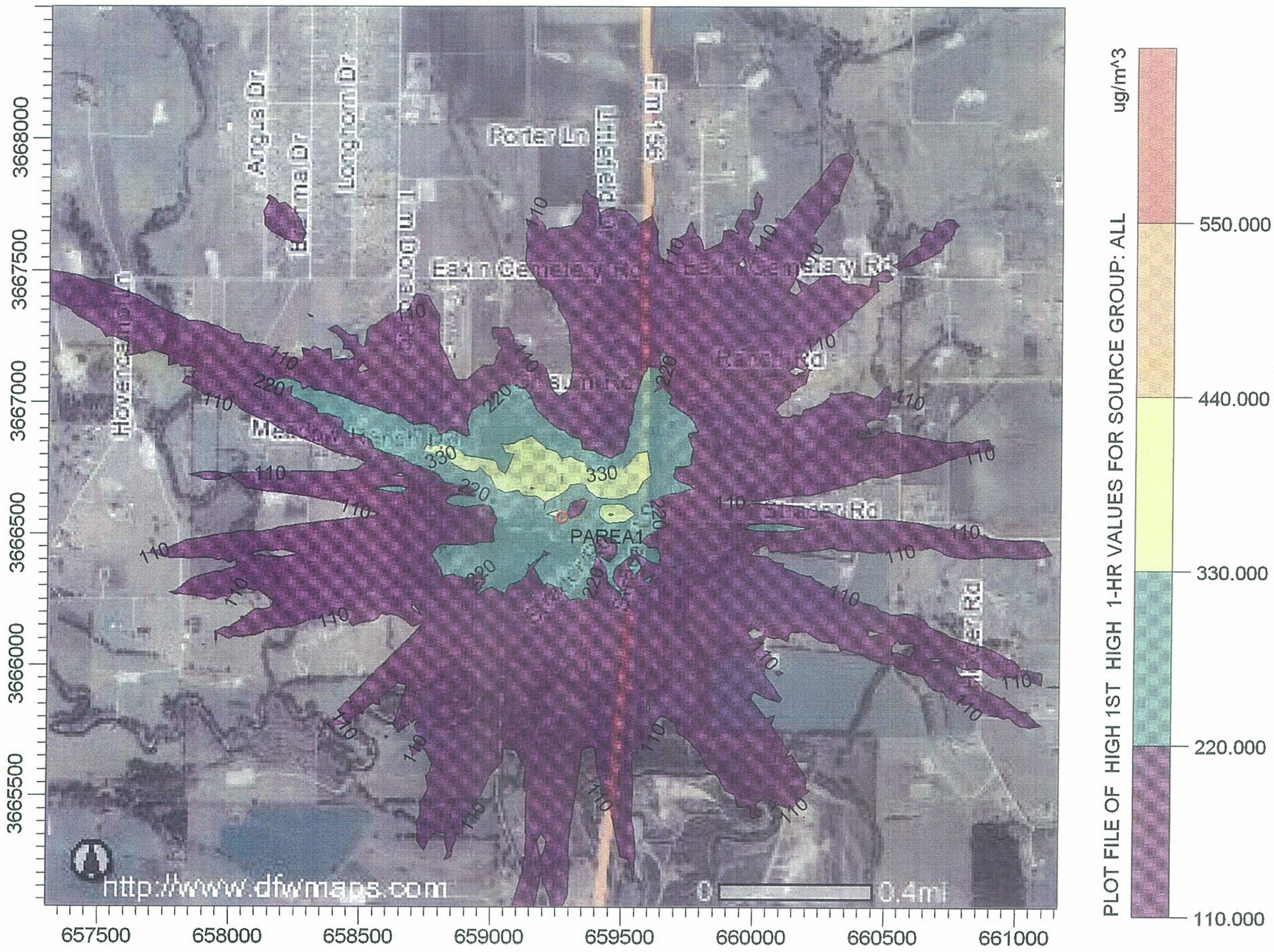

Styrene LT

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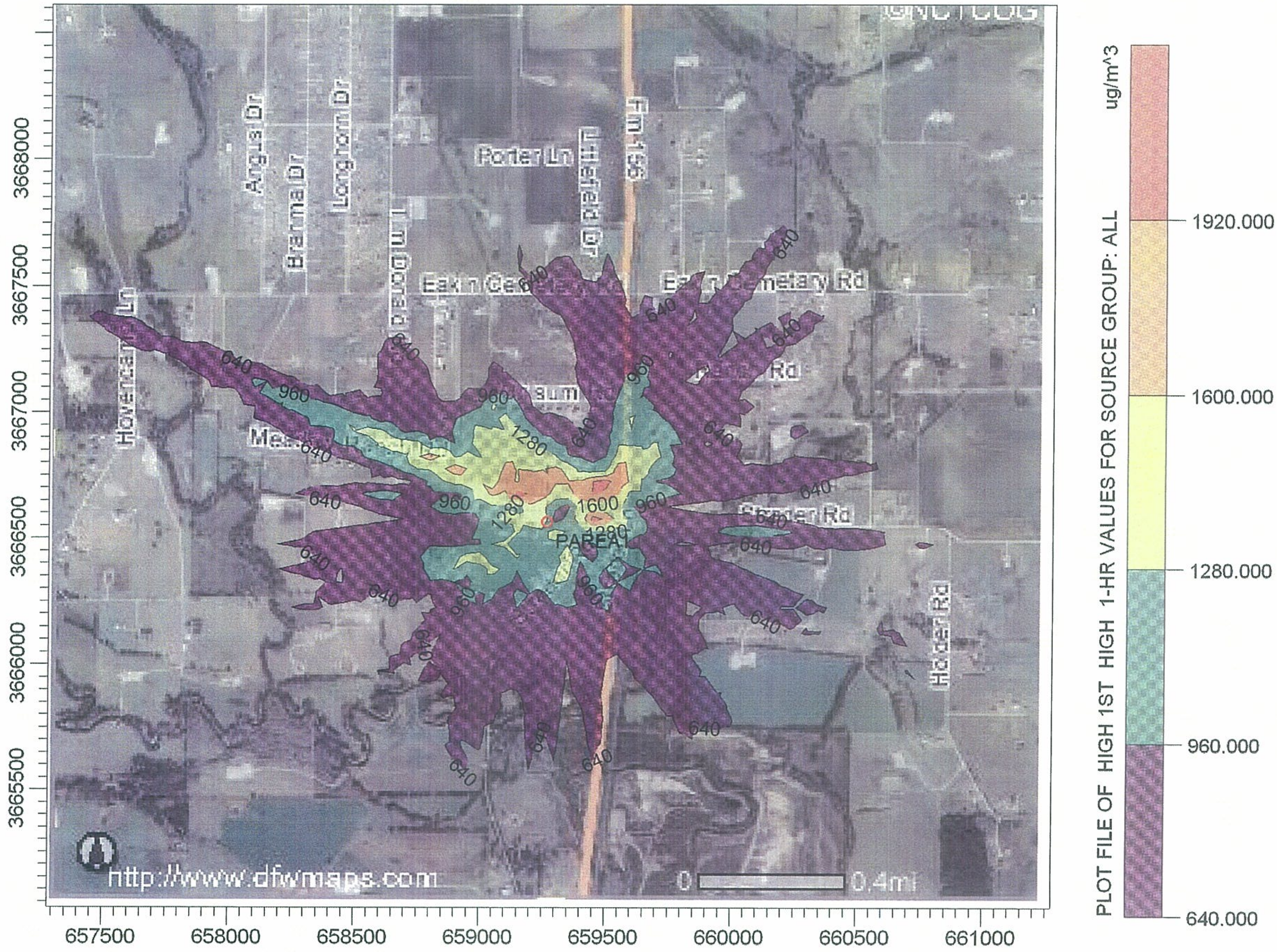
No exceedances for Styrene LT

Toluene ST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Longhorn Dr
Porter Ln
Littlefield Dr
Fm 156
Eakin Cemetery Rd
Hovenkamp Ln
Hoover Rd
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PLOT FILE OF HIGH 1ST HIGH 1-HR VALUES FOR SOURCE GROUP: ALL
ug/m^3
1920.000
1600.000
1280.000
960.000
640.000

