SCAQMD Rule 1180 Fenceline Monitoring Plan

Tesoro Los Angeles Refining & Marketing Company LLC

A subsidiary of Marathon Petroleum Corporation

Los Angeles Refinery

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2350 East 223rd Street
Carson, CA 90810

Wilmington Operations – (Facility ID 800436)
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Rule 1180 Monitoring Plan Prepared for

South Coast Air Quality Management District
Diamond Bar, CA

November 15, 2019

Fenceline Monitoring Plan for the Tesoro Refinery in Carson and Wilmington, California

Prepared by

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Monitoring Plan

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Contents

Figures

Tables

Introduction

Rule 1180 Requirements for Fenceline Monitoring Plans

On December 1, 2017, the South Coast Air Quality Management District (SCAQMD) adopted Rule 1180, "Refinery Fenceline and Community Air Monitoring" (South Coast Air Quality Management District, 2017a). Rule 1180 requires petroleum refineries within the SCAQMD to establish air monitoring systems at facility perimeters (fencelines); these systems will measure pollutant concentrations and provide the public with near real-time information about air quality near the refineries. Rule 1180 also requires a detailed fenceline air monitoring plan (this document) that follows SCAQMD guidelines (South Coast Air Quality Management District, 2017b). This plan must be submitted for approval by August 1, 2018.

According to the SCAQMD's guidelines, an air monitoring plan must include detailed information on several elements to justify the measurement and data dissemination approach being proposed to satisfy Rule 1180 requirements. These elements are listed below, along with Section numbers to indicate where each element is discussed in this document.

- "An evaluation of routine emission sources at the refinery (e.g., utilizing remote sensing or other measurement techniques or modeling studies, such as those used for health risk assessments)" (Section 1). *This plan relies on emissions reported in the annual emissions inventory and modeling data submitted to SCAQMD. The EPA benzene fenceline monitoring data was also utilized to determine the location of monitoring paths.*
- "An analysis of the distribution of operations and processes within the refinery to determine potential emissions sources" (Section 1). *This plan describes refinery operations and processes and also assesses on-site emissions sources.*
- "An assessment of air pollutant distribution in surrounding communities (e.g., mobile surveys, gradient measurements, and/or modeling studies used for health risk assessments)" (Section 1). *The plan relies on the facility annual emissions reporting for criteria pollutants and AB2588 toxic air contaminants and AERMOD modeling*.
- "A summary of fenceline air monitoring instruments and ancillary equipment proposed to continuously measure, monitor, record, and report air pollutant levels in real-time near the petroleum refinery facility perimeter (i.e., fenceline)" (Section 2). *This plan relies on both open-path and point instruments to satisfy Rule 1180 requirements.*
- "A summary of instrument specifications, detectable pollutants, and minimum detection limits for all air monitoring instruments" (Section 2). *This plan relies on information provided by reputable instrument manufacturers for instrument specifications applicable for each specific path-length.*
- "Proposed monitoring equipment siting and selected pathways (when applicable) for fenceline instruments, including the justification for selecting specific locations based on the

assessments mentioned above" (Section 2). *This plan covers critical pathways along the fenceline around the refinery and has accounted for the measurement of all chemical species listed in Rule 1180. Meteorological data obtained from two on-site weather stations was used to determine the wind direction.*

- "Operation and maintenance (O&M) requirements for the proposed monitoring systems; an implementation schedule consistent with the requirements of Rule 1180; and procedures for implementing quality assurance and quality control of the collected data" (Sections 2 and 3). *This plan includes an implementation schedule and Quality Assurance Project Plan (Appendix D) covering instrument operation and maintenance and routine validation procedures.*
- "A web-based system for disseminating information collected by the fenceline air monitoring system" (Section 4). *This plan includes details on the public website, automated data display features, intent and limitations of data, regulatory and industry relevant literature on notification thresholds, background information on measured compounds, and general information on averaging periods.*
- "Details of the proposed public notification system" (Section 5). *This plan includes SCAQMD recommended notification level thresholds, averaging period, email sign-up option to receive notifications, and averaging periods to assist the public in understanding and interpreting the data.*
- "Demonstration of independent oversight" (Section 3). *This plan proposes annual independent instrument and system audits, which will be completed by Sonoma Technology Inc. (STI) in 2020.*

An implementation schedule is shown in **Table 1**, with the assumption that internal project implementation would begin in April 2019, after the approval of the compliance plan, and official data reporting would begin on January 1, 2020.

Table 1. Implementation schedule for Tesoro LAR Carson and Wilmington Rule 1180 monitoring project.

Project Element	Timing (Dates Depend on Approval Date)
Receive approval of the monitoring plan from SCAQMD.	April 2019
Select instrument types based on measurement needs; order instruments, shelters, and supplies.	April – December 2019
Determine final site locations.	
Develop specifications for infrastructure (shelters, pads, power, mounts, etc.).	
Perform preliminary infrastructure design.	
Perform detailed infrastructure design.	
Support engineering and construction work.	
Complete site infrastructure.	
Acquire instruments.	
Acquire and install skids.	
Complete and test data management system.	
Install and test instruments and associated equipment; test.	August – December 2019
Finalize Quality Assurance Project Plan (QAPP).	November 2019
Begin partial internal operations.	September 2019
Operate and maintain equipment, data system, website, and notification system. Perform daily data checks.	On target for completion with SCAQMD Rule 1180 deadline
Operate and maintain data system, website, and notification system.	On target for completion with SCAQMD Rule 1180 deadline
Perform daily data checks	On target for completion with SCAQMD Rule 1180 deadline

Summary of Monitoring Plan for Tesoro LAR Carson and Wilmington Operations

Tesoro's Los Angeles Refinery (LAR) Carson and Wilmington Operations are surrounded on all four sides by various other emissions sources, as well as residential areas. These adjacent emissions sources include the Alameda corridor rail network, multiple chemical plants, other refinery operations, fuel distribution terminals, an asphalt plant, a tank farm, and other commercial and industrial facilities. The distance from the facility to residential areas ranges from 900 to 1,600 feet.

Tesoro will monitor concentrations across **21** open paths, which are shown in **Figures 1a through 1c**. Tesoro LAR evaluated the following to determine the representative locations of the monitoring sites along the fenceline:

1. An evaluation of routine emissions and location of sources/operations at the refinery.
2. An evaluation of distribution and operations of processes within the refinery.
3. Regulatory annual emissions for criteria pollutants and AB2588 reporting for toxic air contaminants (TACs).
4. Regulatory air dispersion modeling for impacts at the refinery fenceline.
5. An evaluation of U.S. Environmental Protection Agency (EPA) benzene fenceline monitoring data and air pollutant distribution in surrounding communities using past monitoring studies (e.g. FluxSense and Atmosphir).
6. An evaluation of meteorological data, wind patterns, and wind roses obtained from two Safer meteorological stations operated at the refinery.
7. Logistical feasibility of shelter, power, and equipment installation, including terrain topography, elevations of sensors and retro-reflectors, and vicinity constraints for refinery equipment, roadways, traffic distribution, vessels, tanks, distillation columns, buildings, asbestos dismantling, pipe-racks, and underground utilities and infrastructure.
8. Consideration of residential and sensitive communities surrounding the refinery.
9. Consideration of the surrounding Alameda corridor rail network, major roads/freeways, traffic pattern, multiple chemical plants, laydown yards, other refinery operations, fuel distribution terminals, asphalt plant, other tank farm, and other commercial and industrial facilities.

The installed instruments will be capable of measuring the pollutants listed in Rule 1180 in near-real-time, and include open-path FTIR and UV-DOAS instruments, as well as point monitors for hydrogen sulfide (H_2S) and black carbon (BC, a surrogate for diesel particulate matter), meteorological, and visibility measurements. All required pollutants will be measured as shown in **Table 2**.

The monitoring data will be quality-assured and displayed to the public in real-time via a website. Members of the public will be able to sign up for notifications when thresholds are exceeded, and when other activities affect the monitoring system.

The following sections provide details of the monitoring plan, including a discussion of all items in SCAQMD's fenceline air monitoring plan checklist (see **Appendix A**).

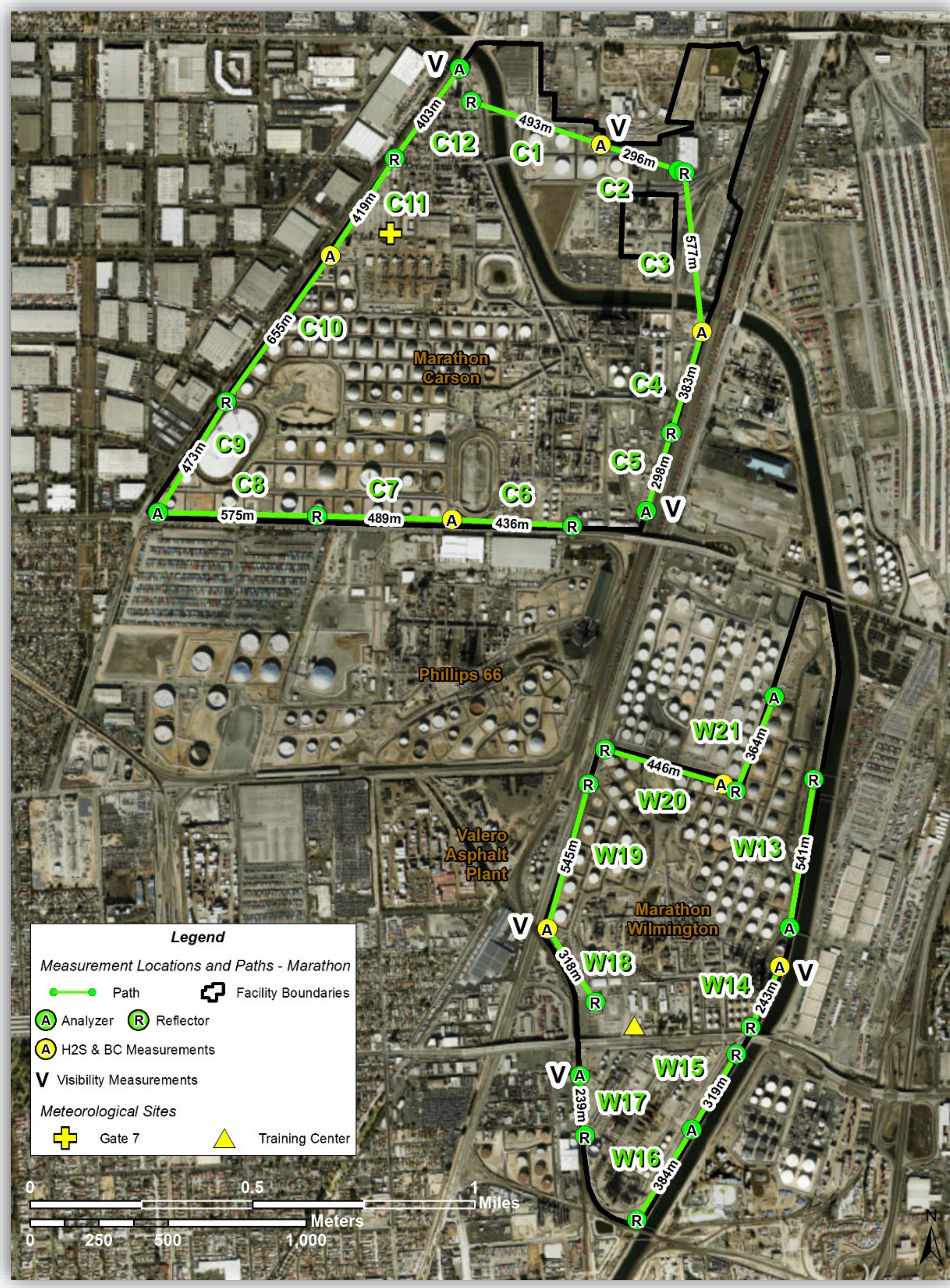

Figure 1a. Monitoring sites and paths.

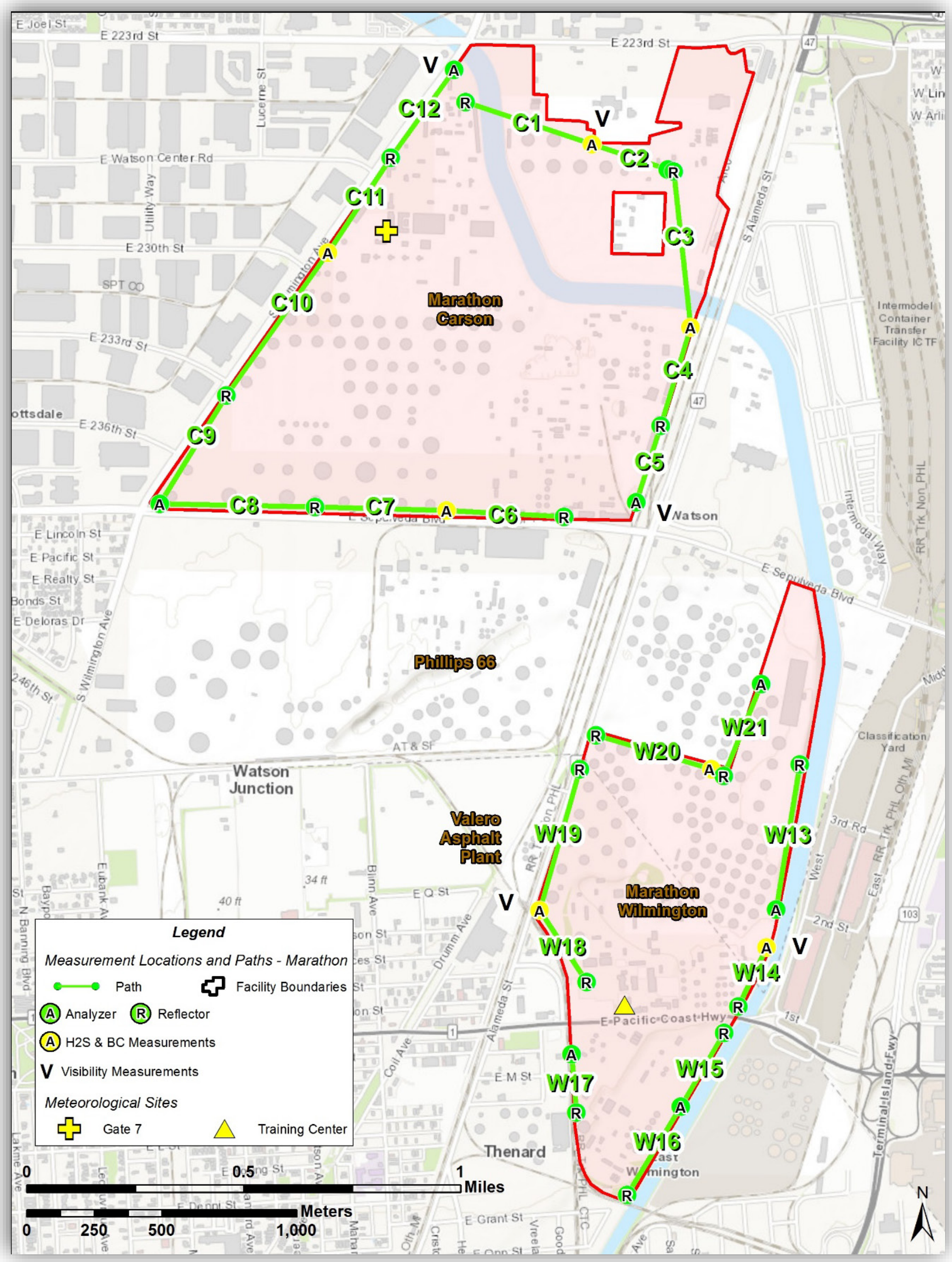

Figure 1b. Monitoring sites and paths.

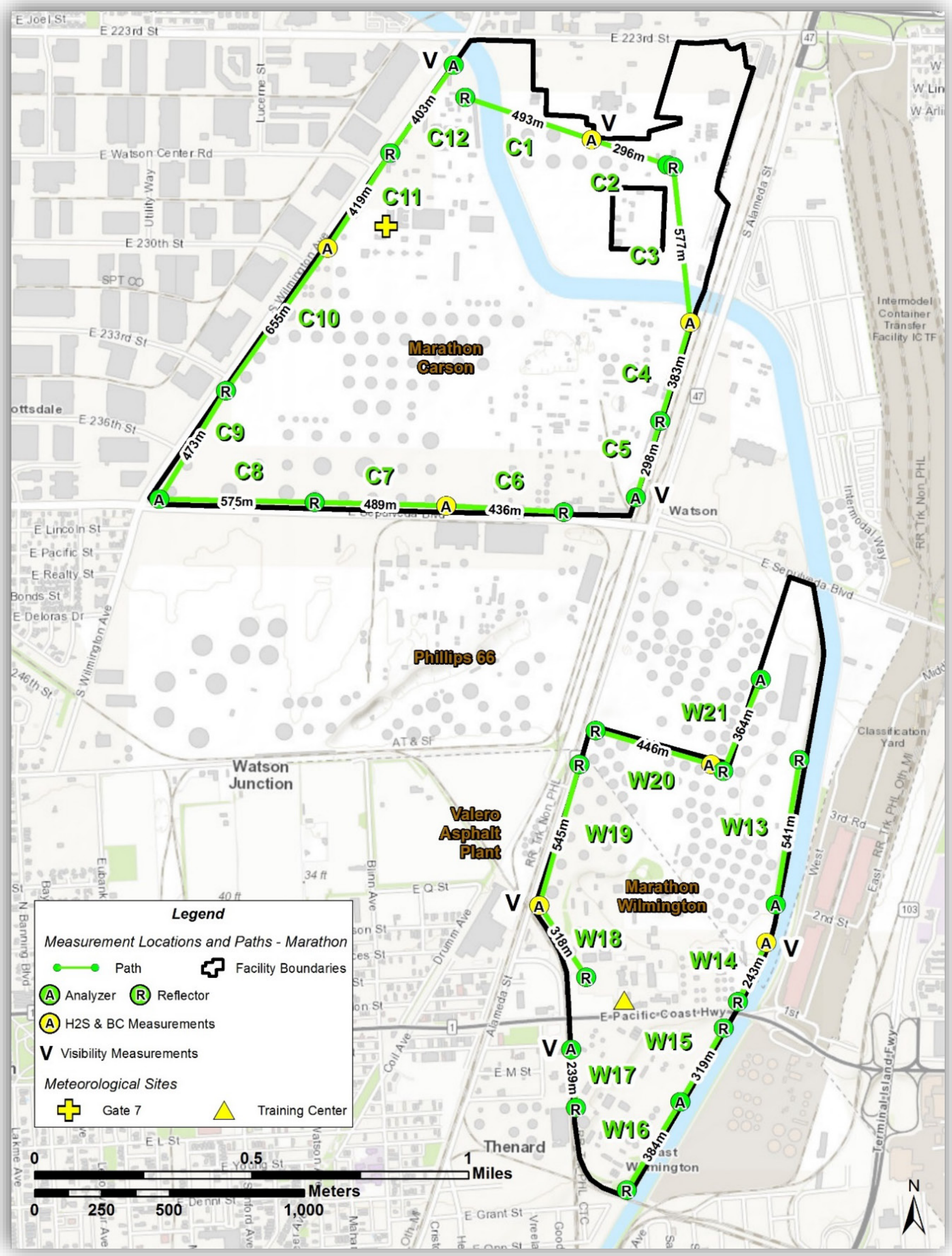

Figure 1c. Monitoring sites and paths.

Table 2. List of pollutants to be measured at the Tesoro LAR Carson and Wilmington Operations.

Pollutant	Instrument	Path
Criteria Air Pollutants		
Sulfur Dioxide	OP UV-DOAS with Xenon	C1-C12, W13-W21
Nitrogen Oxides	OP FTIR	C1-C12, W13-W21
Volatile Organic Compounds (VOC)		
Total VOCs	OP FTIR	C1-C12, W13-W21
Formaldehyde	OP FTIR	C1-C12, W13-W21
Acetaldehyde	OP FTIR	C1-C12, W13-W21
Acrolein	OP FTIR	C1-C12, W13-W21
1.3-Butadiene	OP FTIR	C1-C12, W13-W21
Styrene	OP FTIR	C1-C12, W13-W21
BTEX Compounds	OP UV-DOAS with Xenon	C1-C12, W13-W21
Other Compounds		
Hydrogen Sulfide	Point H_2S	C1, C3, C6, C10, W14, W18, W20
Carbonyl Sulfide	OP FTIR	C1-C12, W13-W21
Ammonia	OP FTIR	C1-C12, W13-W21
Black Carbon	Point Aethalometer	C1, C3, C6, C10, W14, W18, W20
Hydrogen Cyanide	OP FTIR	C1-C12, W13-W21
Hydrogen Fluoride	N/A (not used at this refinery).	N/A

1. Fenceline Air Monitoring Coverage (or Spatial Coverage)

To provide a monitoring network that best serves the community by monitoring the emissions at the refinery fenceline, the following factors were considered while designing the monitoring network: (1) the characteristics of the refinery location, including topology and meteorology, (2) emissions characteristics, (3) sensitive receptors, and (4) the spatial coverage of the monitors. The monitors selected will be described in more detail in Section 2.

1.1 Identify the Facility's Proximity to Sensitive Receptors

This section characterizes the refinery location and the dispersion of subject pollutants to the nearby community. These major factors include the refinery's geographical setting with respect to other non-refinery sources, topography and meteorology, location of sensitive receptors, refinery emissions, and modeling of the dispersion of those emissions to surrounding areas.

1.1.1 Geographical Setting

Tesoro's LAR Carson Operations is located at 2350 East 223rd Street in the city of Carson, California; the Wilmington Operations is located at 2101 East Pacific Coast Highway in the city of Wilmington, California (**Figure 2**). Tesoro's 930-acre property is mostly developed but engineered infrastructure will be required for a fenceline monitoring program. The refinery is surrounded on all four sides by various other emissions sources and residential areas.

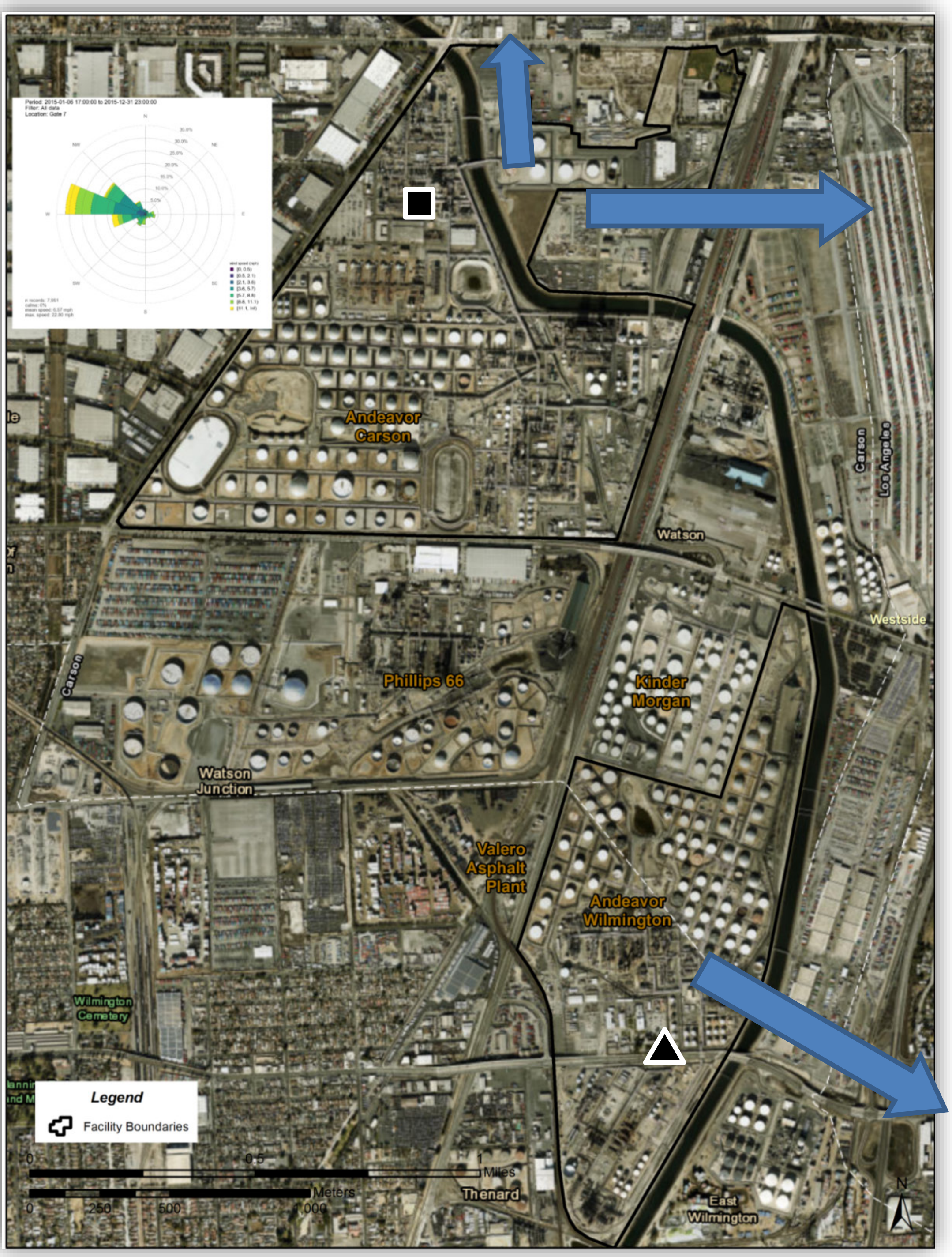

Figure 2. Tesoro LAR Carson and Wilmington Operations and the surrounding area. The wind pattern is dominated by west and northwesterly winds. Icons indicate the locations of the Tesoro meteorological monitoring sites at Carson Gate 7 (■) and Tesoro Wilmington Training Center (▲).

1.1.2 Topography and Meteorology

The topography within the refinery location is characterized by fairly flat terrain approximately 10 to 30 feet above sea level. The refinery is close enough to the coast such that, for the vast majority of the time, the winds are dominated by the sea breeze from the west and west-northwest. To assess wind climatology, meteorological data from the Tesoro Carson Gate 7 and Wilmington Training Center meteorological stations (see Figure 2) for 2015, 2016, and 2017 were used to generate the wind roses shown in **Figure 3**. The petals of a wind rose show the direction from which the wind is blowing.