Toluene LT

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No exceedances for Toluene LT

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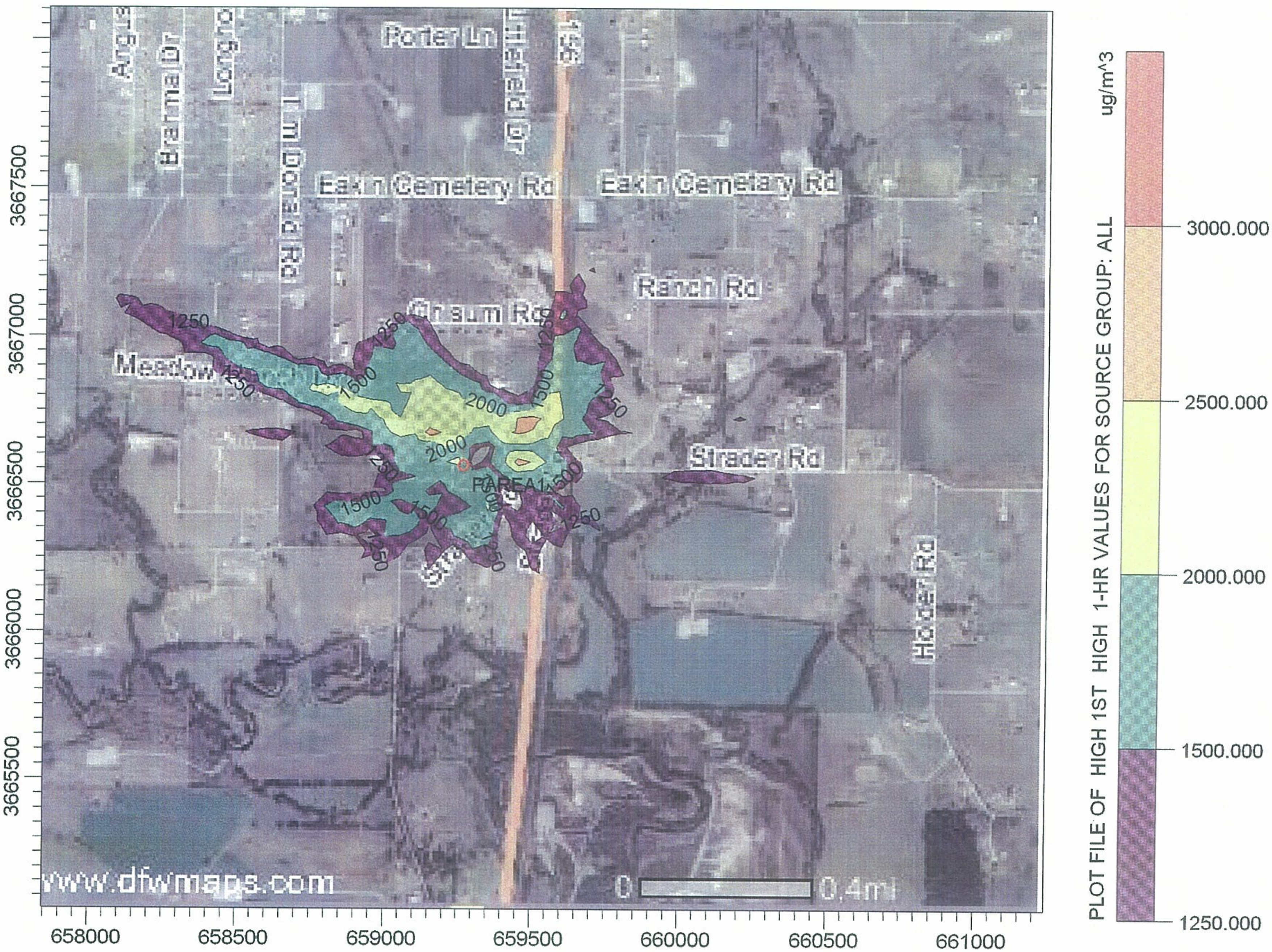
1,2,4-Trimethyl Benzene ST

December 2009



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1,2,4-Trimethyl Benzene LT

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