- **Onshore winds.** Based on the data from the Carson Gate 7 site, which sits at the middle of the western fenceline facing Carson, winds most frequently blow from the west toward the east, and west-northwest toward the east-southeast. Based on data from the Training Center in Wilmington, winds blow from the northwest most frequently. These winds move across the refinery and into the residential and commercial areas to the east and southeast of the refinery. These winds are associated with the sea breeze phenomenon, and are strongest during the daytime, early evening, and summer.
- **Offshore winds.** Weak winds occasionally blow from the south and east (at Gate 7) and from the southeast (Training Center) toward the north, northwest, and west of the refinery. These winds are associated with the land breeze phenomenon and tend to be stronger during the nighttime, during early morning hours, and during the winter

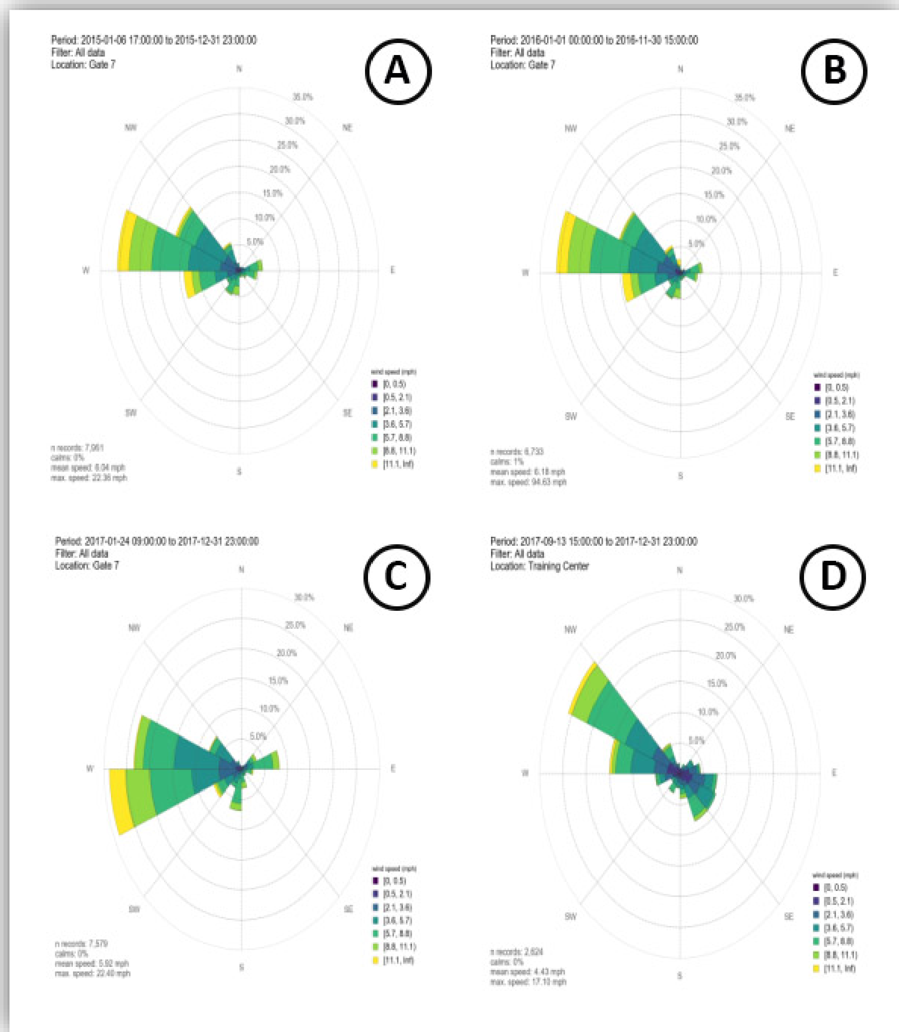

Figure 3. Annual wind roses for 2015, 2016, and 2017, from the Carson Gate 7 site (Figure 3A through 3C), and the wind rose for September 13–December 31, 2017, from the Training Center at Wilmington (Figure 3D). Winds from the west/northwest dominate the flow for Carson, with very infrequent flows from the south and east. For Wilmington, the winds are more from the northwest, with infrequent flows from the southeast.

1.1.3 Stationary Pollution Sources

Major stationary pollutant sources surrounding the Tesoro LAR refinery include (1) the Phillips 66 Refinery just south of the Carson portion; (2) the Valero Asphalt Plant to the west of the Wilmington Operations; (3) and the Kinder Morgan Carson Terminal at the northwest of the Wilmington Operations. Emissions are also generated by the numerous freeway and major surface streets (which carry significant heavy-duty truck traffic from the Ports of Long Beach and Los Angeles) and rail lines that surround the refinery. Additional industrial facilities are located in the surrounding areas. Interstates 405 and 710 and the Alameda corridor are major sources of diesel particulate matter as a result of the large volume of heavy-duty diesel vehicle traffic. All of these sources, at times, may impact the fenceline monitoring network in regards to background levels.

1.1.4 Sensitive Receptors

Figure 4 shows the location of several types of sensitive receptors with respect to the refinery, including schools and childcare facilities, adult health facilities, recreation areas, and residential areas. These sensitive receptors are identified in **Table 3**. At least one of each type of receptor is located within a mile of the refinery fenceline. The combination of winds and proximity of sensitive receptors helped guide the placement of the fenceline monitoring systems. Based on the dominant wind directions and sensitive receptors in residential areas, the north and eastern fencelines are important areas to monitor.

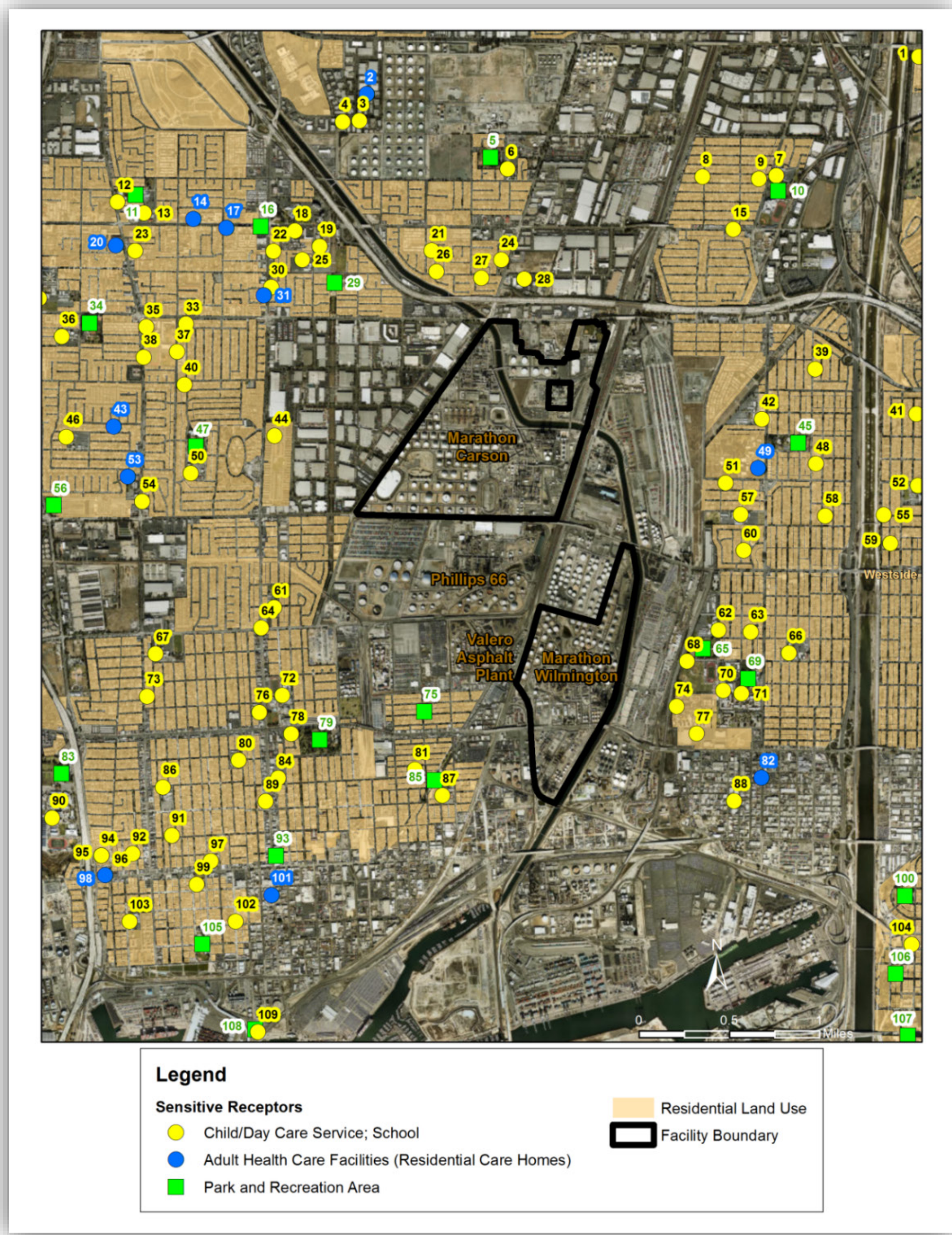

Figure 4. Map of sensitive receptors, which are listed in Table 3. Yellow dots indicate schools and child care facilities; blue dots indicate adult health care facilities and residential care homes; and green squares indicate public parks and recreation areas.

Table 3. Sensitive receptors in the area surrounding the refinery. The receptors are labeled in Figure 4.

Map Label	Name	Receptor Type	Latitude	Longitude
1	Union School	School	33.84585	-118.20118
2	Our House Living & Learning	Adult Health Care Facilities (Residential Care Homes)	33.84229	-118.25433
3	Village Kids USA	Child/Day Care Service	33.84015	-118.25502
4	Curtis Care	Child/Day Care Service	33.84005	-118.25660
5	Dolphin Park	Park and Recreation Area	33.83732	-118.24233
6	Del Amo Elementary School	School	33.83643	-118.24067
7	Rancho Dominguez Prep School	School	33.83613	-118.21479
8	Olivas Family Childcare	Child/Day Care Service	33.83599	-118.22190
9	Dominguez Elementary School	School	33.83585	-118.21646
10	Dominguez Park	Park and Recreation Area	33.83492	-118.21459
11	Carson Park	Park and Recreation Area	33.83397	-118.27650
12	Boys & Girls Club Of Carson 2	Child/Day Care Service	33.83337	-118.27823
13	Carson Street Elementary School	School	33.83252	-118.27563
14	Carson Senior Assisted Living	Adult Health Care Facilities (Residential Care Homes)	33.83210	-118.27089
15	First Baptist Preschool	School	33.83178	-118.21885
16	Time-Out Family Amusement Center	Park and Recreation Area	33.83155	-118.26438
17	Dominic Home Care Svc	Adult Health Care Facilities (Residential Care Homes)	33.83140	-118.26768
18	Golden City Child	Child/Day Care Service	33.83124	-118.26109
19	Carnegie Middle School	School	33.83002	-118.25868
20	Carson Gardens	Adult Health Care Facilities (Residential Care Homes)	33.82989	-118.27830
21	Wilma Bryant Daycare	School	33.82978	-118.24790
22	Carson Christian School	School	33.82957	-118.26314
23	Saint Philomena School	School	33.82946	-118.27646
24	Nevarez Smart Child Day Care	Child/Day Care Service	33.82911	-118.24116
25	Bonita Street Elementary School	School	33.82891	-118.26035
26	Rose's Daycare	Child/Day Care Service	33.82810	-118.24740

Map Label	Name	Receptor Type	Latitude	Longitude
27	Creative Mind Family Home Day Care	School	33.82765	-118.24307
28	Boys & Girls Club Of Carson 1	Child/Day Care Service	33.82759	-118.23893
29	Calas Park	Park and Recreation Area	33.82711	-118.25722
30	Community Development Center	School	33.82670	-118.26332
31	Avalon Courtyard	Adult Health Care Facilities (Residential Care Homes)	33.82602	-118.26401
32	White Middle School	School	33.82557	-118.28563
33	Dolores Combination Childrens Center	School	33.82365	-118.27146
34	Veterans Park and Sports Complex	Park and Recreation Area	33.82362	-118.28075
35	Carson High School	School	33.82337	-118.27530
36	Caroldale Learning Community	School	33.82252	-118.28341
37	Dolores Street School	School	33.82141	-118.27229
38	Eagle Tree High School	School	33.82094	-118.27549
39	Bobo Family Daycare	School	33.82063	-118.21082
40	Family Day Care	School	33.81877	-118.27153
41	Old King Cole Day Care	School	33.81712	-118.20103
42	Webster Elementary School	School	33.81657	-118.21590
43	Paradise Ederly Home	Adult Health Care Facilities (Residential Care Homes)	33.81534	-118.27832
44	Bundle of Fun My Three Kids Daycare	School	33.81473	-118.26281
45	Silverado Park	Park and Recreation Area	33.81468	-118.21236
46	Two Hundred Thirty-Second Elementary School	School	33.81446	-118.28285
47	General Scott Park	Park and Recreation Area	33.81383	-118.27035
48	Muir Elementary School	School	33.81303	-118.21063
49	American Gold Star Manor	Adult Health Care Facilities (Residential Care Homes)	33.81262	-118.21620
50	Catskill Avenue Elementary School	School	33.81166	-118.27085
51	Family Ceja Day Care	School	33.81139	-118.21934
52	Birney Elementary School	School	33.81136	-118.20080
53	Carson Adult Day Health Care	Adult Health Care Facilities (Residential Care Homes)	33.81132	-118.27689
54	Community Development Center	School	33.80935	-118.27548

Map Label	Name	Receptor Type	Latitude	Longitude
55	Vann Family Day Care	School	33.80899	-118.20407
56	Carriage Crest Park	Park and Recreation Area	33.80895	-118.28399
57	Stephens Middle School	School	33.80889	-118.21783
58	Carol Daycare	School	33.80885	-118.20968
59	Fords Family Day Care	Child/Day Care Service	33.80669	-118.20338
60	Johnson Daycare	School	33.80598	-118.21750
61	Broad Avenue Elementary School	School	33.80094	-118.26264
62	Hudson Elizabeth Elementary School	School	33.79958	-118.21983
63	Saint Lucy School	School	33.79946	-118.21674
64	Wilmington Christian School	School	33.79929	-118.26388
65	Hudson Park	Park and Recreation Area	33.79806	-118.22132
66	Garfield Elementary School	School	33.79780	-118.21303
67	Wilmington Middle School	School	33.79711	-118.27399
68	Reid Will J High School	School	33.79703	-118.22282
69	Admiral Kidd Park	Park and Recreation Area	33.79570	-118.21693
70	Juan Rodriguez Cabrillo High School	School	33.79471	-118.21930
71	Boys And Girls Clubs-Long Beach	Child/Day Care Service	33.79449	-118.21755
72	Banning High School	School	33.79391	-118.26174
73	Happy Harbor Preschool	School	33.79368	-118.27479
74	Bethune Mary School	School	33.79340	-118.22379
75	East Wilmington Park	Park and Recreation Area	33.79273	-118.24809
76	Avalon Continuation School	School	33.79252	-118.26396
77	WyoTech - Long Beach Campus	School	33.79123	-118.22182
78	First Baptist Christian School	School	33.79082	-118.26084
79	Banning Park	Park and Recreation Area	33.79037	-118.25811
80	Fries Elementary School	School	33.78863	-118.26590
81	Holy Family Grammar School	School	33.78806	-118.24889
82	Bay Breeze Care	Adult Health Care Facilities (Residential Care Homes)	33.78775	-118.21554
83	Harbor Park Golf Course	Park and Recreation Area	33.78739	-118.28293
84	Harry Bridges Span School	School	33.78725	-118.26204

Map Label	Name	Receptor Type	Latitude	Longitude
85	East Wilmington Greenbelt	Park and Recreation Area	33.78722	-118.24699
86	Gulf Elementary School	School	33.78641	-118.27313
87	Wilmington Park Elementary School	School	33.78600	-118.24622
88	Eugene Field Elementary School	School	33.78585	-118.21813
89	YMCA	Child/Day Care Service	33.78536	-118.26325
90	Los Angeles Harbor College	School	33.78382	-118.28376
91	Yvette's Daycare	School	33.78254	-118.27223
92	Reece Family Day Care	School	33.78103	-118.27598
93	Wilmington Town Square	Park and Recreation Area	33.78101	-118.26219
94	Community Development Center	School	33.78084	-118.27897
95	Friendship Children Center	School	33.78084	-118.27897
96	Vermont Christian School	School	33.78084	-118.27897
97	Flounders 24 Hour Child Care	School	33.78050	-118.26843
98	Wilmington Gardens	Adult Health Care Facilities (Residential Care Homes)	33.77927	-118.27860
99	Saint Peter and Saint Paul Roman Catholic School	School	33.77863	-118.26979
100	Drake Park	Park and Recreation Area	33.77839	-118.20158
101	American AAA Medical Group	Adult Health Care Facilities (Residential Care Homes)	33.77784	-118.26254
102	Banning Elementary School	School	33.77569	-118.26597
103	Hawaiian Elementary School	School	33.77557	-118.27618
104	Edison Elementary School	School	33.77449	-118.20091
105	Wilmington Recreation Center	Park and Recreation Area	33.77382	-118.26916
106	Cesar E Chavez Park-Long Beach	Park and Recreation Area	33.77211	-118.20238
107	Santa Cruz Park	Park and Recreation Area	33.76715	-118.20116
108	College of Oceaneering	Park and Recreation Area	33.76703	-118.26398
109	College of Oceaneering	School	33.76683	-118.26370

1.2 Describe Historical Facility Emission Patterns and Pollutant Hotspots

This section describes refinery operations, processes, emissions sources, and dispersion modeling. Emissions information, together with the information provided about the topology and geographic setting (Section 1.1), is used as additional basis for the placement of the fenceline monitoring systems.

1.2.1 Operations and Processes within the Facility's Perimeter

Tesoro's LAR Carson and Wilmington Operations manufactures fuel products such as gasoline, jet fuel, diesel fuel, petroleum coke, fuel oil, fuel gases, propylene and calcined coke. LAR distributes all grades of gasoline and ultra-low-sulfur diesel. Its Watson Cogeneration plant produces 400 MW and is the largest cogeneration facility in California.

Crude oil, used to produce gasoline and other refinery products, is delivered by ship to the Long Beach marine terminal and pumped to LAR by existing pipelines or received from offshore sources via pipeline directly to LAR. The crude oil is then processed in the crude units where it is heated and distilled into multiple feedstock components that are later processed elsewhere in LAR. The heavy residual oil leaving the crude units is further distilled in the vacuum units to yield additional, lighter hydrocarbon products and vacuum residuum. The vacuum residuum is processed in the Coker Unit and the lighter hydrocarbon components from the crude units and vacuum units are fed to other refinery units for further processing. Some of the major downstream processes are cracking in the Fluid Catalytic Cracking Unit (FCCU) and hydrocracking unit, processing to recover sulfur in the hydrotreating units, synthesizing in the alkylation unit, and reforming in the reforming unit. Auxiliary systems are also needed to support LAR operations including hydrogen plants (to produce hydrogen needed for certain refinery reactions), boilers to produce steam, cogeneration plants to produce electricity and steam, tail-gas, and wastewater treatment systems.

1.2.2 On-Site Emissions Sources and Emissions Levels

LAR submits Annual Emission Reports (AER) under the SCAQMD Inventory program annually with emissions of air contaminants from permitted sources. Fees for emissions of air contaminants are assessed based on the reported data pursuant to Rule 301, subdivision (e) and paragraph (l)(10) (South Coast Air Quality Management District, 2018).

LAR also submits toxics emissions inventory in accordance with SCAQMD's AB2588 Program for reporting quadrennial updates, per Health and Safety Code Section 44344 (California Air Resources Board, 2003).

Summarized below are some key emission source types:

- Heaters, boilers, and gas turbine generators
- Fluid catalytic cracking units
- Selective catalytic reduction unit ammonia slip
- Flares
- Incinerators
- Internal combustion engines
- Process vents
- Cooling towers
- Storage tanks
- Wastewater treatment
- Fugitives components
- Coke handling and transportation
- Bulk loading, and truck and rail car loading
- Fuel dispensing
- Maintenance activities
- Paint and solvent usage
- Vacuum trucks
- Welding equipment
- Tank and vessel degassing

Tesoro has previously submitted AERMOD dispersion modeling data to SCAQMD. This AERMOD dispersion modeling data was also utilized to determine the fenceline paths and monitors.

Table 4 summarizes the representative annual average emissions (AAE) and maximum hourly emissions (MHE) of Rule 1180 target compounds:

Table 4. Tesoro Carson and Wilmington Operations annual average representative emissions (AAE) and maximum hourly representative emissions (MHE) of Rule 1180 target compounds.

	Carson		Wilmington	
Pollutant	AAE (lb/yr)	MHE (lb/hr)	AAE (lb/yr)	MHE (lb/hr)
NO_x	1,549,017	1.77E+02	1,332,379	1.52E+02
SO_x	800,602	9.14E+01	348,567	3.98E+01
Acetaldehyde	770	1.51E-03	2,561	9.43E-03
Acrolein	65	1.32E-03	2	3.00E-05
Ammonia	363,039	5.92E-01	107,154	2.15E-01
Benzene	1,259	1.28E-03	1,359	1.15E-03
1,3-Butadiene	36	4.60E-04	32	1.50E-04
Carbonyl Sulfide	23	2.63E-03	3,358	9.58E-02
Ethylbenzene	2,386	1.55E-03	901	7.50E-04
Formaldehyde	1,510	1.08E-02	5,407	2.06E-02
HCN	34,338	3.92E+00	29,073[1]	3.32E+00
H_2S	2,000	1.66E-03	2,137	1.86E-03
Naphthalene	563	3.20E-04	207	1.70E-04
Styrene	1	6.80E-04	3	1.00E-05
Toluene	4,757	3.79E-03	7,827	5.92E-03
Xylene	5,014	3.30E-03	1,717	1.98E-03

[1] The Wilmington FCCU will shut down in 2018 so there may be negligible emissions of HCN from other sources.

1.2.3 Summary of Modeling Results

Air dispersion modeling runs using AERMOD and HARP2 were completed to calculate pollutant maximum one-hour average and annual average (over 5 years) concentrations at the Tesoro Carson and Wilmington Refineries.

Modeling was completed using AERMOD (Version 18081) and the California Air Resources Board's HARP2 ADMRT modeling software (dated 18159). AERMOD and HARP2 modeling set-up included:

- Emissions:
  - 2015 Annual Emissions Report (AER) profile for Sulfur Dioxide (SO_2), Nitrogen Oxides (NO_x), and volatile organic compounds (VOCs)

  - 2015 AB2588 quadrennial emissions profile for TACs
  - Urban Dispersion Coefficient, Los Angeles Population = 9,862,049
  - Source Emissions: 1 g/sec
  - Operating schedule for all sources: 24 hrs/day, 7 days/week, 52 weeks/year
  - Meteorological data: Long Beach Airport (2012–2016)
- Receptors:
  - Fenceline receptors: 50 m spacing
  - Grid receptors inside fenceline for contours: 100 m spacing
  - Grid receptors outside of fenceline: 50 m to 200 m
  - Elevated terrain (AERMAP processed with DEM files obtained from CARB)
  - Building downwash processed using BPIP

Hourly and annual average plot files from AERMOD were imported into the HARP2 ADMRT module. Annual and hourly emissions of each pollutant from each source were obtained from 2015 AER and AB2588 submitted reports and imported into the Emission Inventory section of HARP2 ADMRT. Ground Level Concentrations (GLCs) at fenceline and grid receptors were then calculated in HARP2, resulting in 1-hour and period GLC files per pollutant.

The concentrations from emissions occurring at both the Carson and Wilmington refinery sources were included in the modeled results. To better visualize the concentration values at receptors, the attached plots (see Appendix C) are provided in separate graphics for the Carson and Wilmington refineries. The concentration results are shown in isopleths, as well as posted values at receptor locations on the fenceline and out 200 meters from the fenceline.

In some of the 1-hour average concentration isopleth graphics, emissions resulting from one facility contribute to peak concentrations near another facility. For example, the graphic showing 1-hour average acrolein concentrations near the Wilmington facility shows that the highest concentrations are coming from the northwest direction from the Carson refinery, where potential acrolein sources are located. This effect will occur only for those periods where winds blow across one refinery toward the other refinery, leading to potentially additive concentrations at receptor locations.

Table 5 and Table 6 show maximum (worst case scenario) modeled results of GLCs at the Carson and Wilmington facilities for each pollutant. The maximum calculated GLCs for Rule 1180 pollutants are well below Cal-OSHA permissive exposure limits (PELs) and OEHHA reference exposure levels (RELs) thresholds.

Table 5. Modeled fenceline GLC for Rule 1180 pollutants at the Carson facility.

Air Pollutant	Units	AERMOD Predicted Max. 1-Hr Avg. Concentration	AERMOD Predicted Annual Avg. Concentration
Sulfur Dioxide (SO_2)	ug/m^3	52.0	2.42
Nitrogen Oxides (NOx)	ug/m^3	224	8.42
Total VOCs (Non-Methane Hydrocarbons)	ug/m^3	568	28.60
Formaldehyde	ppb	12.9	0.03
Acetaldehyde	ppb	1.45	0.00445
Acrolein	ppb	0.66	0.0013
1,3 - Butadiene	ppt	163	5.59
Styrene	ppt	10.7	0.04
Benzene	ppb	0.58	0.04
Toluene	ppb	5.25	0.45
Ethyl Benzene	ppb	0.61	0.04
Xylenes	ppb	1.90	0.23
Hydrogen Sulfide	ppb	1.59	0.14
Carbonyl Sulfide	ppt	30.5	1.83
Ammonia	ppb	13.9	0.85
Hydrogen Cyanide	ppb	0.64	0.04

Table 6. Modeled fenceline GLC for Rule 1180 pollutants at the Wilmington facility.

Air Pollutant	Units	AERMOD Predicted Max. 1-Hr Avg. Concentration	AERMOD Predicted Annual Avg. Concentration
Sulfur Dioxide (SO_2)	ug/m^3	34.8	1.05
Nitrogen Oxides (NOx)	ug/m^3	177	5.23
Total VOCs (Non-Methane Hydrocarbons)	ug/m^3	785	40.52
Formaldehyde	ppb	0.85	0.02
Acetaldehyde	ppb	0.18	0.0045
Acrolein	ppb	0.01	0.00031
1,3 - Butadiene	ppt	44.1	7.34
Styrene	ppt	9.83	1.20
Benzene	ppb	0.69	0.04
Toluene	ppb	2.81	0.21
Ethyl Benzene	ppb	0.49	0.04
Xylenes	ppb	0.85	0.05
Hydrogen Sulfide	ppb	2.56	0.40
Carbonyl Sulfide	ppt	91.1	5.55
Ammonia	ppb	23.2	1.38
Hydrogen Cyanide	ppb	0.21	0.01

The 1-hour GLC files were converted from units of ug/m^3 to ppb (or ppt if modeled results show very low concentrations), and Google Earth (GE) overlays of GLC isopleths in units of ppb, ppt, or ug/m^3 were created for each pollutant's maximum 1-hour impact and annual average impact at each receptor location. The maximum 1-hour impact and annual average impact GLC isopleth and concentration Google Earth overlays for each Rule 1180 pollutant for Carson and Wilmington operations are provided in Appendix C. The scaling has been adjusted to indicate concentration origination within the refinery.

The wind patterns in the area are influenced by the Palos Verdes Peninsula to the west. The wind flows at the north side of the Carson tend to be more westerly during the day, with less southerly component. Further south at the southern end of the Wilmington refinery, a daytime southerly wind component becomes more prominent. The Long Beach Airport wind data used captures these patterns to a certain extent. Use of this data to determine monitoring locations is expected to be conservative for the Wilmington refinery, with higher prevalence of impacts on the eastern fenceline than actually occur.

2. Fenceline Air Monitoring Equipment Description

This section describes the sampling locations, paths, and monitoring equipment selected for fenceline monitoring, the specifications and maintenance requirements for each monitor, and the compounds that will be monitored along each path/location. Since the Rule 1180 guidance stresses the use of open-path measurements wherever possible, point measurements will be made only for DPM (using BC as a surrogate) and H_2S as they cannot be measured using open-path technology at low detection levels. The selection of monitoring locations and instrument types was based on the emissions characteristics, locations of sensitive receptors, and dispersion modeling results presented in Section 1.

2.1 Select Sampling Locations Along the Perimeter of the Facility

Tesoro LAR operations are surrounded on all four sides by various other emissions sources, as well as residential areas. These adjacent emissions sources include the Alameda corridor rail network, multiple chemical plants, other refinery operations, fuel distribution terminals, an asphalt plant, a tank farm, and other commercial, and industrial facilities. The distance from the facility to residential areas ranges from 900 to 1,600 feet.

Tesoro LAR evaluated the following to determine the representative locations of the monitoring sites along the fenceline:

1. An evaluation of routine emissions and location of sources/operations at the refinery.
2. An evaluation of distribution and operations of processes within the refinery.
3. Regulatory annual emissions for criteria pollutants and AB2588 reporting for toxic air contaminants (TACs).
4. Regulatory air dispersion modeling for impacts at the refinery fenceline.
5. An evaluation of U.S. Environmental Protection Agency (EPA) benzene fenceline monitoring data and air pollutant distribution in surrounding communities using past monitoring studies (e.g. FluxSense and Atmosphir).
6. An evaluation of meteorological data, wind patterns, and wind roses obtained from two Safer meteorological stations operated at the refinery.

7. Logistical feasibility of shelter, power, and equipment installation, including terrain topography, elevations of sensors and retro-reflectors, and vicinity constraints for refinery equipment, roadways, traffic distribution, vessels, tanks, distillation columns, buildings, asbestos dismantling, pipe-racks, and underground utilities and infrastructure.
8. Consideration of residential and sensitive communities surrounding the refinery.
9. Consideration of the surrounding Alameda corridor rail network, major roads/freeways, traffic pattern, multiple chemical plants, laydown yards, other refinery operations, fuel distribution terminals, asphalt plant, other tank farm, and other commercial and industrial facilities.

The monitoring sites and paths for Rule 1180 fenceline monitoring are indicated in **Figure 5**. The selected instruments will be capable of measuring the pollutants listed in Rule 1180 in near-real-time (5-min readings), and include open-path FTIR and UV-DOAS, as well as point monitors for hydrogen sulfide (H_2S) and black carbon (BC, a surrogate for diesel particulate matter), and visibility measurements. The monitoring sites at the fenceline include consideration for generating data for both upwind and downwind scenarios to differentiate contributions from the facility and external sources.

The monitoring sites, paths, sensor elevations, and instrumentation selection are summarized in **Table 7**.

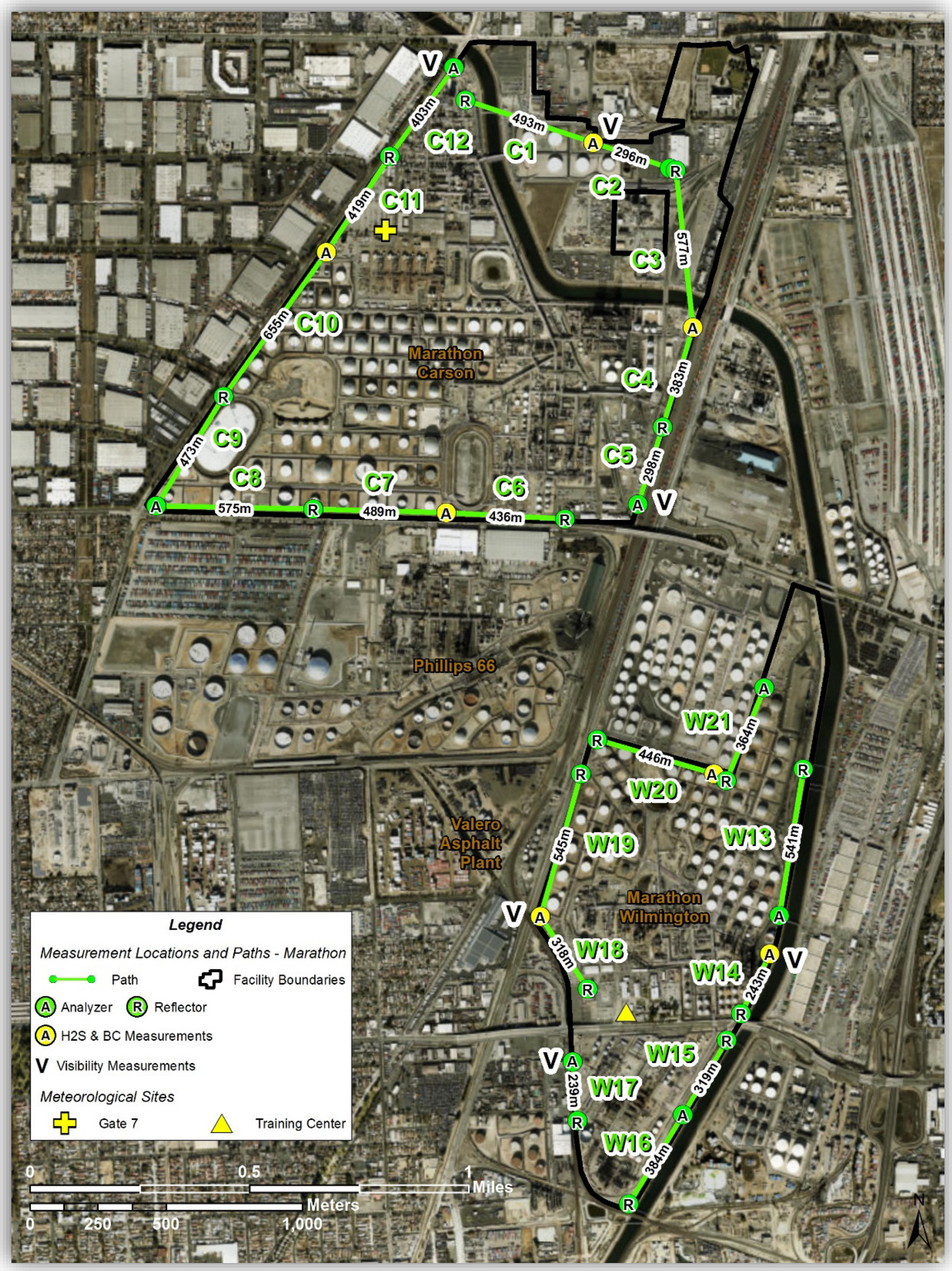

Figure 5. Monitoring sites and paths.

Table 7. Summary of paths, elevations, and selected instrumentation.

		Skid floor	Skid/Analyzer GPS		Reflector GPS			Path Length (m)	FTIR	UVDOAS	Points	Visibility	
PathID	**DESCRIPTION**	**Elev(ft)**	**A-Lat**	**A-Long**	**Elev(ft)**	**R-Lat**	**R-Long**				**H_2S and BC**		**PathID**
C1	PATH 1-2 SKID	12'	33°49'15.21"N	118°14'14.38"W	39'	33°49'20.13"N	118°14'32.67"W	493	√ *	√	√	√	**C1**
C2		12'	33°49'15.21"N	118°14'14.38"W	25'	33°49'12.30"N	118°14'3.39"W	296	√ *	√			**C2**
C3	PATH 3-4 SKID	10'	33°48'53.32"N	118°13'59.79"W	25'	33°49'12.03"N	118°14'2.55"W	577	√	√	√		**C3**
C4		10'	33°48'53.32"N	118°13'59.79"W	20'	33°48'41.40"N	118°14'3.95"W	383	√	√			**C4**
C5	PATH 5 SKID	12'	33°48'32.15"N	118°14'7.34"W	20'	33°48'41.40"N	118°14'3.95"W	298	√	√			**C5**
C6	PATH 6/7 SKID	18'	33°48'30.88"N	118°14'34.69"W	27'	33°48'30.30"N	118°14'17.72"W	436	√	√	√		**C6**
C7		18'	33°48'30.88"N	118°14'34.69"W	20'	33°48'31.13"N	118°14'53.72"W	489	√	√			**C7**
C8	PATH 8/9 SKID	18'	33°48'31.28"N	118°15'16.15"W	20'	33°48'31.13"N	118°14'53.72"W	575	√	√			**C8**
C9		18'	33°48'31.28"N	118°15'16.15"W	30'	33°48'44.45"N	118°15'6.74"W	473	√	√			**C9**
C10	PATH 10/11 SKID	30'	33°49'1.79"N	118°14'52.26"W	30'	33°48'44.45"N	118°15'6.74"W	655	√	√	√		**C10**
C11		30'	33°49'1.79"N	118°14'52.26"W	20'	33°49'13.28"N	118°14'43.38"W	419	√	√			**C11**
C12	PATH 12 SKID	12'	33°49'24.00"N	118°14'34.37"W	20'	33°49'13.28"N	118°14'43.38"W	403	√	√		√	**C12**
W13	PATH 13 SKID	12'	33°47'43.31"N	118°13'46.49"W	20'	33°48'0.81"N	118°13'43.30"W	541	√	√		√	**W13**
W14	PATH 14 SKID	12'	33°47'38.73"N	118°13'47.76"W	20'	33°47'31.59"N	118°13'51.79"W	243	√	√	√		**W14**
W15	PATH 15/16 SKID	18'	33°47'19.44"N	118°13'59.92"W	20'	33°47'28.37"N	118°13'53.74"W	319	√	√			**W15**
W16		18'	33°47'19.44"N	118°13'59.92"W	20'	33°47'8.72"N	118°14'7.46"W	384	√	√			**W16**
W17	PATH 17 SKID	12'	33°47'25.61"N	118°14'15.73"W	20'	33°47'18.55"N	118°14'14.98"W	239	√	√		√	**W17**
W18	PATH 18/19 SKID	18'	33°47'42.85"N	118°14'20.61"W	25'	33°47'34.28"N	118°14'13.72"W	318	√	√	√	√	**W18**
W19		18'	33°47'42.85"N	118°14'20.61"W	20'	33°47'59.95"N	118°14'15.02"W	545	√	√			**W19**
W20	PATH 20 SKID	12'	33°48'0.12"N	118°13'56.03"W	20'	33°48'4.02"N	118°14'12.78"W	446	√	√	√		**W20**
W21	PATH 21 SKID	12'	33°48'10.47"N	118°13'49.00"W	20'	33°47'59.33"N	118°13'54.28"W	364	√	√			**W21**

* panning head for one FTIR.

Paths C1-C12 and W13-W21 will provide monitoring data around all sides of both the Carson and Wilmington portion of the refinery. Both UV-DOAS and FTIR measurements will be made at all paths show in Figure 5. Point monitors for H_2S and black carbon (BC, as a surrogate for diesel particulate matter) will be placed at open-path skid locations on the north, east, south, and west sides of Carson Operations, and on the east, southwest, and north sides of Wilmington Operations. Both the open-path and point monitors will provide fenceline monitoring concentrations for (1) specific sources within the refinery under a range of wind conditions, and (2) nearby sensitive receptors in all directions from the refinery.

Paths C1 and C2 (Carson-NW and Carson NE) will provide representative monitoring data from process units located in the northern area of the refinery; however, the locations of the instrumentation will also enclose the Polypropylene plant owned by Ineos. Based on engineering surveys and feasibility analysis, open-path monitoring cannot be conducted across or on either side of the Dominguez Channel. The survey teams could not identify any clear path with line of sight for optical beam. Other constraints and factors include the asbestos field east of the Dominguez Channel; lack of real estate or space, or limited access for shelter or retro-reflectors; blockage to roadway access for routine traffic or heavy rigs; the nearest power supply being some 450 m away; underground constraints; terrain topography; pipe-racks; and the vicinity of hydrogen lines. Tesoro LAR projects team have reviewed other potential options, but have concluded that the paths 1 and 2 are the best option and will provide maximum potential monitoring coverage from refinery operations.

The Tesoro LAR projects team identified similar constraints along several other paths, necessitating small gaps in the fenceline between analyzers and/or reflectors. However, Tesoro LAR projects team indicates that the current paths will provide more data and operational reliability with fewer hindrances or obstructions to the optical beams.

Please note that due to Wilmington Refinery FCCU shutdown, there are no monitoring paths for the southwestern portion of Wilmington Refinery (south of PCH). In addition, based on the feedback and information from Tesoro LAR projects team, it was not possible to install a monitoring path along the southern fenceline, north of PCH, due to many obstructions, buildings, parking, utilities, and roadways.

Block diagrams that identify individual refinery process unit descriptions, tank locations, property boundary, roadways, cooling towers, reservoirs, buildings, and parking lots are provided in Appendix B.

2.2 Select Fenceline Air Monitoring Equipment that Is Capable of Continuously Measuring Air Pollutants in Real Time

Tesoro's LAR Carson and Wilmington Operations manufactures fuel products—primarily gasoline, diesel, liquefied petroleum gas (LPG), residual fuel oils, and petroleum coke—through the distillation of crude oil, coking, cracking, hydroprocessing, alkylation, and reforming processes. In consideration of the refinery's products, processes, and potential emissions sources, the rationales summarized in **Table 8** were applied to determine which species would be measured. Literature reviews, site surveys, and interviews with instrument manufacturers were performed to determine the instruments needed to meet Rule 1180 requirements. Both fixed-site and open-path instruments were investigated. Based on the distances that need to be covered by measurements (hundreds of meters), data time-resolution requirements (5 minutes), and current measurement technology, various open-path instruments were selected to best measure the target species. Point monitors were selected for black carbon (BC, a surrogate for diesel particulate matter) and for visibility.

Table 8. Summary of monitoring locations and instruments for species listed in Rule 1180.

Species	Required by the SCAQMD	To Be Measured (Paths)	Instrument(s)	Rationale, Comments
Benzene	Yes	C1-C12, W13-W21	OP UV-DOAS with Xenon	Included.
Toluene	Yes	C1-C12, W13-W21	OP UV-DOAS with Xenon	Included.
Ethylbenzene	Yes	C1-C12, W13-W21	OP UV-DOAS with Xenon	Included.
Xylenes	Yes	C1-C12, W13-W21	OP UV-DOAS with Xenon	Included.
H_2S	Yes	C1, C3, C6, C10, W14, W18, W20	Point H_2S	Included.
NO_x	Yes	C1-C12, W13-W21	OP FTIR	Measures NO_2 only.
SO_2	Yes	C1-C12, W13-W21	OP UV-DOAS with Xenon	Included.
Ammonia	Yes	C1-C12, W13-W21	OP FTIR	Included.
Acrolein	Yes	C1-C12, W13-W21	OP FTIR	Included.
Acetaldehyde	Yes	C1-C12, W13-W21	OP FTIR	Included.
1,3-Butadiene	Yes	C1-C12, W13-W21	OP FTIR	Although not needed because 1,3-butadiene is (1) coincident with benzene, and (2) not emitted by the refinery in high concentrations, concentrations will be monitored since FTIR instruments will be used to monitor NH_3.
Carbonyl Sulfide	Yes	C1-C12, W13-W21	OP FTIR	Included.
Formaldehyde	Yes	C1-C12, W13-W21	OP FTIR	Included.
Hydrogen Cyanide	Yes	C1-C12, W13-W21	OP FTIR	Included.
Hydrogen Fluoride	Yes, if used	N/A	NA	The refinery does not use hydrogen fluoride.
Styrene	Yes	C1-C12, W13-W21	OP FTIR	Included.
Total VOCs (non-methane hydrocarbons)	Yes	C1-C12, W13-W21	OP FTIR	Will report "total hydrocarbons" as propane based on characteristic spectral features.
Black Carbon	Yes	C1, C3, C6, C10, W14, W18, W20	Point Aethalometer	Required. BC is a surrogate for diesel particulate matter. BC measurements are also highly correlated with polycyclic aromatic hydrocarbon (PAH) measurements.

2.2.1 Pollutant Detection Limits

Table 9 summarizes the approximate minimum detection limits (MDLs) and upper detection limits (UDLs) by instrument that will be used in Tesoro's monitoring program. Detection limits are approximate; while they are based on the theoretical capabilities of the instruments, they are supported by manufacturers' lab tests and real-industry applications. Actual detection limits will depend on atmospheric conditions. MDLs will be determined during routine measurements and bump tests; UDLs cannot be tested in a refinery environment, due to chemical property and safety considerations. The detection limits are for the average species concentration along a path; narrow plumes that only cover a portion of the path would need to have a higher concentration than the MDL to be detected.

Open-path instruments transmit light or infrared energy across a long open path. Energy absorption relates to the average concentration of gases of interest along the path, according to the Beer-Lambert absorption law. Individual gases absorb most effectively at characteristic wavelengths; therefore, measurements of energy absorption at specific wavelengths can be used to infer path-average concentrations for species of interest. The transmitted energy signal is typically either detected remotely by a targeted detector or reflected for detection elsewhere. A combined transmitter-detector unit is often positioned at one end of a path, and a retroreflector—a type of mirror with a geometric shape that gathers and re-focuses the transmitted energy—is positioned at the other end of the path. The retroreflector returns the transmitted energy to the transmitter-detector unit for detection. **Figure 6** illustrates the basic concepts of open-path measurements. Rather, the instruments detect average concentrations across the entire distance from the transmitter to the detector (or the distance from the transmitter-detector to a retroreflector, and back again). Periods of poor visibility due to weather-related conditions (e.g., fog) are known to interfere with open-path measurements. Rule 1180 anticipates some data loss due to poor visibility and allows for such data loss if supported by visibility measurements. LAR will monitor visibility using a standard light-scattering device to identify periods of poor visibility that may cause data loss. These visibility sensors will be located on the east side of Carson and Wilmington along paths near cooling towers.

Table 9. Estimated open-path instrument detection limits (in parts per billion, ppb) by technology, species, and path lengths of 454 m and 200 m, as examples of what will be expected in the field. Detection limits for actual path lengths will be determined during operations. The MDL for the black carbon monitor is expected to be about 0.5 µg/m3 with a UDL of about 20 µg/m^3.

		Shortest Path (244 m)		Longest Path (603 m)	
Technology	1180 Compound	MDL (ppb)	UDL (ppb)	MDL (ppb)	UDL (ppb)
FTIR	1,3-Butadiene	8	20,000	3	7,900
	Acetaldehyde	10	410,000	4	170,000
	Acrolein	31	180,000	12	74,000
	Ammonia	6	110,000	3	45,000
	Benzene	61	61,000	25	25,000
	Carbonyl Sulfide	2	TBD*	1	TBD*
	Ethylbenzene	51	77,000	21	31,000
	Formaldehyde	2	51,000	1	21,000
	Hydrocarbons	12	12,000	5	5,000
	Hydrogen Cyanide	3	41,000	1	17,000
	Nitrogen Dioxide	12	TBD*	5	TBD*
	Styrene	16	23,000	7	9,500
	Total Xylenes	610	150,000	250	62,000
UV-DOAS	Acrolein	17	390,000	7	160,000
	Benzene	1	65,000	0.2	26,000
	Ethylbenzene	4	45,000	2	18,000
	Sulfur Dioxide	6	85,000	2	34,000
	Toluene	2	92,000	1	37,000
	Total Xylenes	2	15,000	1	6200

*TBD – to be determined

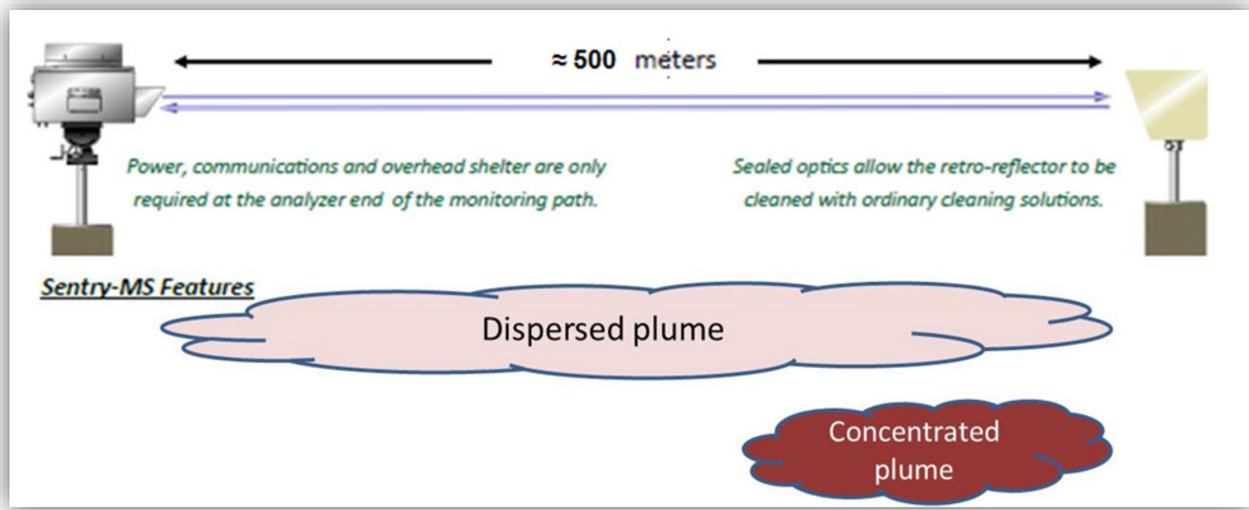

Figure 6. Basic premise for open-path instrument operation. Image from CEREX Sentry-MS monitoring brochure.

Monostatic (as opposed to bistatic) open path instruments have been selected to (1) reduce the need for substantial power at the retroreflector sites, and (2) improve minimum detection limits by increasing effective path lengths. Thus, only the light-source/detector end of the monitoring path requires substantial power, communications equipment, and a large shelter. Limited power is needed at the retroreflectors, but the retroreflector needs to be aligned correctly at its end of the path for maximum performance, and should be cleaned regularly. Photos of an exterior and an interior of an analyzer shelter showing an FTIR analyzer are shown in Figure 7, and photos of two UV-DOAS analyzers, a point-monitor rack, and a retroreflector tower with UV-DOAS and FTIR retroreflectors are shown in Figure 8.

Figure 7. An example of an analyzer shelter (left) and an FTIR system (right).

Figure 8. An example of two UV-DOAS analyzers, the point-monitor rack inside the communications cabinet, and a retroreflector tower with both a UV-DOAS and FTIR retroreflectors,

2.2.2 Point Monitors

A Magee AE33 Aethalometer will be used to measure BC. An aethalometer works by pulling air through a filter tape where particulate matter is deposited. The transmission of the filter is monitored as several wavelengths. The BC concentration is calculated from the attenuation of light passing through the filter.

A Picarro G2204 monitor will be used to measure hydrogen sulfide (H_2S). This monitor works by pulling air into a chamber to perform cavity ring-down spectroscopy that is specific to H_2S.

To measure visibility, a light-scattering device will be used. This device shines light through open air to a detector that measures the transmitted light and relates it to the visibility range. When the visibility range gets below approximately 500 to 1,000 meters, the light transmission used by the open-path instruments may be impacted.

2.2.3 Operations and Maintenance

Instrument operations, maintenance, and bump tests include daily checks to ensure that data are flowing consistently, as well as monthly, quarterly, and annual maintenance activities. Further details are provided in the following sections, which describe routine instrument and data management operations. Additional details and documentation, including standard operating procedures (SOPs), for example, are included in the QAPP. Modest adjustments to the operation plans may be needed based on the brand of instruments that are ultimately selected. Meteorological sensors will meet EPA requirements and will be operated to meet EPA operational requirements.

UV-DOAS

The UV-DOAS system is designed to require only modest service and maintenance. **Table 10** summarizes typical maintenance activities for a UV-DOAS system, as recommended by a typical manufacturer. Preventive maintenance frequency depends on the operating environment, and may need to be adjusted beyond the manufacturers’ recommendations once the instruments are deployed in the field. System status alarms will alert operators on an as-needed basis to specific issues needing to be addressed.

Table 10. Schedule of typical maintenance activities for the UV-DOAS.

Activity	Monthly	Quarterly	Annually
Visually inspect the system.	✓	✓	✓
Inspect optics on detector and retroreflector; clean if necessary.	✓	✓	✓
Inspect system filters.	✓	✓	✓
Confirm the alignment to verify there has not been significant physical movement. Note that this is also automatically monitored.	✓	✓	✓
Download data from detector hard drive and delete old files to free space, if needed.	✓	✓	✓
Ensure no obstructions are between the detector and the retroreflector (such as equipment, vegetation, vehicles).	✓	✓	✓
Change out the UV source.		✓	
Replace ventilation exit and intake filters.		✓	
Clean optics on detector and retroreflector.		✓	
Realign system after service.		✓	✓
Check system performance indicators.		✓	✓
Perform bump test (simulates system-observed gas content at the required path average concentration) to verify the system can detect at or below a lower alarm limit.		✓	
Review and test light and signal levels. Check average light intensity to establish baseline for bulb change frequency.		✓	✓
Verify system settings.			✓

FTIR

The FTIR requires maintenance activities similar to those for the UV-DOAS, but is also designed to require only modest service and maintenance. Table 11 summarizes the maintenance activities for a FTIR system, as recommended by a typical manufacturer. Preventative maintenance frequency depends on the operating environment, and may need to be adjusted. System status alarms may alert operators on an as-needed basis to specific issues that need to be addressed. Bump tests are performed on site.

Table 11. Schedule of typical maintenance activities for the FTIR.

Activity	Monthly	Quarterly	Semi-Annually	Annually	Three Years	Five Years
Visually inspect the system.	✓	✓		✓		
Inspect and clean AC system exterior heat sink.			✓			
Inspect and clean AC system interior heat sink.				✓		
Confirm the alignment to verify there has not been significant physical movement. Note that this is also automatically monitored as well.	✓	✓		✓		
Download data from detector hard drive and delete old files to free space, if needed.	✓	✓		✓		
Ensure no obstructions are between the detector and the retroreflector (such as equipment, vegetation, vehicles).	✓	✓		✓		
Change out the IR source.						✓
Realign system after service.		✓		✓		
Check system performance indicators.		✓		✓		
Perform bump test.		✓				
Review and test light and signal levels. Check average light intensity to establish baseline for infrared source change frequency and retroreflector wear.				✓		
Verify system settings.		✓				
Replace cryocooler or swap detector module assembly.					✓	

Aethalometer

The Aethalometer system is designed to require only modest service and maintenance. Table 12 summarizes the typical maintenance activities for an Aethalometer, as recommended by a manufacturer. Preventive maintenance frequency depends on the operating environment and may need to be adjusted beyond the manufacturers' recommendations once the instruments are deployed in the field. System status alarms will alert operators on an as-needed basis to specific issues needing to be addressed.

Table 12. Schedule of typical maintenance activities for Aethalometers.

Activity	Monthly	Semiannual	Annual
Visually inspect the system.	✓	✓	✓
Inlet flow check	✓		
Clean size selective inlet	✓		
Clean cyclone	✓		
Verify date and time	✓		
Inspect optical chamber and clean as necessary		✓	
Calibrate flow		✓	
Change bypass cartridge filter			✓
Check tape roll, install new tape roll if necessary	✓		
Calibrate tape sensor		✓	

H_2S Point Analyzer

Table 13 describes maintenance actions for the Picarro G2204 H_2S analyzer, including cleaning and inspections and their required frequencies for routine system management. The frequency of preventive maintenance depends on the operating environment and may be adjusted beyond manufacturers' recommendations once the instruments are deployed in the field. On an as-needed basis, system status alarms will alert operators to specific issues needing to be addressed.

Table 13. Typical schedule of maintenance activities for the Picarro G2204.

Maintenance Action	Frequency
Inspect sample line tubing	Monthly, or during a site visit
Inspect and clean sample inlet	Monthly, or during a site visit
Inspect and clean insect/moisture trap	Monthly, or during a site visit
Backup data to external storage	Monthly
Gas verification test	Quarterly
Replace particulate filter	Annually

Maintenance and Failure Plan

Normal routine scheduled maintenance for open-path instruments occurs at least once per month. During these maintenance visits, the operator will carry repair parts to the site. It is expected that routine maintenance periods—when the equipment might not be reporting data—will be about 2 hours long.

If between routine visits, monitors fail to report data or appear to be reporting erroneous data, both remote diagnosis and, if necessary, a site visit will be conducted. If the problem cannot be resolved with the equipment or parts on hand, Tesoro will obtain replacement parts from the vendor. Tesoro has negotiated to have spare parts, including major components, available locally for emergency repairs. It is expected that with these measures, the problem can be resolved by the next business day. Tesoro also has a spare analyzer for the FTIR, the UV-DOAS, the H_2S analyzer, and the BC monitor; these will be put in place if operations cannot be resolved with the above procedures.

If downtime exceeds 24 hours, Tesoro will respond with the required written notification.

Tesoro will submit the required written notification to the SCAQMD Executive Officer of any equipment failure that results in a failure to accurately provide continuous, real-time air monitoring information for 24-hours or longer. The written notification shall be submitted to the Executive Officer within 24 hours of discovering the equipment failure, and shall include the following:

- An explanation of activities currently being pursued or taken to remedy the equipment failure;
- The estimated time needed to restore the fenceline air monitoring equipment to normal operating conditions that comply with the approved fenceline and community air monitoring plan; and
- Temporary air monitoring measures to be implemented until the fenceline air monitoring system is restored to normal operating conditions.

2.2.4 Excluded Pollutants

Hydrogen fluoride is not used in Alkylation Units at the LAR Carson and Wilmington Operations; therefore, it will not be measured.

3. Quality Assurance

3.1 Quality Assurance Procedures for Data Generated by the Fenceline Air Monitoring System

Raw data management occurs on a daily, monthly, quarterly, and annual basis. On a daily basis, data are transferred from infield instruments through a data acquisition system (DAS) to a data management system (DMS) in real-time. Data are also stored onsite on instrument computers in case of data network failure.

The DMS can handle the large volumes of data that will be generated in this project. The DMS will be used to automatically quality-control data, detect outliers and problems, and create alerts. The auto-screening and graphical capabilities of the DMS will be used to continuously examine data quality. The DMS will feed auto-screened data to the field operations website and notification system to inform project and facility staff. The operations website will show maps and time-series plots of the pollutants, winds, and visibility data. The auto-QC'd air quality data will be fed to the public website (see Section 4) in near-real time. The DMS data will be backed up on a daily basis. Historical data for up to two years will be made available on the public website while the archived data will be maintained for five years pursuant to Rule 1180.

All data values not associated with bump tests or other instrument maintenance will be displayed to the public in near-real time (i.e., about 10 minutes or less). If data are subsequently proven to be invalid, they will be removed from the public display, and the rationale for data removal will be provided.

A non-public field operations website will be used for daily graphical review of the data (an example is provided in **Figure 9**). Common data problems include flat signal/constant values, no signal/missing data, extremely noisy signal, rapid changes (spikes or dips), and negative concentrations (see annotated **Figure 10** for examples). An initial review, typically of a three-to-five-day running time-series plot of selected parameters for each instrument, allows the analyst to see common problems and verify instruments are operational. If it appears that an instrument is not operating, or the data are missing, the field operator will be notified and further investigation and corrective action will be taken if needed.

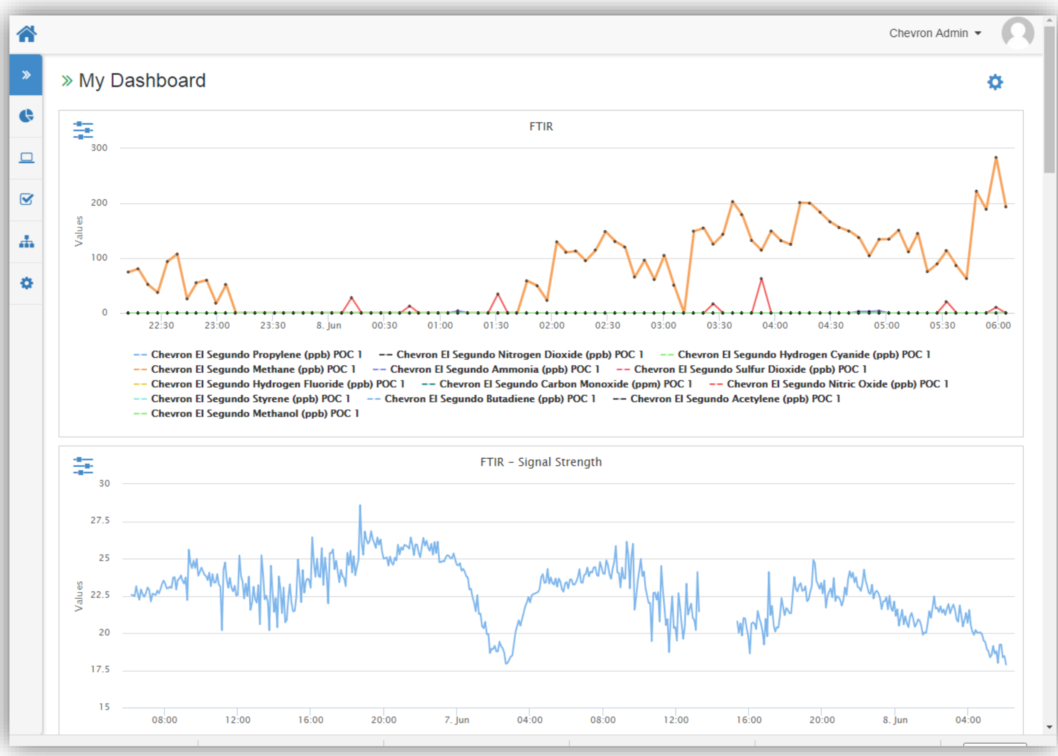

Figure 9. Example of a non-public field operations website used for daily review of instrument operations.

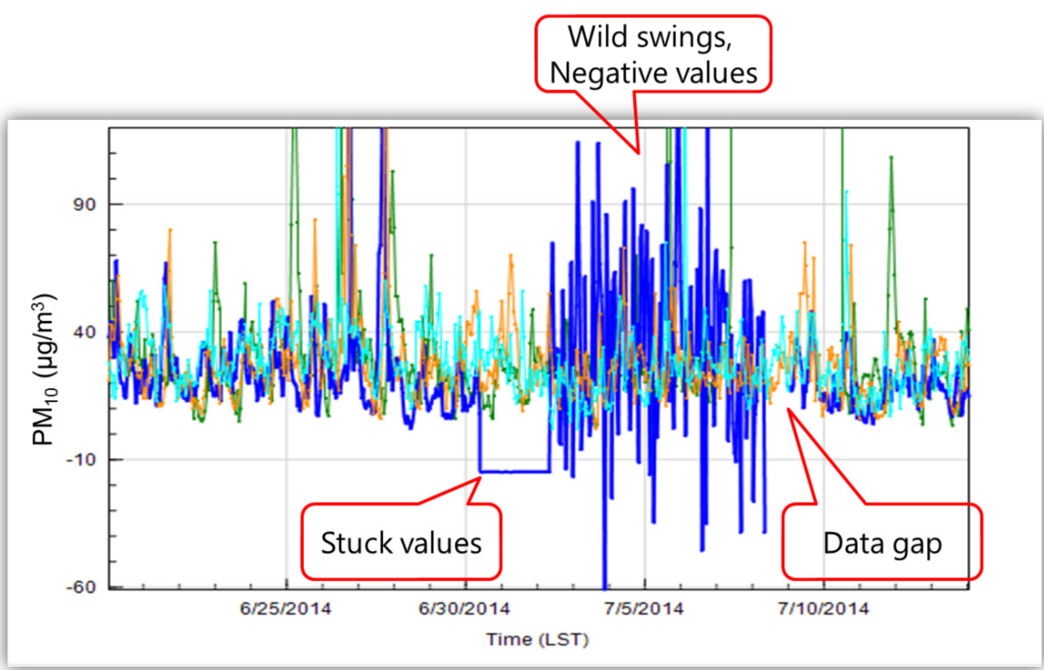

Figure 10. Example of species concentration time series showing stuck values, wild swings, large negative values, and a data gap. Such features in the data indicate instrument issues.

Once it is clear that instruments are operational, the next step will be to review whether the species concentration patterns are reasonable with respect to the time of day, season, meteorology, facility operations, and concentrations expected and observed at other sites. If anomalies are observed, additional analysis will be conducted to determine whether there is an instrument malfunction or the data are truly anomalous, but explainable and valid.

Visual review of data will be augmented by automated data screening within the DMS upon data ingest. Automated screening checks of data feeds are helpful to focus the analyst's efforts on the data that need the most attention and are used to screen out invalid data. All data above notification threshold levels (Section 5) will be flagged as suspect. Screening criteria (flags and rates of change) are preliminary and will be refined during the project based on actual observations and instrument performance. In summary, the DMS auto-screening checks that will be used include:

- **Range.** These checks will ensure the instrument is not reporting values outside of reasonable minimum and maximum concentrations.
- **Sticking.** If values are repeated for a number of sampling intervals, data will be reviewed for validity. Typically, four or more intervals of sticking values are a reasonable time span to indicate that investigation is needed. Sticking checks will not be applied to data below the instrument detection limit.
- **Rate of Change.** Values that change rapidly without reasonable cause will be flagged as suspect and reviewed.
- **Missing.** Missing data will be flagged.
- **Sensor OP Codes and Alarms.** If the instrument assigns operation (OP) codes to data automatically (e.g., for bump tests, internal flow rate checks), the data will be reviewed, the OP codes will be confirmed, and the data flags will be checked.

Additional QC checks for the instruments are summarized in Table 14. Data that fail checks will be flagged in the DMS and brought to the attention of the reviewer. Data are invalidated only if a known reason can be found for the anomaly or automated screening check failure. If the data are anomalous or fail screening, but no reason can be found to invalidate the data, the data are flagged as suspect. Additional analysis may be needed to deem data valid or invalid. Common reasons for invalidation include instrument malfunction, power failure, and bump test data that were not identified as such. As the measurements progress over time, Tesoro will update and refine the screening checks. Screening checks are typically specific to the site, instrument, time of day, and season, and are adjusted over time as more data are collected.

Table 14. Typical instrument QA/QC checks.

QA/QC Checks	Frequency	Acceptance Criteria
UV-DOAS		
Bump test (accuracy)	Quarterly and after major service	±25%
Baseline stability	Continuous	±5%
Measurement quality (R^2)	Continuous	0.8 to 1.0
Integration time	Continuous	80-200 mS *300 mS integration time results in a warning notification*
Signal intensity	Continuous	>80% *Signal intensity below 30 results in a warning notification*
FTIR		
Bump test	Quarterly and after major service	±25%
Baseline stability	Continuous	±5%
IR single beam ratio test (background vs. sample intensity)	Real time	*To be determined*
Measurement quality (R^2)	Continuous	0.7 to 1.0
Signal intensity	Continuous	>5% *Signal intensity below 5 results in a warning notification*
Aethalometer		
Flow rate		±10%
Span check		±10%
Zero check		<550 ng/m^3 for Ch. 6
Picarro G2204		
Multipoint calibration	Quarterly	20%

In addition to auto-screening and daily visual checks, data will be subjected to more in-depth review on a quarterly basis and when data fail screening. Final data sets will be compiled quarterly—60 days after each quarter's end—and will be provided to the SCAQMD. Tesoro will maintain a data record for five years consistent with Rule 1180.

Any corrections or updates will be copied to the website. Validation checks will include:

- Looking for statistical anomalies and outliers in the data.
- Inspecting several sampling intervals before and after data issues, bump tests, or repairs.
- Evaluating monthly summaries of minimum, maximum, and average values.
- Ensuring data reasonableness by comparing to remote background concentrations and average urban concentrations.
- Referring to site and operator logbooks to see whether some values may be unusual or questionable based on observations by site operator.
- Ensuring that data are realistically achievable, i.e., not outside the limits of what can be measured by the instrument.
- Confirming that bump tests were conducted and were within specifications.

These in-depth analyses typically require data not available in real time and ensure that the data on the website are updated.

On a quarterly basis, to ensure daily QC tasks are complete, analysts will:

- Review any instrument bump test results.
- Verify that daily instrument checks were acceptable.
- Review manual changes to operations/data, and verify that the changes were logged and appropriately flagged.
- Ensure that daily bump tests or instrument checks have the appropriate QC codes applied.

On a quarterly basis, analysts will subject the data to a final QC screening, including filling in missing records with null values, and adding in Null Codes. Additional steps include

- Creating a null record for data completeness purposes if a record is not created for a particular site/date/time/parameter combination.
- Assigning a Null Code to any invalid data to explain why the data is invalid.
- Inspecting data consistency over three months.
- Reviewing ranges of values for consistency—ranges should remain consistent over months of monitoring.
- Checking bump test values for consistency.
- Reviewing data completeness.

To support the traceability of the actions taken to produce the data on the website, all analyst work will be recorded and the raw data will be retained.

On an annual basis, Tesoro or its designated contractor will review the performance of the network by (1) reviewing the data completeness by monitoring path, instrument, and species; (2) reviewing results of bump tests; (3) analyzing the reported values in the context of refinery operations; and (4) analyzing the data in the context of the meteorology. The results will be summarized in a technical memorandum and provided to the SCAQMD upon request.

Data flagged through auto-screening checks (discussed in Section 3.1) will be graphically reviewed. QC flags will be updated as needed with daily, monthly, and quarterly actions (see Figure 11), and the QC flags will be updated on the public website as needed. DMS keeps track of data QC changes.

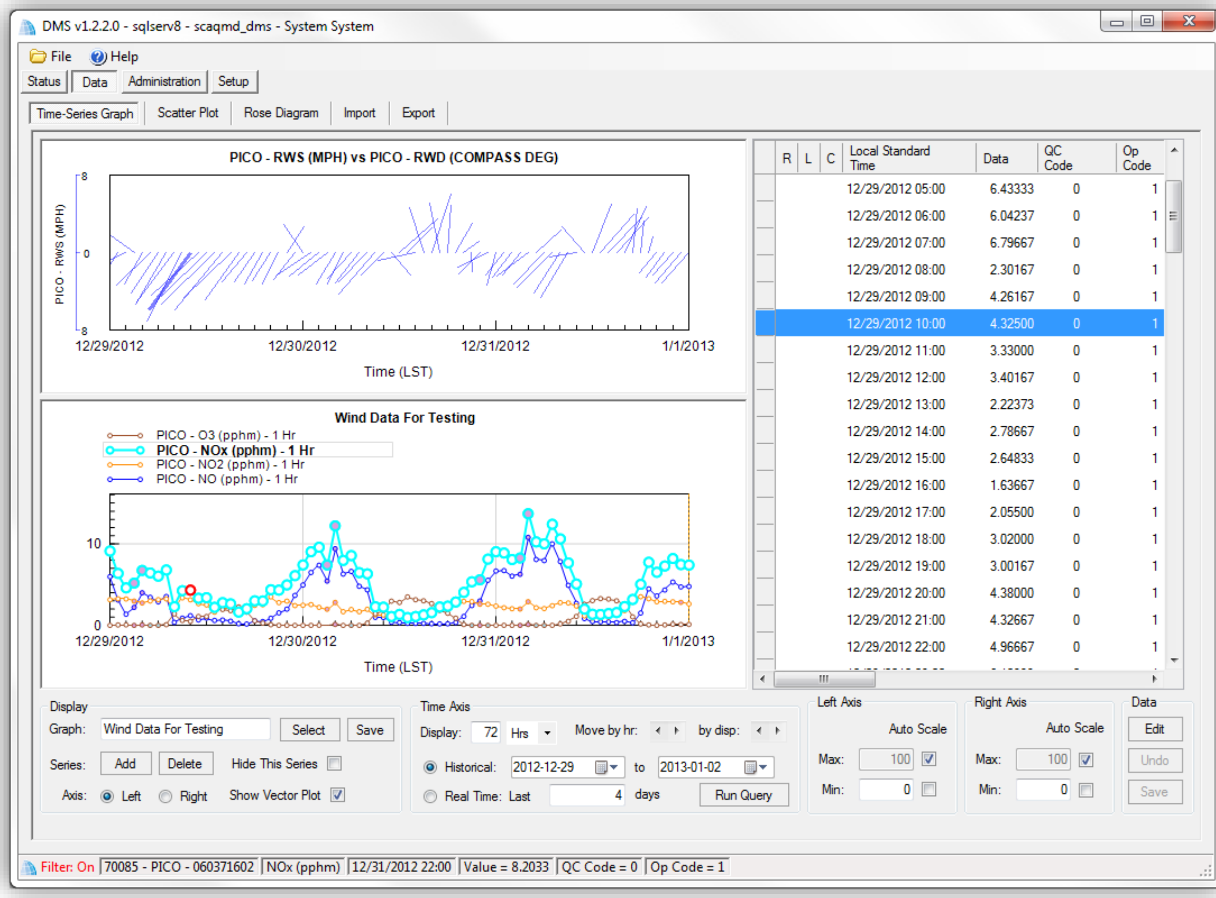

Figure 11. Screenshot of a typical DMS showing winds and species concentrations. Actual screens may vary.

3.2 Quality Assurance Project Plan

Tesoro LAR has submitted to SCAQMD a Quality Assurance Project Plan (QAPP) and associated SOPs; this QAPP and associated SOPs are attached to this Monitoring Plan as Appendix D.

3.3 Routine Equipment and Data Audits

Rule 1180 specifically calls for “procedures for implementing quality assurance by a qualified independent party, including quality control and audits of the fenceline air monitoring systems” (South Coast Air Quality Management District, 2017a). Quality assurance takes two forms; (1) internal quality assessment is conducted or arranged within Tesoro as directed by the QA Manager, and (2) external QA will be provided by a third party, to be determined at a later date.

The following is a list of internal and external assessment tools that will be utilized by the Tesoro refinery:

Internal Audits

- Data quality assessments – as requested by QA Manager
- Performance Evaluations – initial, semi-annual
- Flow rate audits – initial, quarterly
- Internal technical system audits – initial, 3 to 5 years

External Audits (by Third Party)

- Third-party performance audit – initial, annual
- Third-party technical systems audit – every 3 years

The audit function has two components: the system audit (in essence, a challenge to the QAPP), and the performance audit (a challenge to the individual measurement systems).

The system audit provides an overall assessment of the commitment to data validity; as such, all commitments made in the QAPP should be subject to challenge. Typical questions asked in the systems audit include, "Are standard operating procedures being followed?" and "Are there any errors in the data flow from the instrument to the website?" During this audit, the QA Manager reviews the calibration sources and methods used, compares actual test procedures to those specified in this protocol, and reviews data acquisition and handling procedures. The QA Manager also reviews instrument calibration records and gas certificates of analysis. All deficiencies should be recorded in the audit report, along with an assessment of the likely effect on data quality. Corrective actions related to a systems audit should be obvious if the appropriate questions are asked.

The performance audit is similar to a calibration in terms of the types of activities performed—all the performance audit adds is an independent assurance that the calibrations are done correctly and that the documentation is complete and accurate. In the ideal case, when both the auditor and site operator are equally knowledgeable, the auditor functions as an observer while the site operator performs the calibration; in this instance, the auditor functions in a "hands-off" mode. In initial audits, since newly hired site operators may have little or no experience with instruments, the hands-off approach may not be practical or desirable. In these instances, the audit may also function as a training exercise for the site operator (U.S. Environmental Protection Agency, 2000). **Table 15** describes acceptance testing parameters for the sensors described in this monitoring plan. Where possible, NIST-traceable gas standards should be used for the UV-DOAS, FTIR, and TDLAS instruments. The Aethalometer should be subjected to both a leak check and flow rate check.

Tesoro LAR maintains and operates one meteorological stations each at Carson and Wilmington Refineries. Tesoro LAR will be using a third-party to certify these meteorological stations in accordance with Rule 1180 requirements. Preventative maintenance, routine certification, and third-party audit details will be provided in the QAPP to be submitted at a later date before the start of the fenceline monitoring regime on January 1, 2020.

The existing meteorological stations at Carson Operations Gate 7 and Wilmington Operations Training Center sites will also be subject to audit. The simplest acceptance test for temperature and temperature difference is a two-point test using room temperature and a stirred ice slurry. A reasonably good mercury-in-glass thermometer with some calibration pedigree can be used to verify agreement to within 1°C. For wind anemometers, the measurement system is challenged with various rates of rotation on the anemometer shaft to test the performance from the transducer in the sensor to the output. The starting torque of the bearing assembly is measured and compared to the range of values provided by the manufacturer. In addition, these meteorological stations will be certified and maintained in accordance with EPA protocols. A third-party audit will be completed on a semi-annual basis to satisfy EPA requirements. The data from these meteorological stations will also be displayed live on the data display website.

The QA Manager, during the course of any assessment or audit, shall identify any immediate corrective action that should be taken to the technical staff performing experimental activities. If serious quality problems exist, the QA Manager is authorized to stop work. Once the assessment report has been prepared, the Field Staff Manager ensures that a response is provided for each adverse finding or potential problem, and implements any necessary follow-up corrective action. The QA Manager shall ensure that follow-up corrective action has been taken.

Table 15. Description of performance audits for the sensor systems planned for this project.

Sensor	Test	Acceptance Criteria
UV-DOAS	100 ppm p-Xylene; internal flow-through QA cell	±25%
FTIR	100 ppm isobutylene; internal flow-through QA cell	±25%
H_2S Point Monitor	0, 250, 150, 50 ppb	±20%
Aethalometer	Bubble flow meter, internal leak check	±10%
Temperature	Two point test	±0.5ºC
Relative Humidity	Hygrometer	±7%
Wind Speed	Starting threshold test; transfer function test	±0.25 m/s below 5 m/s and ± 5% above 5 m/s
Wind Direction	Angle verification	±5 degrees
Visibility	Extinction	±10%

4. Data Presentation to the Public

A key part of this monitoring program is disseminating the measured data to the public. This will be accomplished using Marathon LAR's public-facing website, marathonlosangelesrefineryfencelinemonitoring.com. Tesoro Refining & Marketing Company LLC (Carson and Wilmington Operations) is a subsidiary of Marathon Petroleum Corporation. This website is linked to the data management system (DMS) described in Section 3. This section describes how the information will be displayed to the public. For the public website, key components will include:

- Visual display of data in near-real time
- A description of monitoring techniques
- A description of monitored pollutants
- Hyperlinks to related information

4.1 Educational Material that Describe the Objectives and Capabilities of the Fenceline Air Monitoring System

The home page of the public-facing website is dedicated to providing background on reasons the monitoring is taking place and the type of technology being used in the monitoring system. Figure 12 shows the public-facing website's home page. A brief paragraph written in plain English explains the monitoring objectives and gives a short overview of the monitoring program. The Resources page linked from the home page includes (1) information on the compounds monitored at the refinery; (2) the data flags used in QA checks; (3) definitions for technical terms—such as fenceline monitoring, open-path monitors, and visibility—to help the public better understand the information provided on the website; (4) web links to the SCAQMD website for further information on Rule 1180 and the rule guidance; and (5) a frequently asked questions (FAQ) topic that describes the nature of real-time data (5-minute averages reported about 10 minutes after it was measured, allowing for automatic quality checks) vs. non-real-time data (data reported quarterly after it has been validated) so that the public appreciates the rapid nature of the reporting system. FAQs will not necessarily evolve based on public comment, and Tesoro may decide to modify FAQs at any time.

Figure 12. Home page of the public-facing fenceline monitoring site.

4.2 Description of all Pollutants Measured and Measurement Techniques

Data for all pollutants measured is displayed under the Monitors section of the website (shown in Figure 13) that is readily available from the home page. On this page, members of the public can view any one of a number of concentrations (1,3-butadiene is selected in Figure 13) of the monitored pollutants; concentrations are displayed for each monitoring site with the necessary instrument. The Monitors section also shows the current meteorological information collected from Tesoro LAR's two meteorological sites.

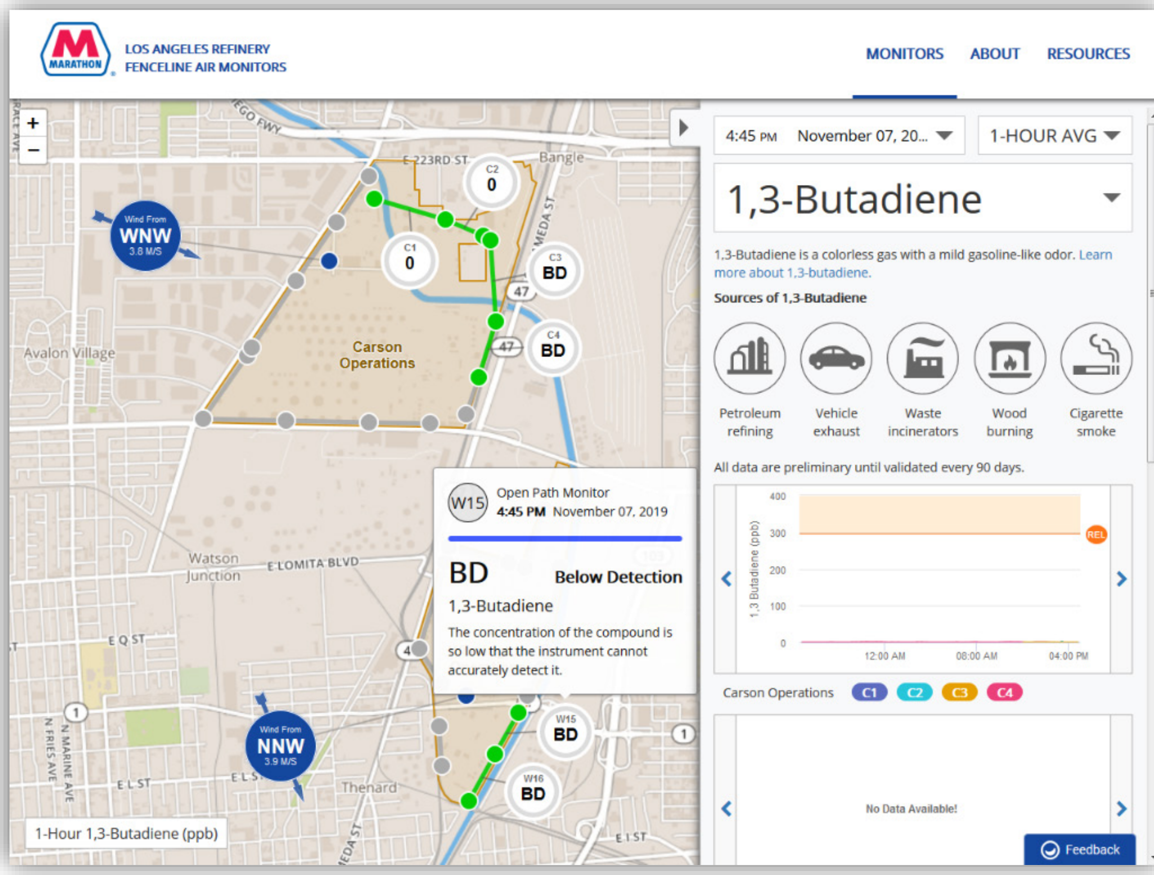

Figure 13. The Monitor section of the public-facing website showing concentrations monitored along the 21 pathways; this view shows data for just a few paths in start-up mode. This example shows benzene concentrations; a dialog box appears when the user hovers over a data point.

If a member of the public selects "All Compounds" from the drop down menu, concentrations of all 19 monitored pollutants are displayed across all 21 pathways at the refinery (shown in Figure 14).

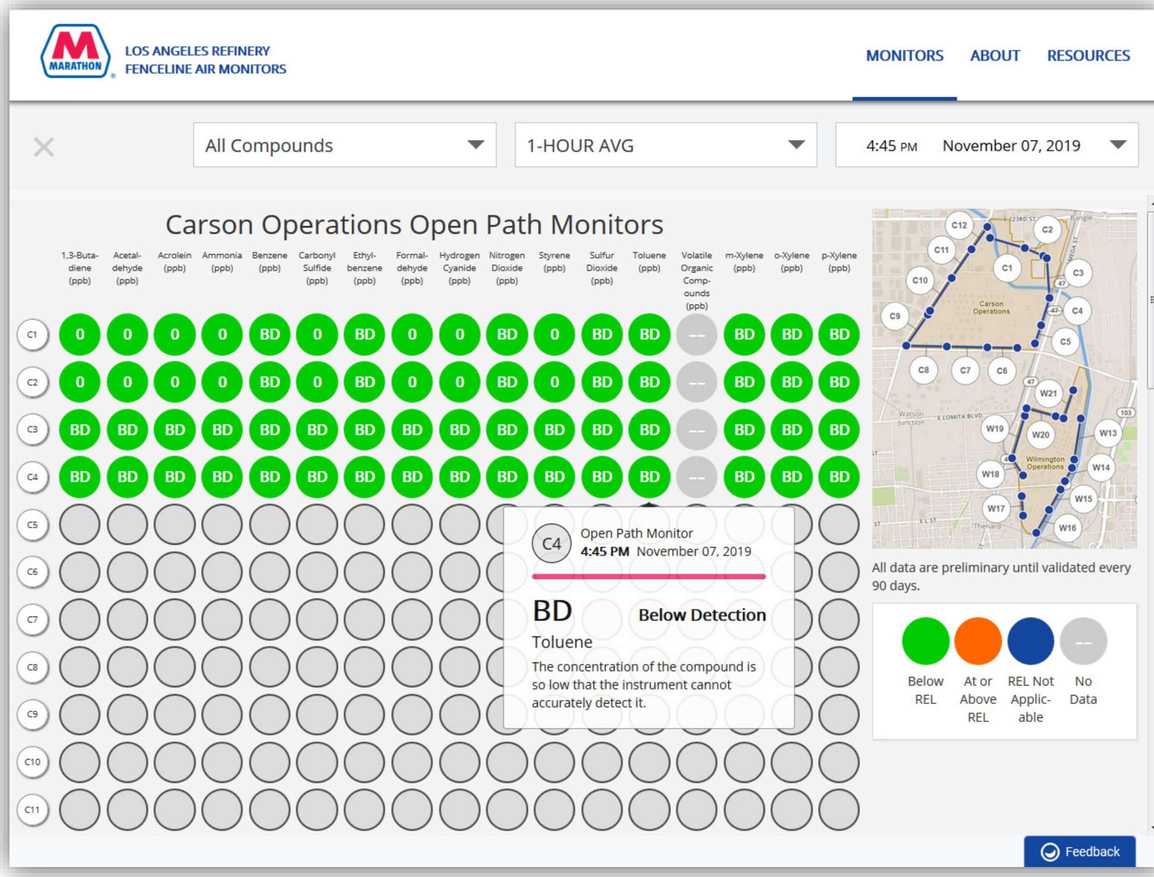

Figure 14. The "All Compounds" view of the Monitors page, accessed by selecting All Compounds from the concentration drop-down menu. A dialog box appears when the user hovers over a data point. This view shows data for just a few paths in start-up mode.

From both the Map and the All Compounds view, historical archived data will be available. As mentioned in the Figures 13 and 14 captions, when the user hovers over a data point, a dialog box will appear. This dialog box shows the value (concentration, etc.), time, and any pertinent QC flags.

4.3 Description of Background Levels for All Pollutants Measured and Provide Context to Levels Measured at the Fenceline

Rule 1180 requires that concentration data be set in the context of pollutant concentrations measured elsewhere in the Los Angeles Basin. The Monitors page of the public website displays the fenceline monitoring concentrations of the pollutants listed in Rule 1180, and the Resources page includes links to other sources of data such as the SCAQMD Multiple Air Toxics Study (MATES IV or MATES V), or Clearinghouse data links proposed to be hosted by SCAQMD.

4.4 Procedures to Upload the Data and Ensure Quality Control

The pathway followed by the data from the sensor to the public website is shown in Figure 15. Depending on the sensor used, data will be collected into a data processing server via a "pulling" or "pushing" method. The data will then be archived and ingested into the DMS. Data will be screened in real time upon upload into the DMS, as described in previous sections. Automated procedures will be used to ensure that data are properly uploaded, stored, processed, and quality-assured, and that products are delivered to a public-facing website in near-real time (defined here as about 10 minutes after data collection).

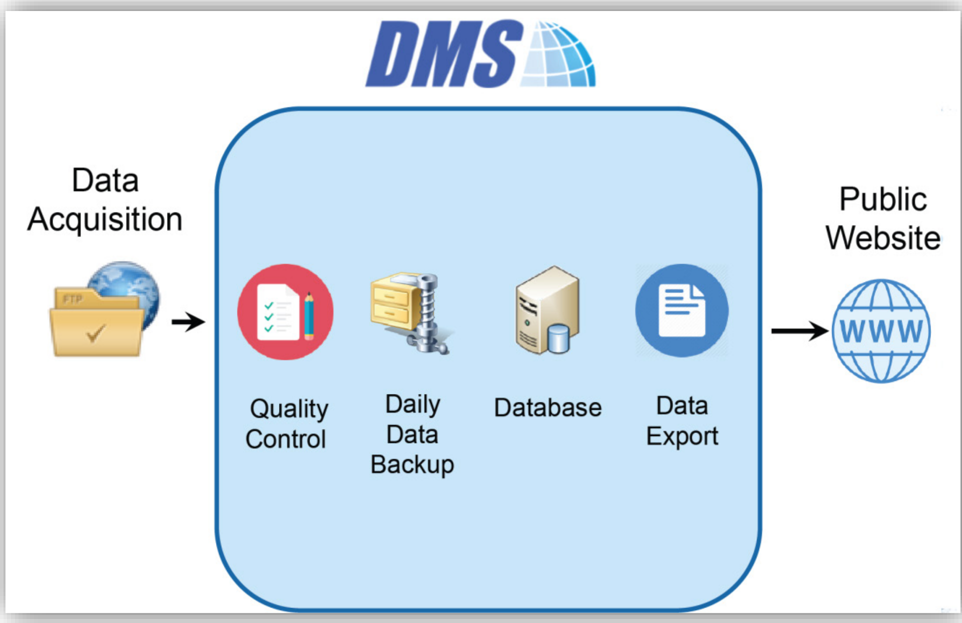

Figure 15. Schematic representation of the flow of data from acquisition at the sensor to the public website.

As shown in Figure 13, the preliminary quality-controlled data is further presented as chart (time series) of pollutant concentrations, visibility, and wind speed and direction. Data will be provided as 5-minute averages. Data will be annotated for quality (valid, invalid, suspect, or missing). In the event that high concentration levels occur, Tesoro will follow its existing procedures to determine whether any additional information needs to be provided to the public.

The public-facing website allows users to explore 5-minute data. Displaying the data in a map format showing wind direction further helps to explain observed concentrations.

4.5 Further Information to Guide Public Understanding

The collected data have high time resolution, are spatially variable, and are chemically complex. To provide the public with context about this complex data set, the following information are included in the Resources page of the website.

- Definitions of abbreviations.
- Discussion of data below method detection limit (MDL).
- Definition of data QC flags and their meaning.
- Quality procedures.

4.6 Means for the Public to Provide Comments and Feedback, and Procedures to Respond

Public feedback will be available through Tesoro's corporate website and community hotline. A log of comments will be made available upon request. The feedback will be delivered to a Tesoro contact responsible for deciding whether and how to respond to the public comments. Tesoro will determine whether some comments warrant a direct response and what that response procedure should be. Although not all comments have to be addressed, they will be made available to SCAQMD upon request. Some of the comments will aid in the creation of FAQs.

4.7 Quarterly Data Summary Reports, Including Relationship to Health Thresholds, Data Completeness, Instrument Issues, and Quality Control Efforts

As part of this monitoring program, quarterly reports will be generated in PDF format. These reports will contain a statistical summary of the data from all sensors, chain of custody information, and graphical views of the historical data. Access to these reports will be available to the public in the form of web links.

4.8 Public Outreach

The monitored and collected data will be made available in near-real time to the public, and will be displayed online in a relevant, useful, and understandable manner at www.marathonlosangelesrefineryfencelinemonitoring.com. To make the data available and useful to the public, the website will include the following:

1. The near-real time data display will be automated.
2. The website will contain reliable, useful, and understandable information, including information on the intent and limitations of the data.
3. A Data link to the SCAQMD community monitoring website will be provided for background concentrations and/or contributions from other sources that may affect measured concentrations.
4. The website will contain an email sign-up option for the community to receive alert notifications on threshold exceedances.
5. The website will contain regulatory and industry relevant literature on notification thresholds, background information on measured compounds, and general information on averaging periods to assist the public in understanding and interpreting the data.
6. The website will contain site specific wind speed and direction data.
7. The website will list the refinery's community hotline (310-522-6367, or 800-377-2726) so that the public can contact the refinery to ask questions about monitoring equipment, readings, and threshold exceedances.
8. The website display will contain data visualization tools, including maps and time series plots of measured compounds and wind data, to graphically depict information .
9. In order to provide context to the monitored and measured data sets, the website will contain information on measurement techniques and potential non-refinery sources that could contribute to measured concentrations, as well as the definitions of data QC flags.
10. The QA/QCed quarterly reports will also be posted on the website. The website will include one year of archived data and quarterly reports. These reports will include data quality control flags, maintenance and calibration activities, rationales for any changes, and other chain of custody information to identify data that were removed from the data set, as well as information on why the data were removed.
11. The Refinery will continue to utilize existing protocols for actual emergency conditions and notification to the public pursuant to State Law, local fire agencies, and emergency response agencies.
12. LAR will develop education materials in Spanish to inform the public of why and how fenceline monitoring is conducted, and availability of the data. The information will be

shared at periodic community forums.

13. The key stakeholders for the fenceline monitoring program include, but are not limited to, residential and business communities, sensitive receptors, schools, libraries, health care providers, neighborhood association representatives, local fire agencies, emergency response agencies, and public officials. The Refinery currently maintains a comprehensive public outreach program that engages stakeholders on topics of interest such as emergency preparedness and response, and other matters. Elements from this refinery fenceline monitoring plan will be included in this outreach program.

14. Our community outreach program includes the following activities and communications, and will incorporate education on our fenceline monitoring program:

    - A community newsletter sent to approximately 29,000 residents within a 2-mile perimeter of our refinery facilities. Our Winter Community Newsletter will be titled "Focus on the Fenceline" and will provide information on our fenceline air monitoring program, in addition to other refinery perimeter topics.
    - The refinery's Community Advisory Panel (CAP), which meets bi-monthly to provide presentations to CAP members regarding refinery safety and environmental protection and regulatory compliance. To date, we have provided multiple presentations to our 35+ CAP members regarding SCAQMD Rule 1180, our fenceline monitoring plan and equipment, and the public notification sign-up system. Our January 2020 CAP meeting will include a real-time review of the website.
    - Participation in Carson Sheriff Station Block Captain meetings, including refinery tours and educational booths on our fenceline monitoring program.
    - Participation and funding for Beach Cities Community Awareness and Emergency Response (CAER) program with CUPAs (Certified Unified Program Agencies) and other first responder organizations in the South Bay.
    - We will continue to work with I Heart Carson and I Heart Wilmington grass-roots community service groups. These are groups of residents in each respective community to whom we can provide refinery information, such as our fenceline monitoring program.
    - We will seek additional community forums and communication avenues for educating the public on our fenceline monitoring program and website, such as at meetings of the West Long Beach Neighborhood Association and Rotary Clubs, and the Chambers of Commerce in Carson, Wilmington and Long Beach. We will also perform outreach to our neighboring schools, parent-teacher organizations, and non-profit community partners.

5. Notification System

On the home page of the Tesoro LAR public-facing website, members of the public can subscribe to be notified when certain pollutant concentrations exceed pre-configured thresholds. The public can also sign up for notifications of new data reports and monitoring system status.

The system will provide the flexibility to add manual alerts and expand to other pollutants and parameters in the future. The notification system will be integrated into (1) the same architecture as the public facing website, (2) the DMS, and (3) the existing QA procedures. The administrator of the public website will be able to make changes to the alert messages (the email list, the distributed message, the concentrations at which alerts are sent out, etc.) via a separate administrator website.

The sign-up portion of the home page is shown in Figure 16.

Figure 16. Home page of the fenceline monitoring site; the notification tool (circled) allows the public to sign up for notifications when pollutants exceed monthly threshold values.

When a notification is triggered for a threshold exceedance, a message will be displayed on the website. Public notifications will be triggered automatically when fenceline concentrations exceed the threshold levels listed in Table 16. The notification concentrations will be calculated on a 1-hour rolling weighted average that is updated every 5 minutes. These notifications will be accompanied by a message on the home page of the public website. Concentration thresholds at the nearest receptor (1-hour rolling average) will correspond to the OEHHA (Office of Environmental Health Hazard Assessment) acute relative exposure limits (RELs) (California Office of Environmental Health Hazard Assessment, 2017). A notification will be sent when the concentration decreases below the threshold level.

Table 16 summarizes SCAQMD recommended thresholds for Rule 1180 compounds to trigger data notification to the public. The notification thresholds are based on rolling 1-hr exposure using 5-min block-monitored data. A follow-up notification will also be issued when the rolling average 1-hr concentrations fall below the thresholds. Notifications will include the following information:

1. Name of compound, with 1-hr rolling average value and time stamp
2. Identification of the measured path
3. Time stamp and wind direction at the time of exceedance
4. Link to SCAQMD community monitoring website for background concentrations

Currently the health-based exposure limits for VOC (non-methane non-ethane HC) and black carbon are not promulgated by regulatory agencies. In addition, OEHHA does not have a 1-hr REL for ethylbenzene. As indicated by SCAQMD, the fenceline data for the first six months of operation will be analyzed and discussed, and a notification level will be proposed for approval in the third quarter of 2020.

The 1-hr REL for acrolein is 1.1 ppb, lower than the MDL of the OP-FTIR, which is 12 ppb; therefore, we propose to provide no notification. As indicated by SCAQMD, the fenceline data for the first six months of operation will be analyzed and discussed, and a notification level may be proposed for approval in the third quarter of 2020.

Near real-time 5-min data for all Rule 1180 compounds will be displayed on the public website. In case of compound concentrations below the MDL, only corresponding MDL value will be displayed for each compound on the website.

Table 16. Thresholds for triggering automated notifications , based on 1-hour fenceline data, determined every 5 minutes, as recommended by the South Coast Air Quality Management District (SCAQMD). These thresholds are acute 1-hour RELs, as determine by California OEHHA, unless otherwise noted.

Pollutant	Notification Threshold (ppb)
1,3 –Butadiene	303
Acetaldehyde	265
Acrolein	N/A*
Ammonia	4662
Benzene	8.6
Black Carbon	None established
Carbonyl Sulfide	273
Ethylbenzene	None established
Formaldehyde	45.5
Hydrogen Cyanide	312
Hydrogen Sulfide	30
Nitrogen Dioxide	100**
Sulfur Dioxide	75**
Styrene	5000
Toluene	9964
Total Hydrocarbon	N/A
Total Xylene	5142

* The 1-hr REL for acrolein is lower than the MDL of the OP-FTIR.
** NAAQS

6. References

California Air Resources Board (2003) H&S 44344 biennial updates. Available at https://www.arb.ca.gov/bluebook/bb03/HS/44344.htm. Accessed July 26, 2018.

California Office of Environmental Health Hazard Assessment (2017) Analysis of refinery chemical emissions and health effects. Draft report, September. Available at https://oehha.ca.gov/media/downloads/faqs/refinerychemicalsreport092717.pdf.

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U.S. Environmental Protection Agency (2000) Meteorological monitoring guidance for regulatory modeling applications. Office of Air Quality Planning and Standards, Research Triangle Park, NC, Document EPA-454/R-99-005, February. Available at http://www.epa.gov/scram001/guidance/met/mmgrma.pdf.

Appendix A. Fenceline Air Monitoring Plan Checklist (and Section in This Plan Where the Topic is Discussed)

Fenceline Air Monitoring Plan Checklist	
Fenceline Air Monitoring Coverage (or Spatial Coverage) (Section 1)	
☒	**Identify the facility's proximity to sensitive receptors affected by the refinery operation and provide the information below. (Section 1.1)**
	• Distance from facility to closest sensitive receptor(s) • Location of downwind and upwind communities • Eminent sources of non-refinery emissions surrounding the facility (e.g. non-refinery industrial facilities) • Dispersion modeling†
☒	**Describe historical facility emission patterns and pollutant hotspots based on the following (Section 1.2):**
	• On-site location of operations and processes within the facility's perimeter • On-site location of emissions sources and level of emissions • Facility plot plans and topography • Dispersion modeling†
Fenceline Air Monitoring Equipment Description (Section 2)	
☒	**Select sampling locations along the perimeter of the facility based on the information above. Also, provide the following (Section 2.1):**
	• Locations where equipment will be sited (e.g., GIS coordinates) and measurement pathways • Elevations of equipment and pathways • A description of how the monitoring system will cover all nearby downwind communities
☒	**Select fenceline air monitoring equipment that is capable of continuously measuring air pollutants in real-time and provide the following (Section 2.2):**
	• Specifications for the fenceline instruments (e.g., detection limits, time resolution, etc.) • Explanation of the operation and maintenance requirements for selected equipment • Substantiate any request to use alternative technologies

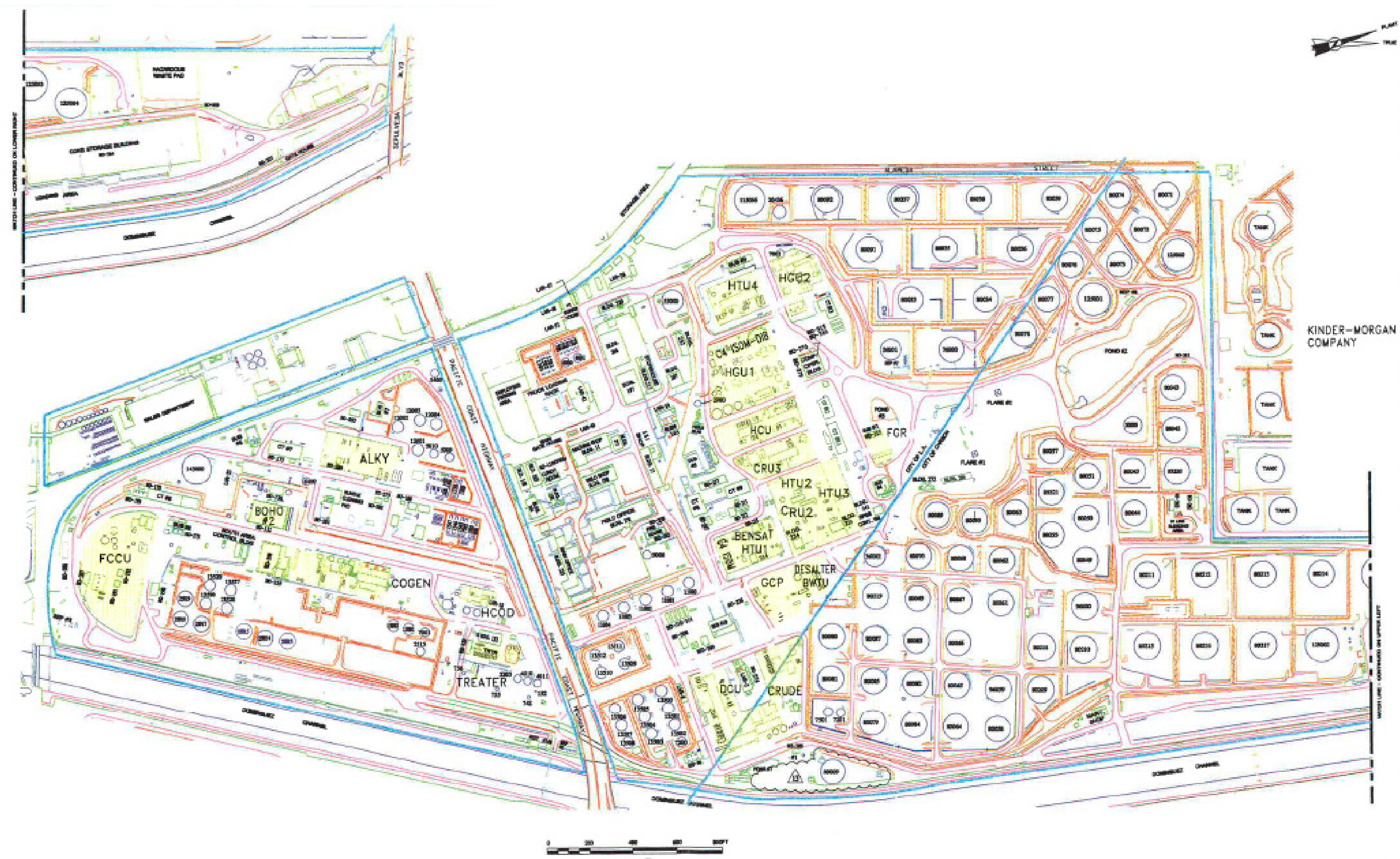
☒	**Monitor for the pollutants listed in Table 1 of Rule 1180 and include the following:**
	• Specify pollutant detection limits for all instruments and paths measured • Substantiate any exclusion of chemical compounds listed in Table 1 of Rule 1180 or measurement of a surrogate compound
Quality Assurance (Section 3)	
☒	**Develop a Quality Assurance Project Plan (QAPP) that describes the following (Section 3.2):**
	• Quality assurance procedures for data generated by the fenceline air monitoring system (e.g. procedures for assessment, verification and validation data) (Section 3.1) • Standard operating procedures (SOP) for all measurement equipment (Section 3.2) • Routine equipment and data audits (Section 3.3)
Data Presentation to the Public (Section 4)	
☒	**Design a data display website that includes the following:**
	• Educational material that describes the objectives and capabilities of the fenceline air monitoring system (Section 4.1) • A description of all pollutants measured and measurement techniques (Section 4.2) • A description of background levels for all pollutants measured and provide context to levels measured at the fenceline (Section 4.3) • Procedures to upload the data and ensure quality control (Section 4.4) • Definition of QC flags (Section 4.5) • Hyperlinks to relevant sources of information (Section 4.5) • A means for the public to provide comments and feedback; Procedures to respond (Section 4.6) • Archived data that with data quality flags, explains changes due to QA/QC and provides chain of custody information • Quarterly data summary reports, including relationship to health thresholds, data completeness, instrument issues, and quality control efforts (Section 4.7)

Notification System (Section 5)	
☒	**Design a notification system for the public to voluntarily participate in that includes the following (Section 5):**
	• Notifications for activities that could affect the fenceline air monitoring system (e.g., planned maintenance activities or equipment failures) • Notifications for the availability of periodic reports that inform the community about air quality • Triggers for exceedances in thresholds (e.g. Acute Reference Exposure Levels (RELs) • Communication methods for notifications, such as, website, mobile applications, automated emails/text messages and social media

†Dispersion modeling shall be conducted using U.S. EPA's Preferred and Recommended Air Quality Dispersion Model (e.g., Health Risk Assessment)

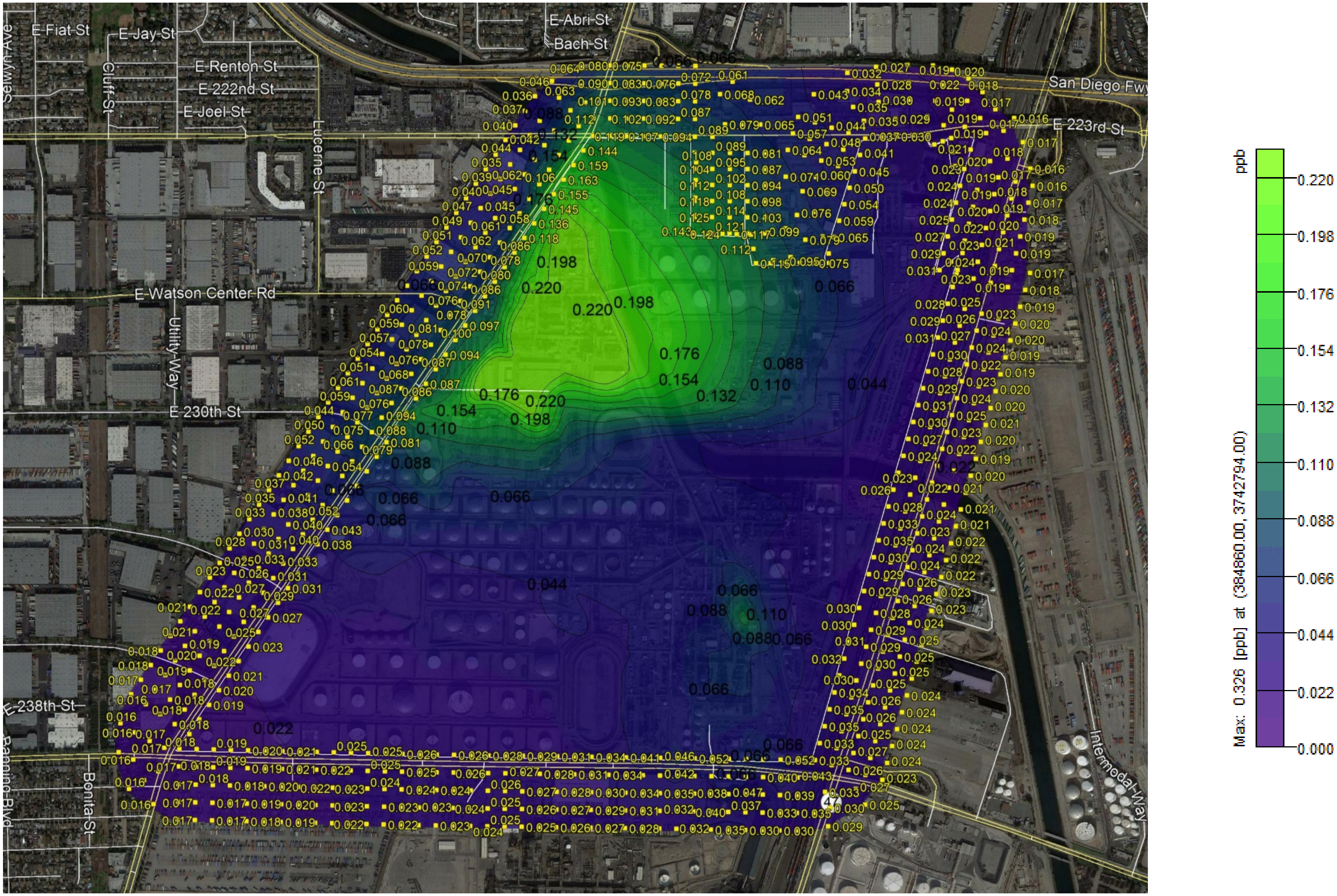
Appendix B. Refinery Identification Maps


TESORO
Los Angeles Refinery
Carson Operations
(LAR-C)
NORTH ZONE
2 - SHORT BLASTS
PAUSE
2 - SHORT BLASTS
(REPEATS 6 TIMES)
ALL CLEAR 20 SEC. BLAST
SOUTH ZONE
3 - SHORT BLASTS
PAUSE
3 - SHORT BLASTS
REPEATS 6 TIMES
ALL CLEAR 20 SEC. BLAST
FLAGPOLE
223 ST
HYDROGEN PLANT
JET HYDROTREATER
HYDROCRACKER FRACTIONATION
HYDROCRACKER
NORTH PROCESSING
GATE 7 PARKING
NORTH CHANGE ROOM
GATE 7
GATE 8
GATE 5
GATE 4
GATE 3
GATE 16
GATE 23
GATE 21
GATE 60
GATE 62
GATE 62 PARKING LOT
BUTANE SPHERES
WILMINGTON AVENUE
NO. 502 RESERVOIR
OLD 503
COGEN
WAREHOUSE
BABIKIAN AVE.
HDS FLARE
RESERVOIR NO. 506
PROPANE BULLETS
SPHERES 73-76,78,79
700TH AVE.
600TH AVE.
500TH AVE.
400TH AVE.
300TH AVE.
200TH AVE.
100TH AVE.
WEST BASIN
LPG RACK
NO. 501 RESERVOIR
#1 PUMP HOUSE
SEPULVEDA BLVD
SAFETY ISSUE
NORTHEAST PROPERTY
PP ADMIN
PP TECH CENTER
CARSON CAMPUS ONE
SUBSTA
MAINTENANCE BUILDING
POLYPROPYLENE UNIT
PROPYLENE BULLETS
RAIL CARS
FIRE TRAINING GROUNDS
CONTRACTOR LAYDOWN YARDS
POLYMER GRD PROP SPHERES
ECX BRIDGE
HYDROCRACKER FLARE
CHANNEL AVE.
EAST BASIN
COKER FLARE
NORTH RESOURCE RECOVERY YARD
SULFUR
COMPOUND
PENTANE SPHERES
SPILL RESPONSE EQUIPMENT
BUTAMER
C3 SPLITTER
WEIGH STATION
FIRE & SAFETY INSPECTION
OLD ADMIN
SCRAP YARD
SOUTH YARD
ISOM
PARKING
SLOUGH
SCAFFOLD YARD
FRONT ST.
MAIN ST.
HDS
ESP
LRU
LT. HYDRO
#1 REF
#2 REF
#3 REF
SUB 1
CENT CONTROL


KINDER–MORGAN COMPANY
FCCU
BOHO #2
ALKY
COGEN
HCOD
TREATER
HTU4
HCU2
C4 ISOM–DIB
HGU1
HCU
CRU3
HTU2
HTU3
CRU2
BENSAT
HTU1
FCR
GCP
DESALTER
BWTU
DCU
CRUDE

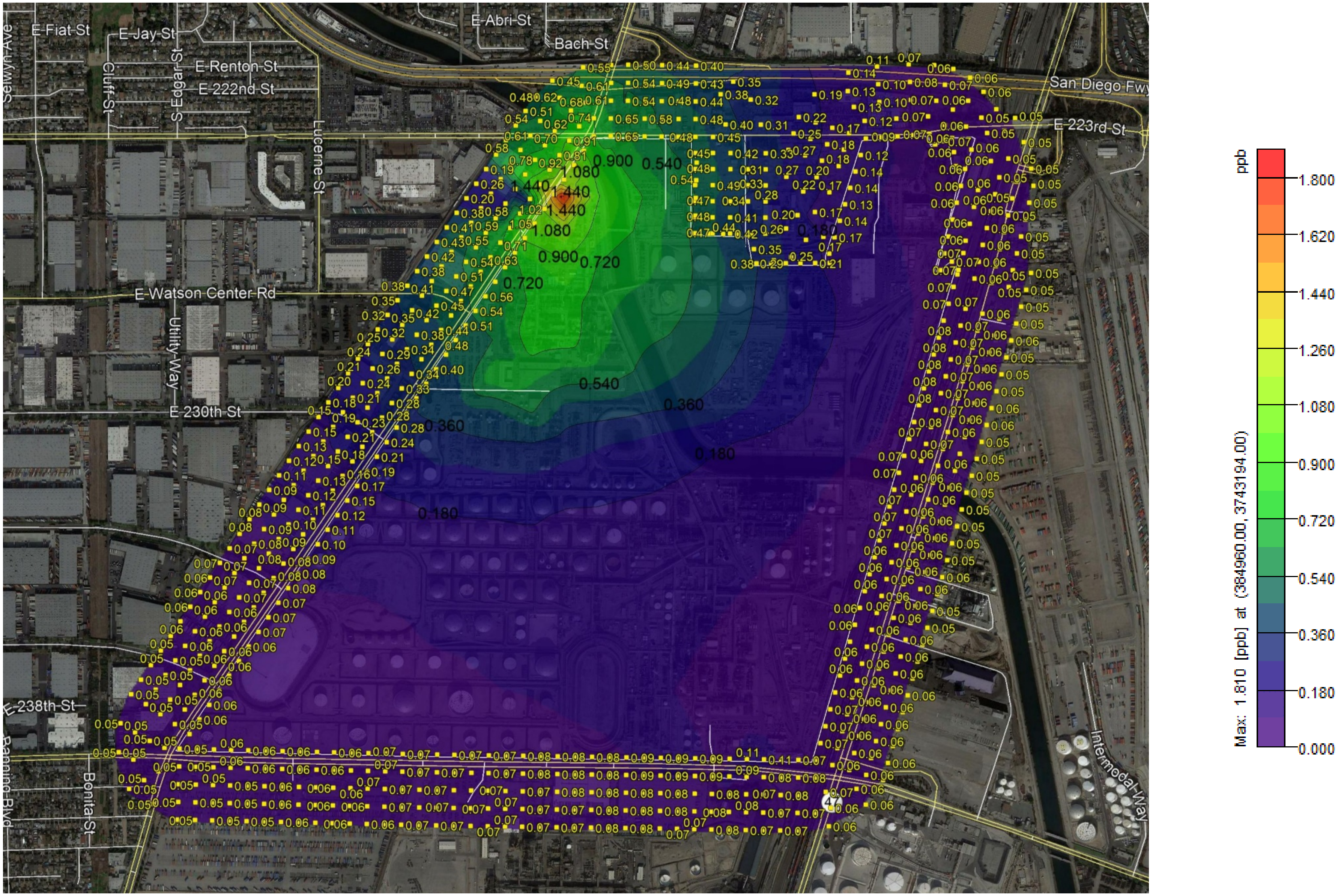
Appendix C. AERMOD Modeling Contours

1,3-Butadiene Maximum 1-hour Average Concentrations (ppb), Tesoro Refinery, Carson



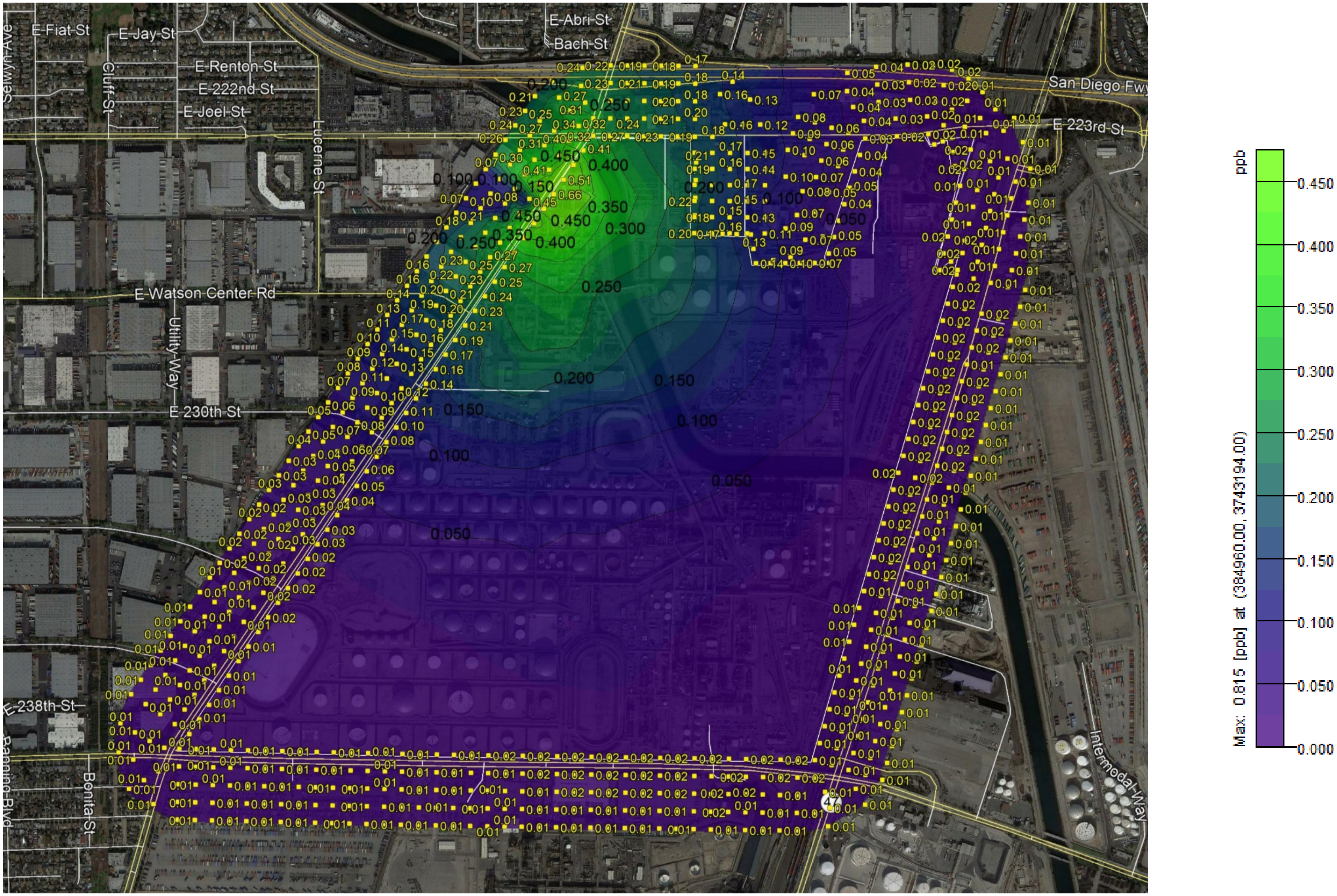
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Acetaldehyde Maximum 1-hour Average Concentrations (ppb), Tesoro Refinery, Carson



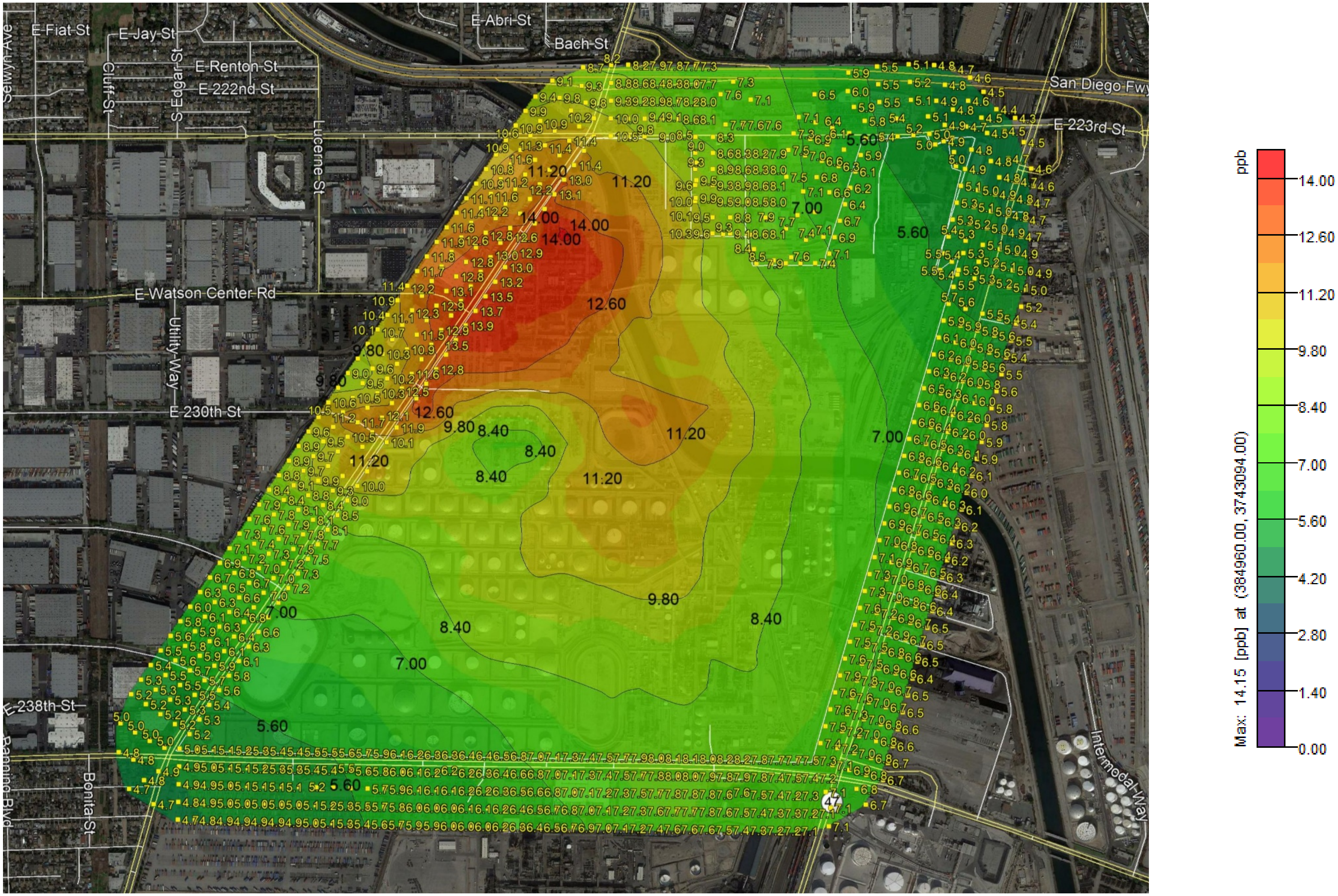
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Acrolein Maximum 1-hour Average Concentrations (ppb), Tesoro Refinery, Carson



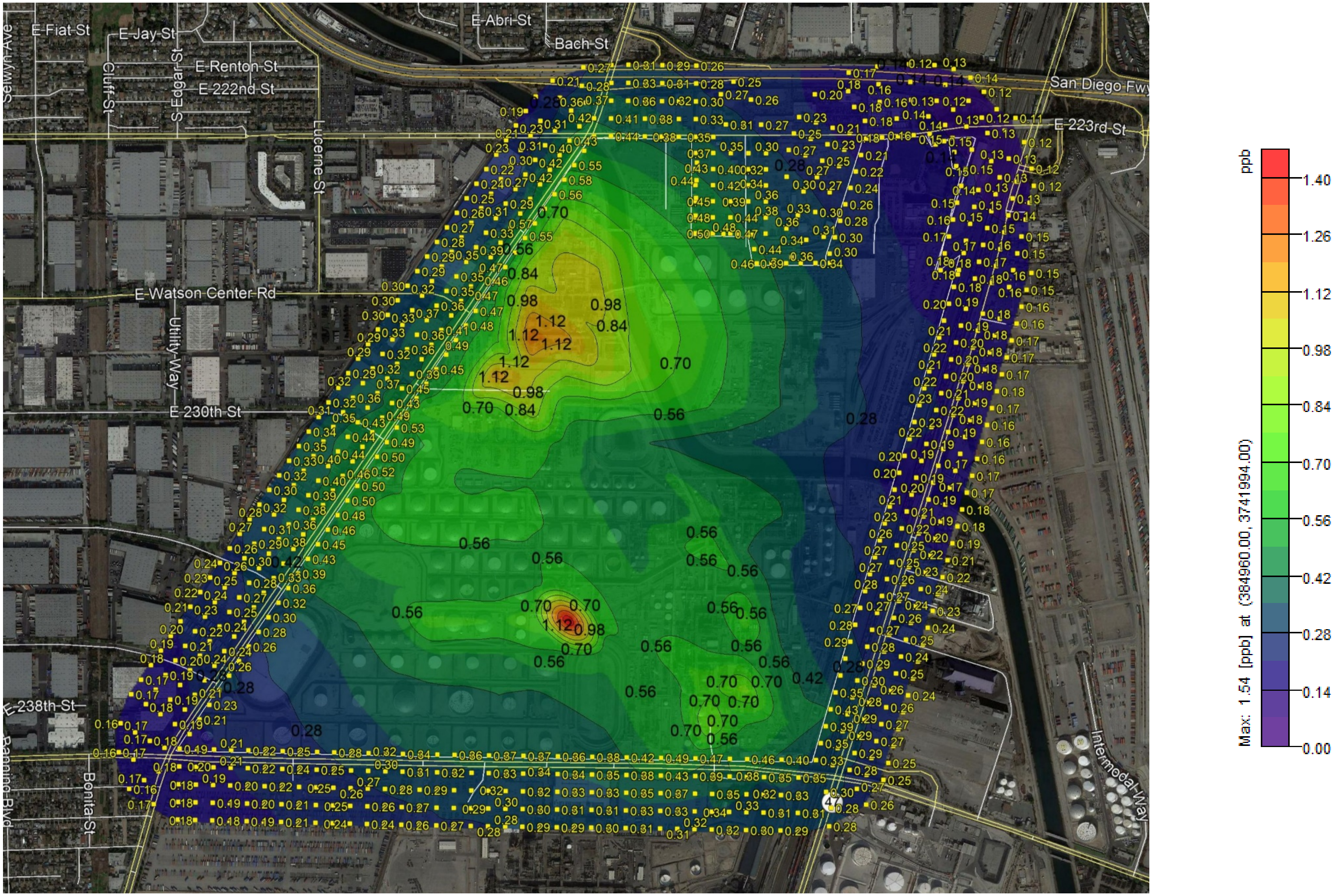
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Ammonia Maximum 1-hour Average Concentrations (ppb), Tesoro Refinery, Carson



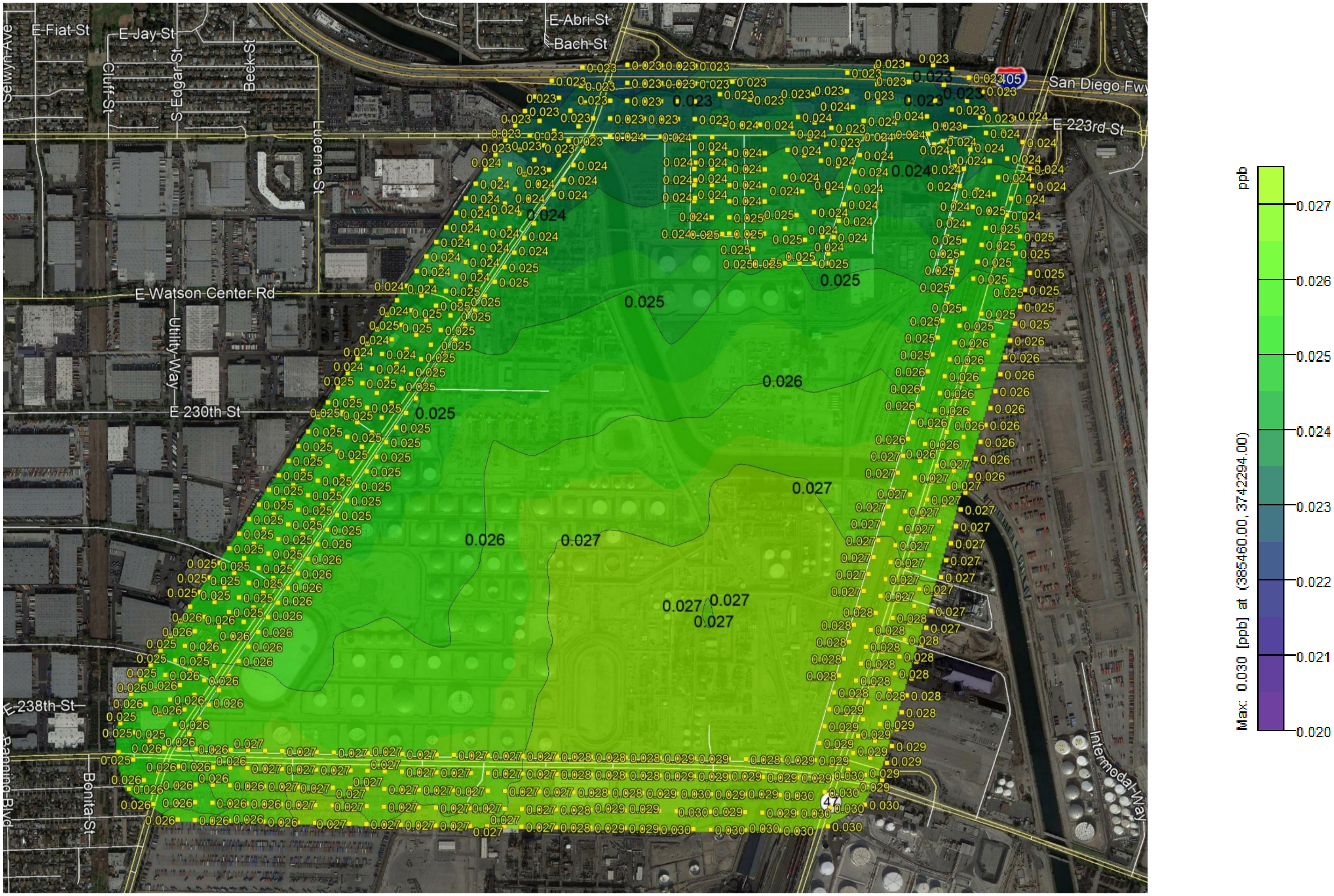
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Benzene Maximum 1-hour Average Concentrations (ppb), Tesoro Refinery, Carson



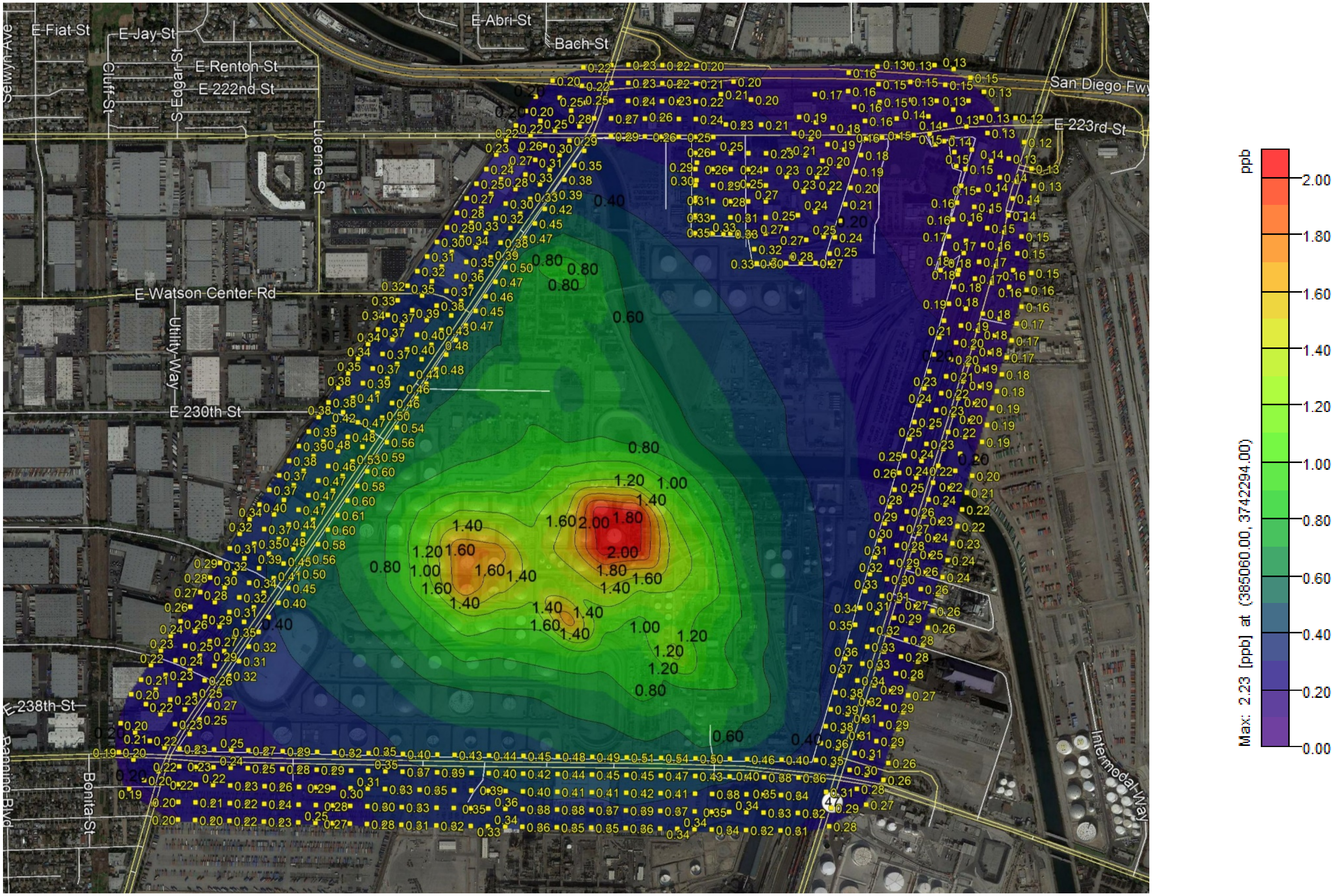
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Carbonyl Sulfide Maximum 1-hour Average Concentrations (ppb), Tesoro Refinery, Carson



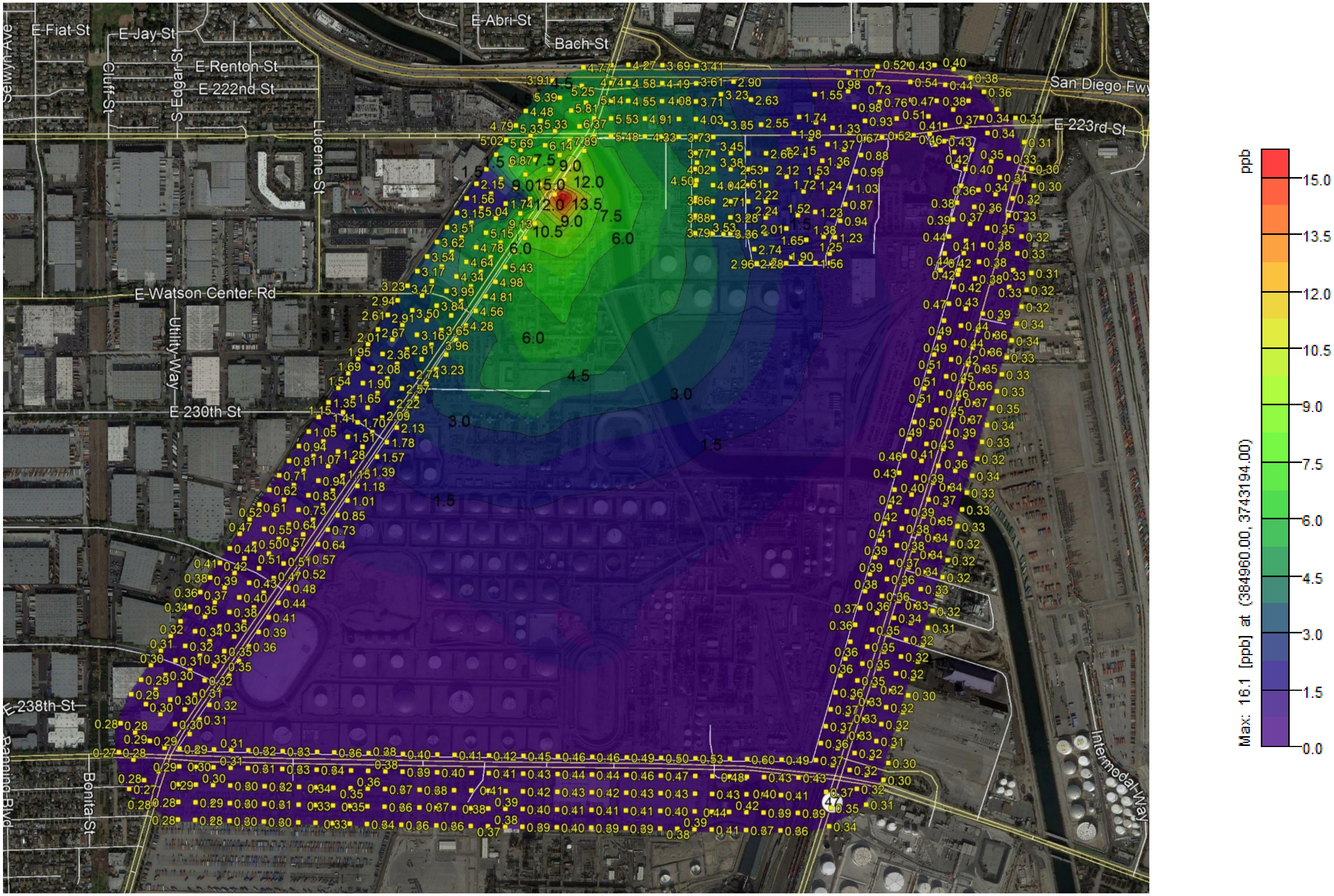
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Ethylbenzene Maximum 1-hour Average Concentrations (ppb), Tesoro Refinery, Carson



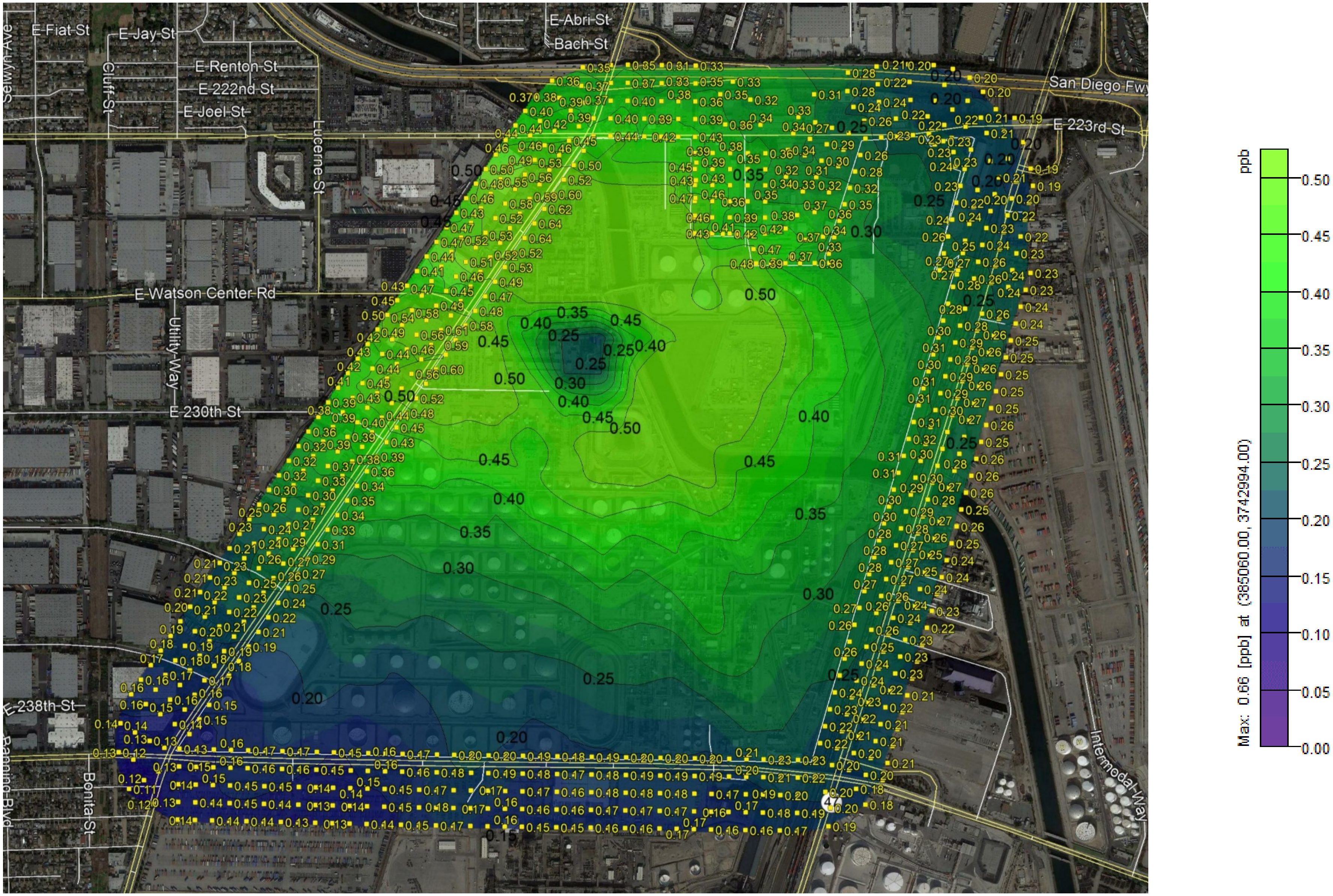
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Formaldehyde Maximum 1-hour Average Concentrations (ppb), Tesoro Refinery, Carson



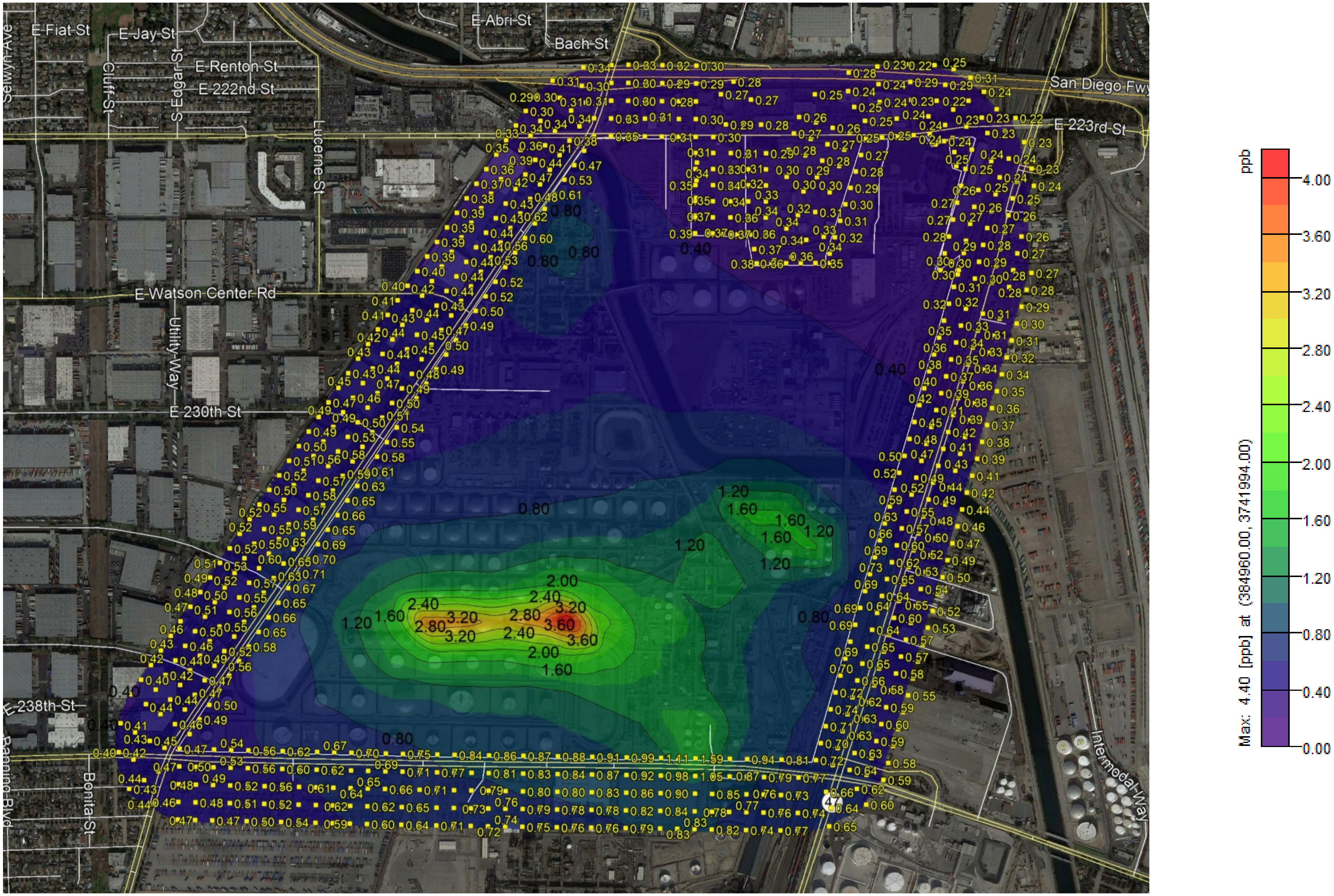
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Hydrogen Cyanide Maximum 1-hour Average Concentrations (ppb), Tesoro Refinery, Carson



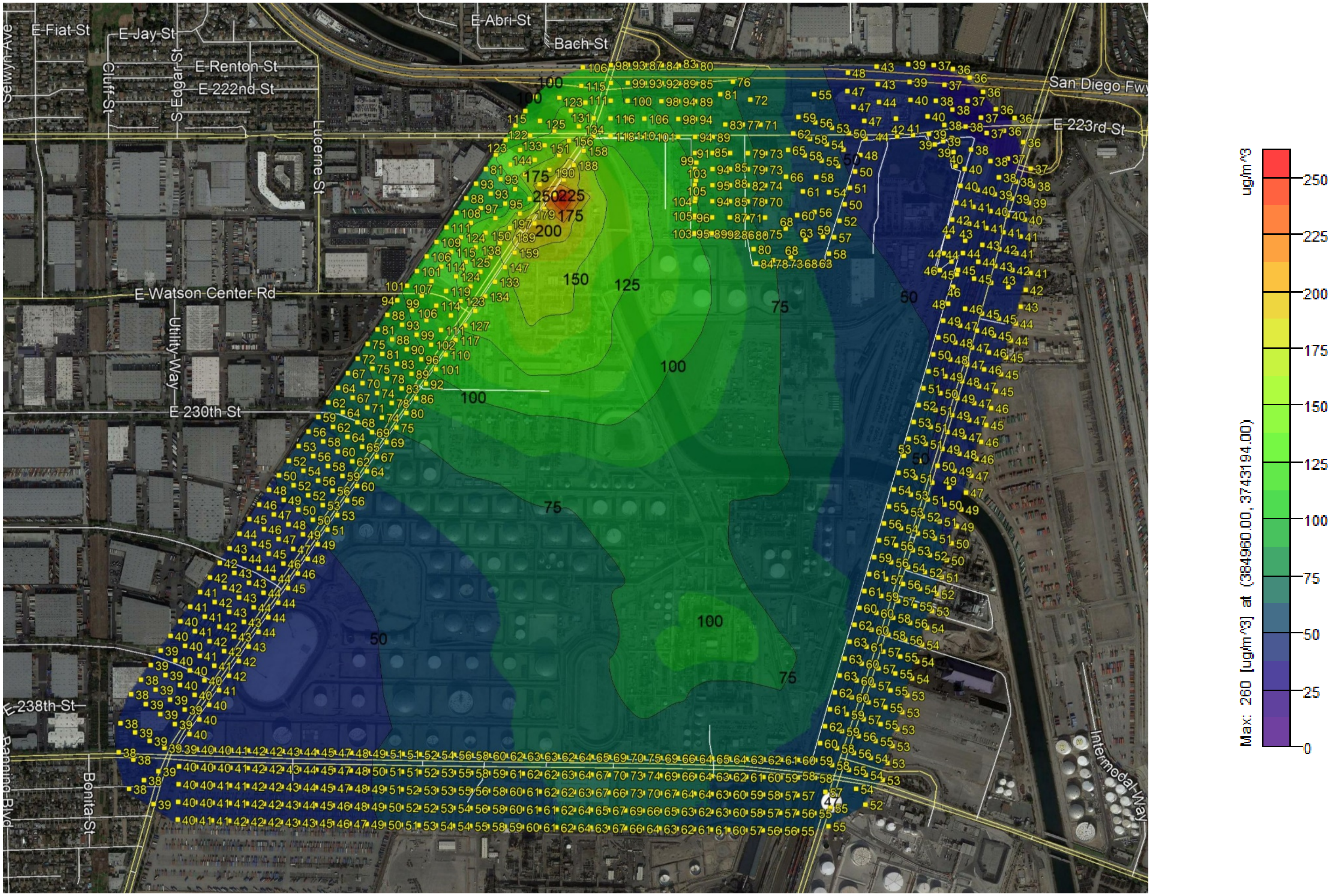
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Hydrogen Sulfide Maximum 1-hour Average Concentrations (ppb), Tesoro Refinery, Carson



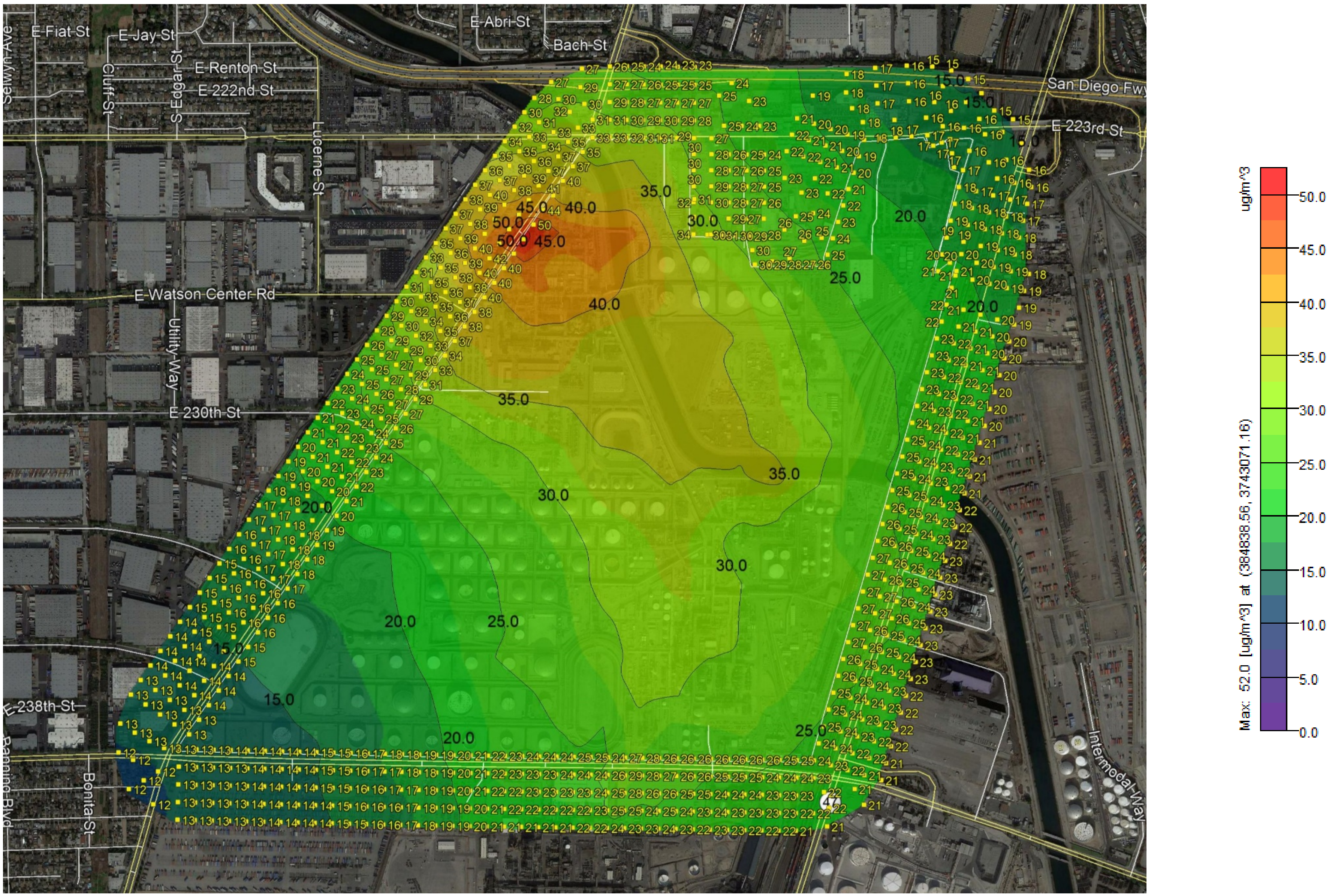
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

NOx Maximum 1-hour Average Concentrations (µg/m3), Tesoro Refinery, Carson



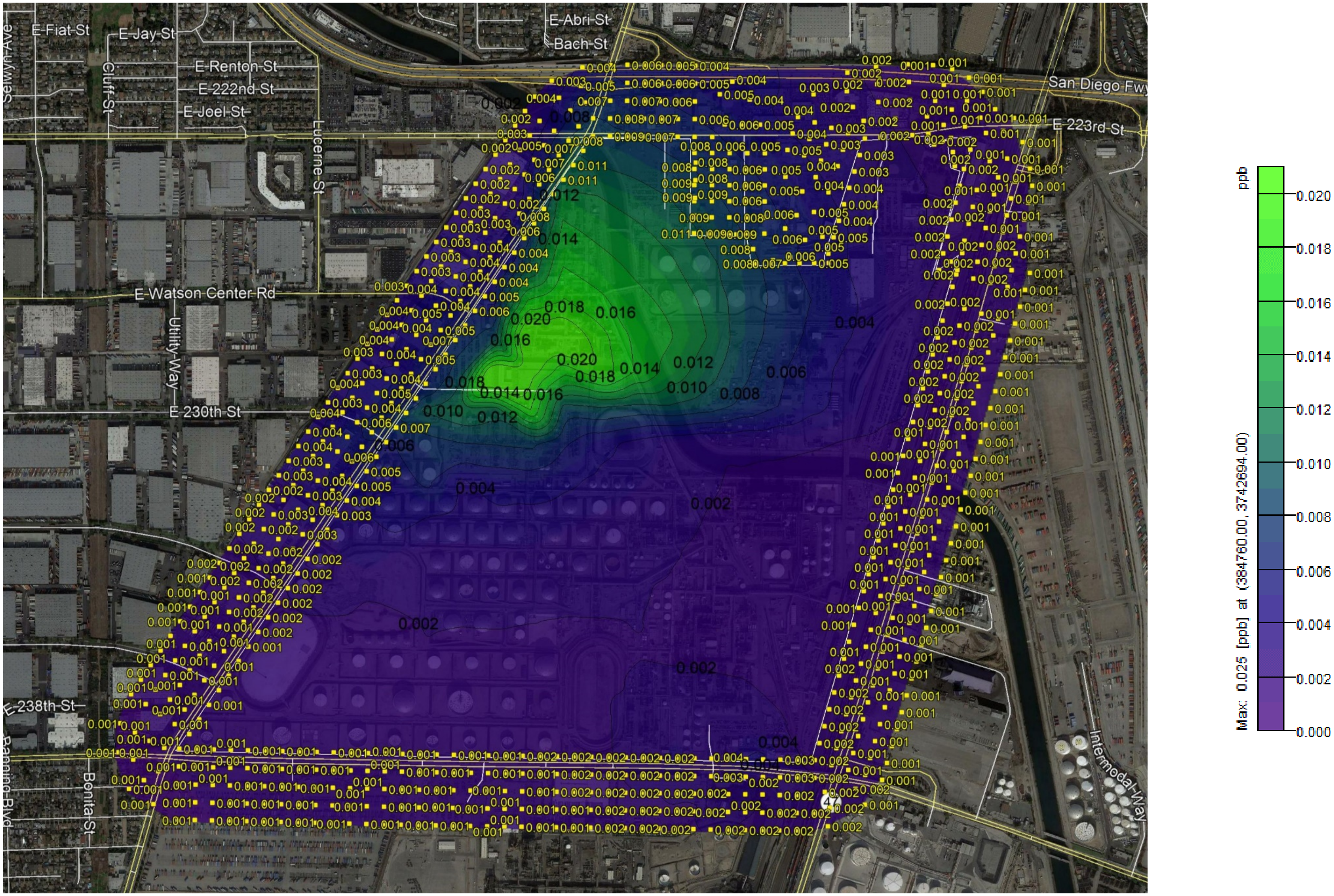
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

SOx Maximum 1-hour Average Concentrations (µg/m3), Tesoro Refinery, Carson



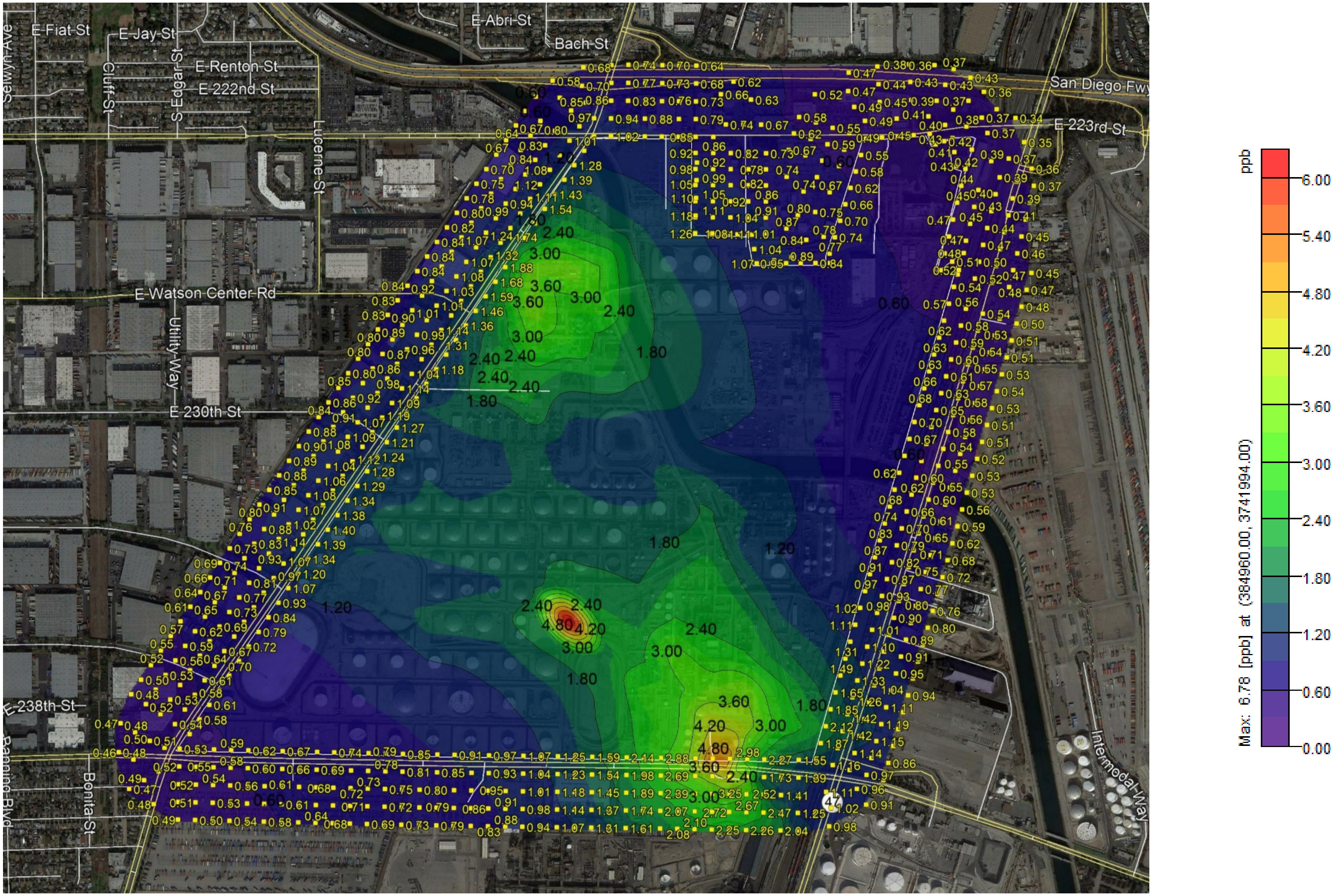
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Styrene Maximum 1-hour Average Concentrations (ppb), Tesoro Refinery, Carson



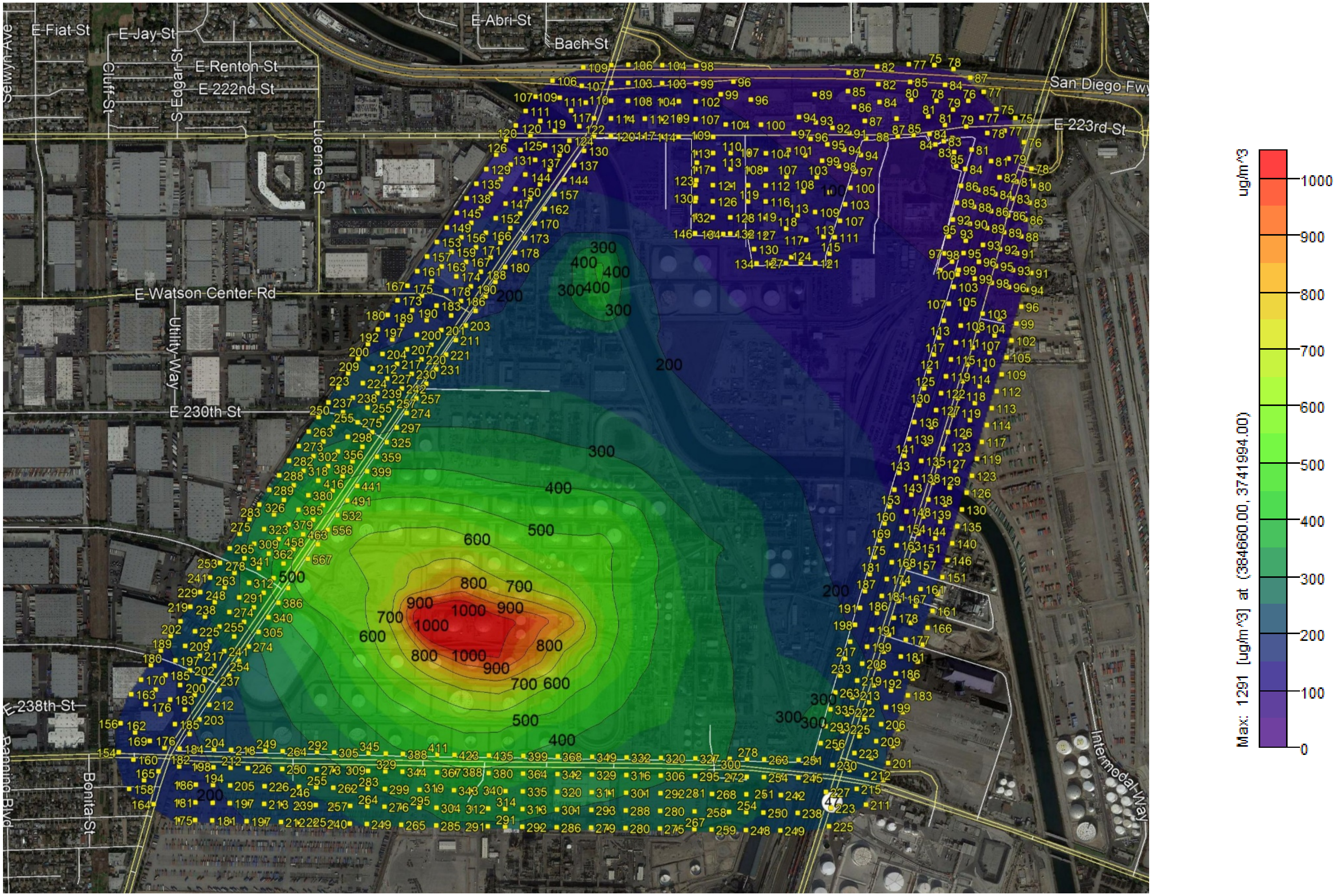
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Toluene Maximum 1-hour Average Concentrations (ppb), Tesoro Refinery, Carson



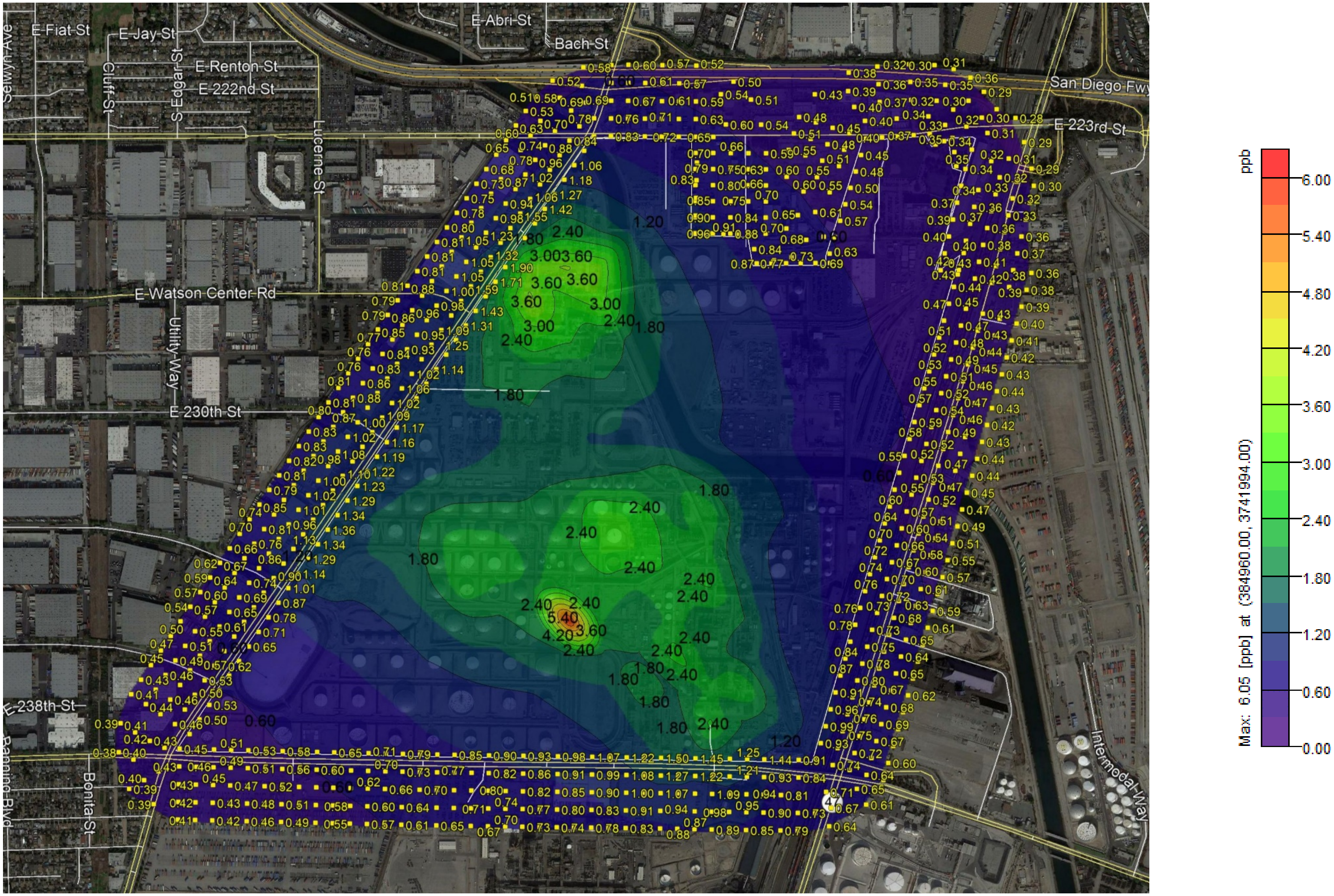
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

VOC Maximum 1-hour Average Concentrations (μg/m3), Tesoro Refinery, Carson



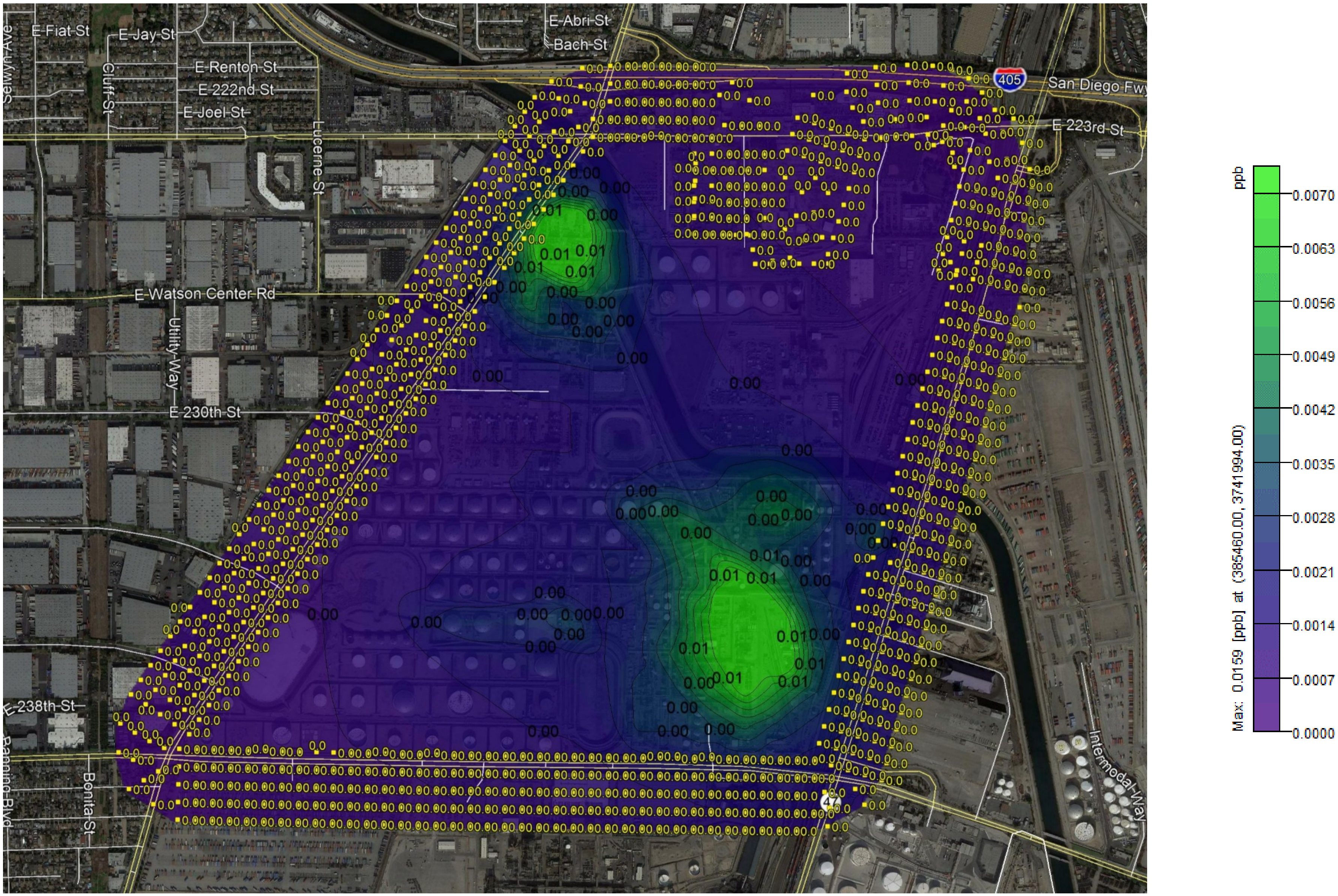
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Xylenes Maximum 1-hour Average Concentrations (ppb), Tesoro Refinery, Carson



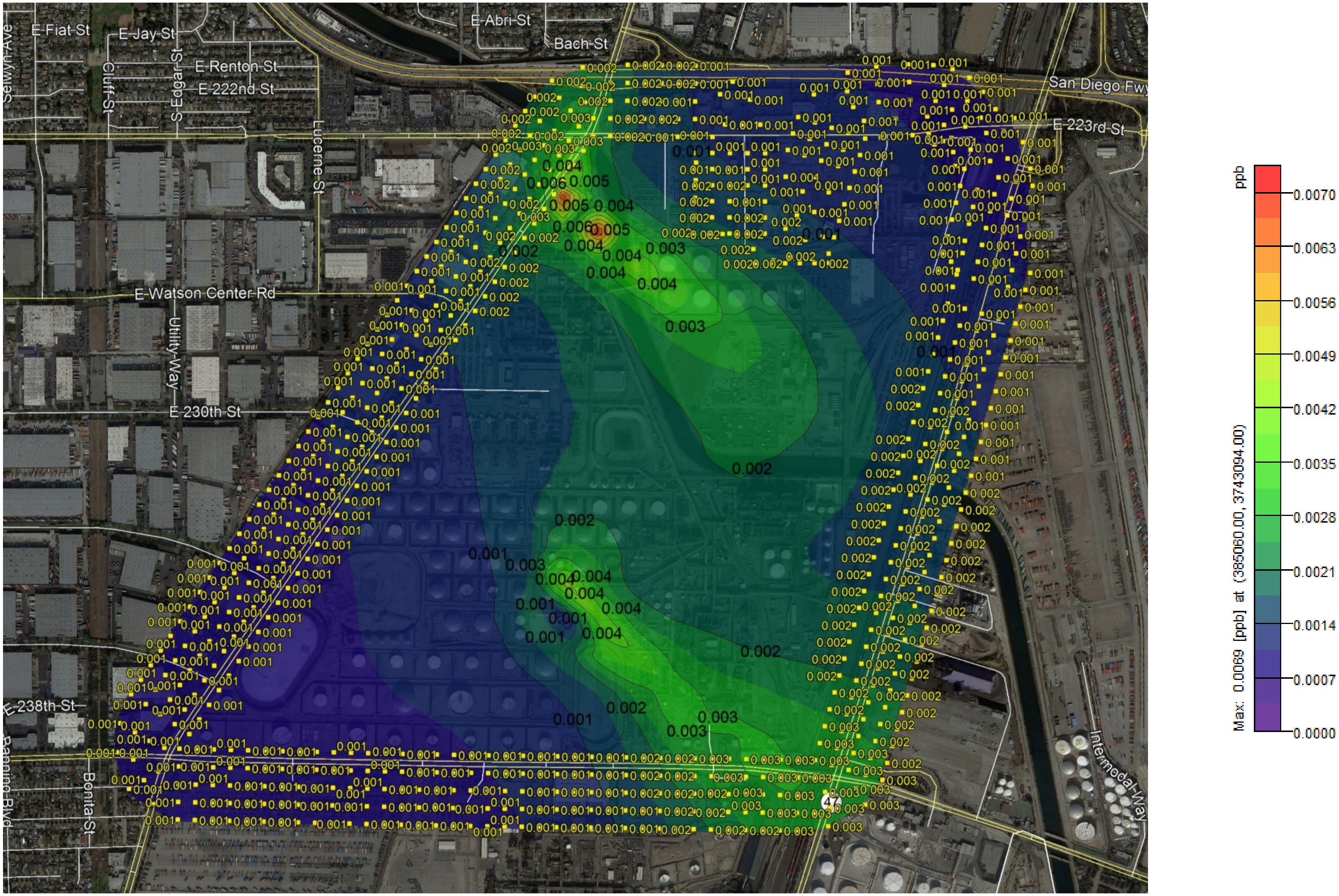
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

1,3-Butadiene 5-Year Average Concentrations (ppb), Tesoro Refinery, Carson



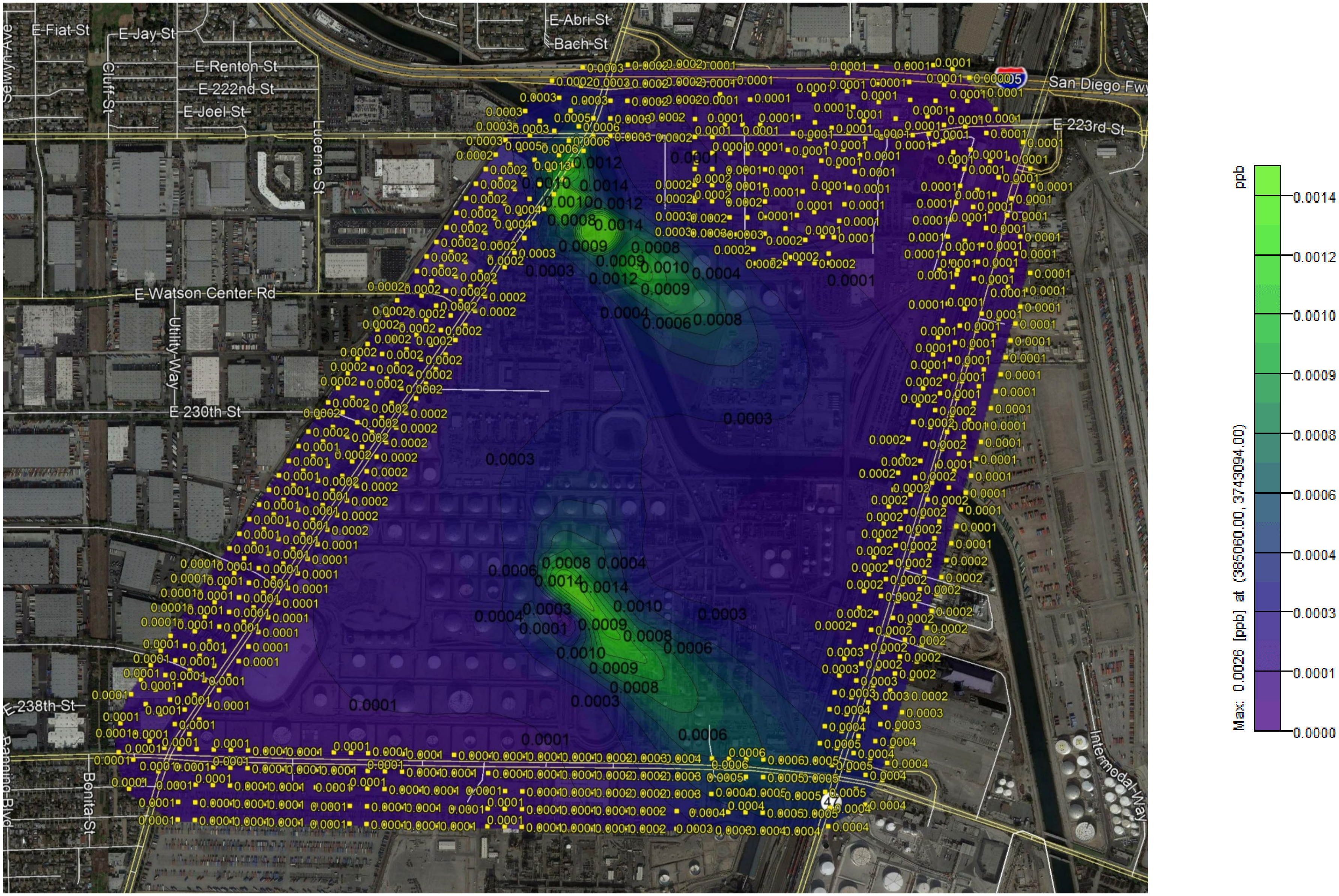
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Acetaldehyde 5-Year Average Concentrations (ppb), Tesoro Refinery, Carson



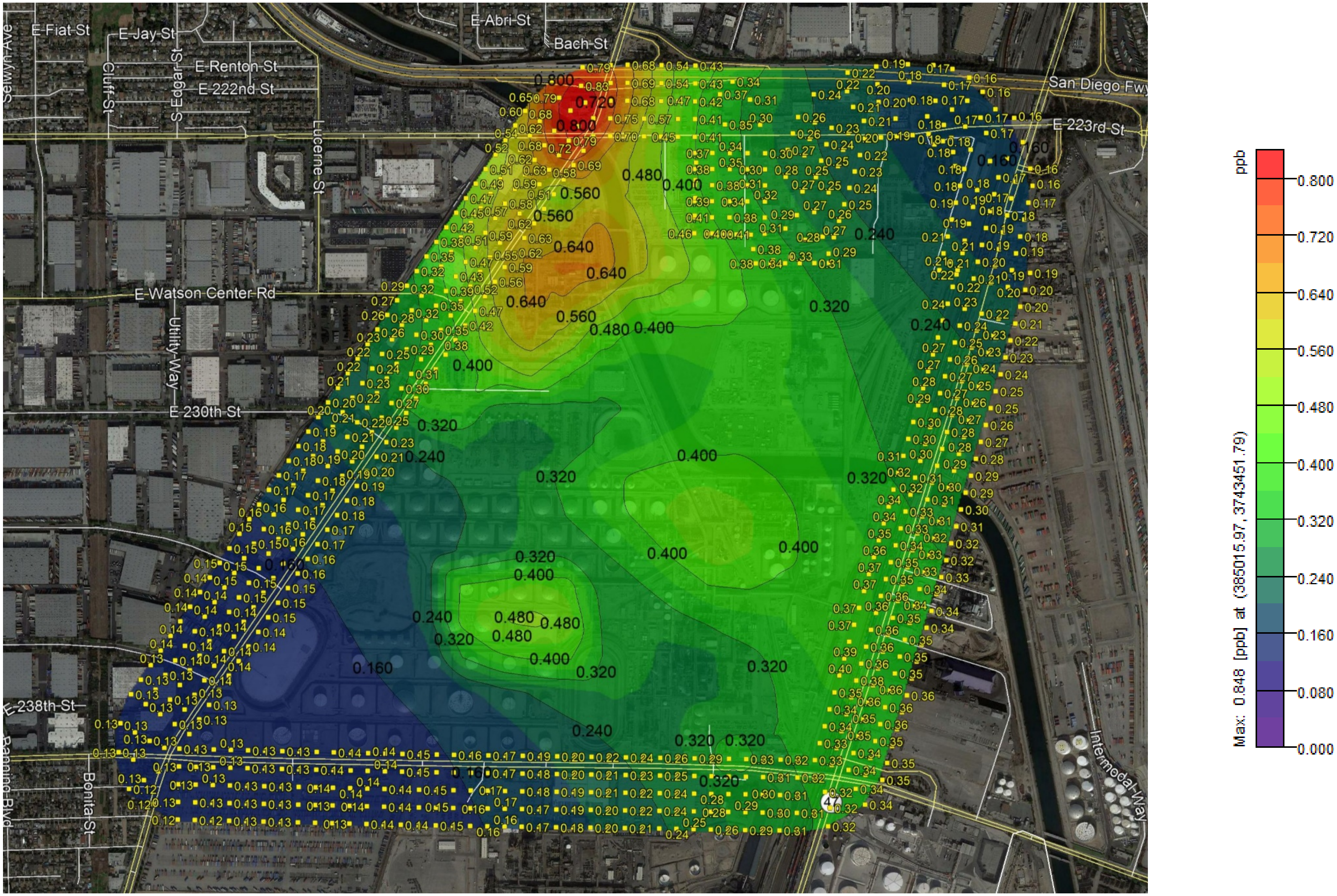
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Acrolein 5-Year Average Concentrations (ppb), Tesoro Refinery, Carson



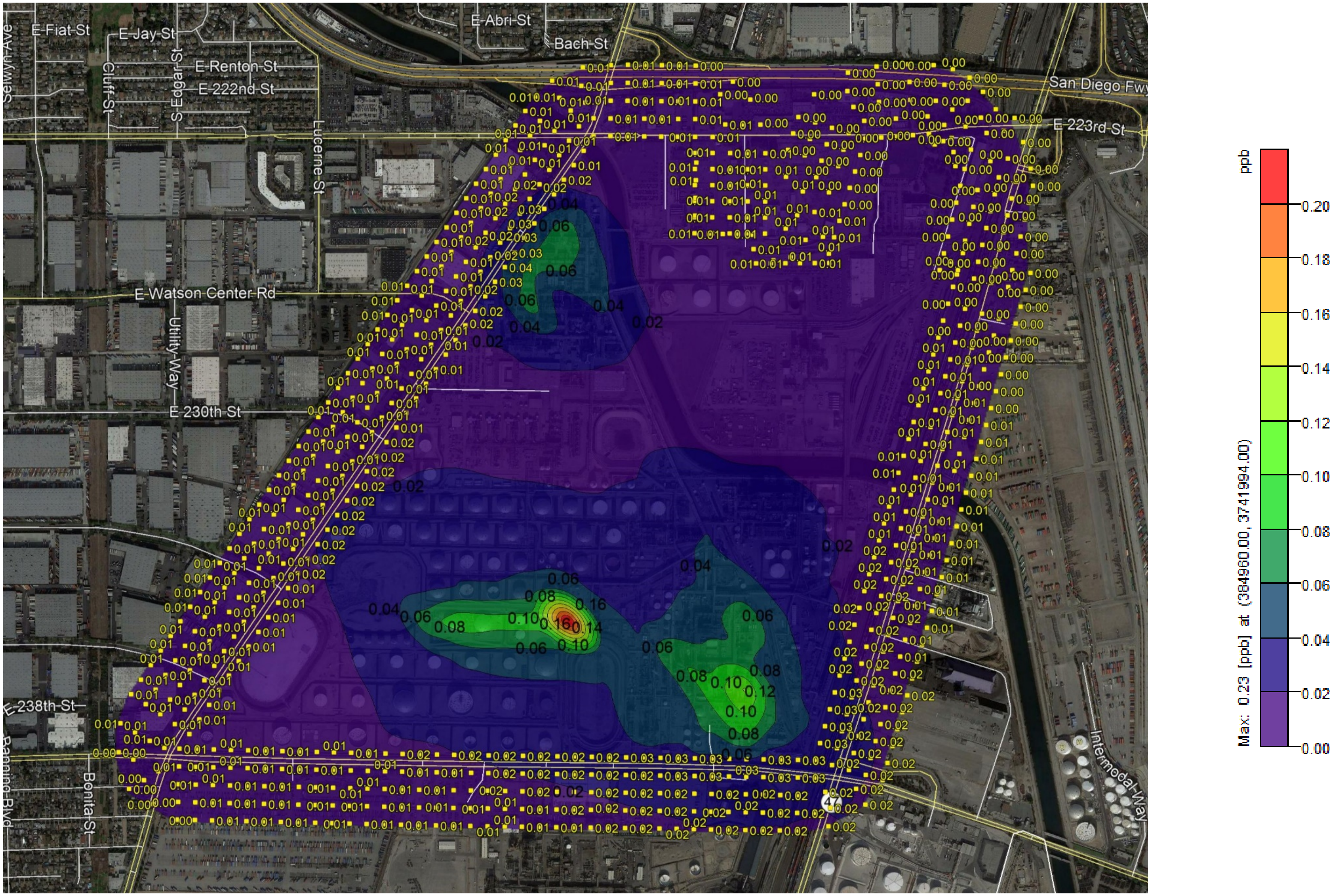
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Ammonia 5-Year Average Concentrations (ppb), Tesoro Refinery, Carson



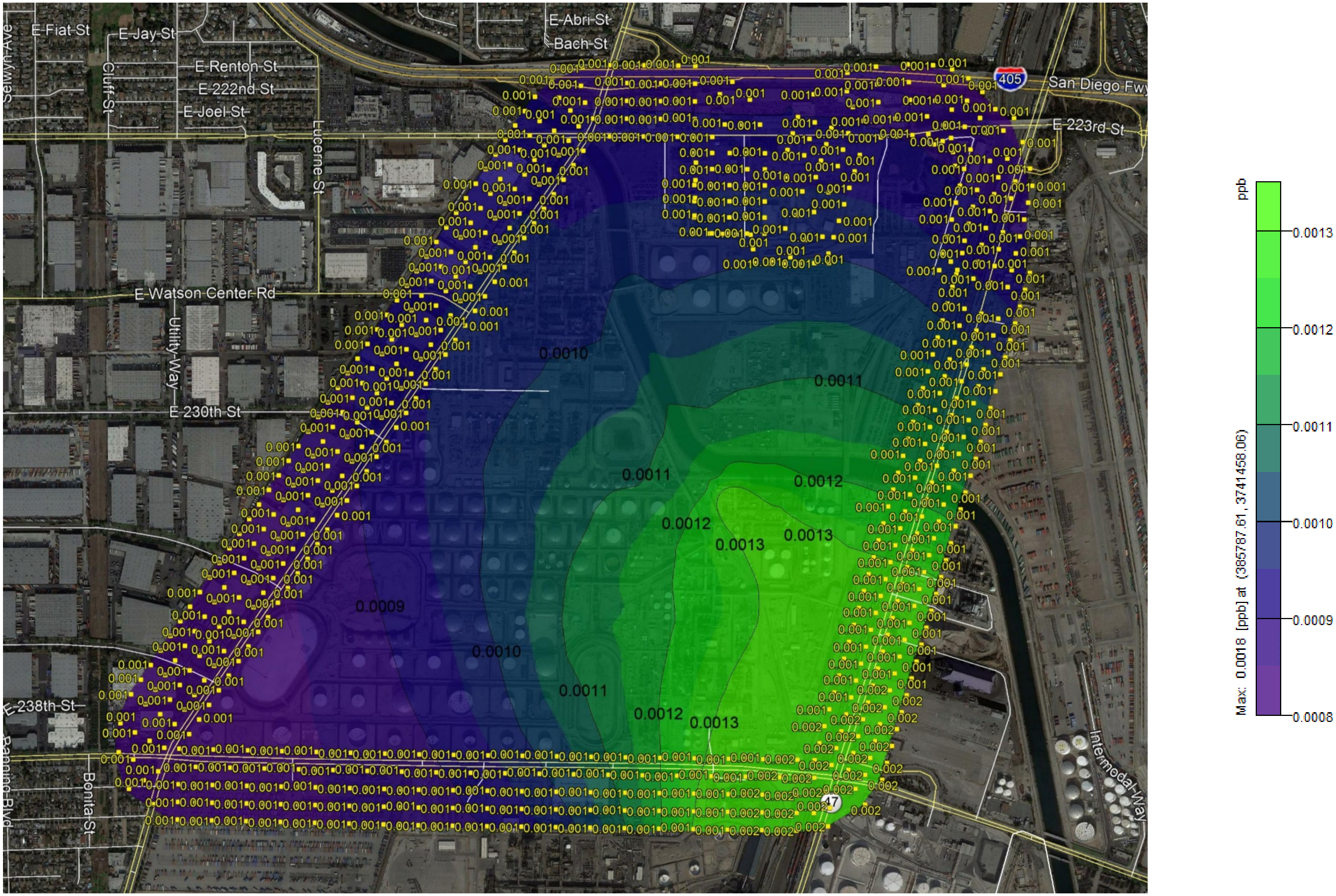
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Benzene 5-Year Average Concentrations (ppb), Tesoro Refinery, Carson



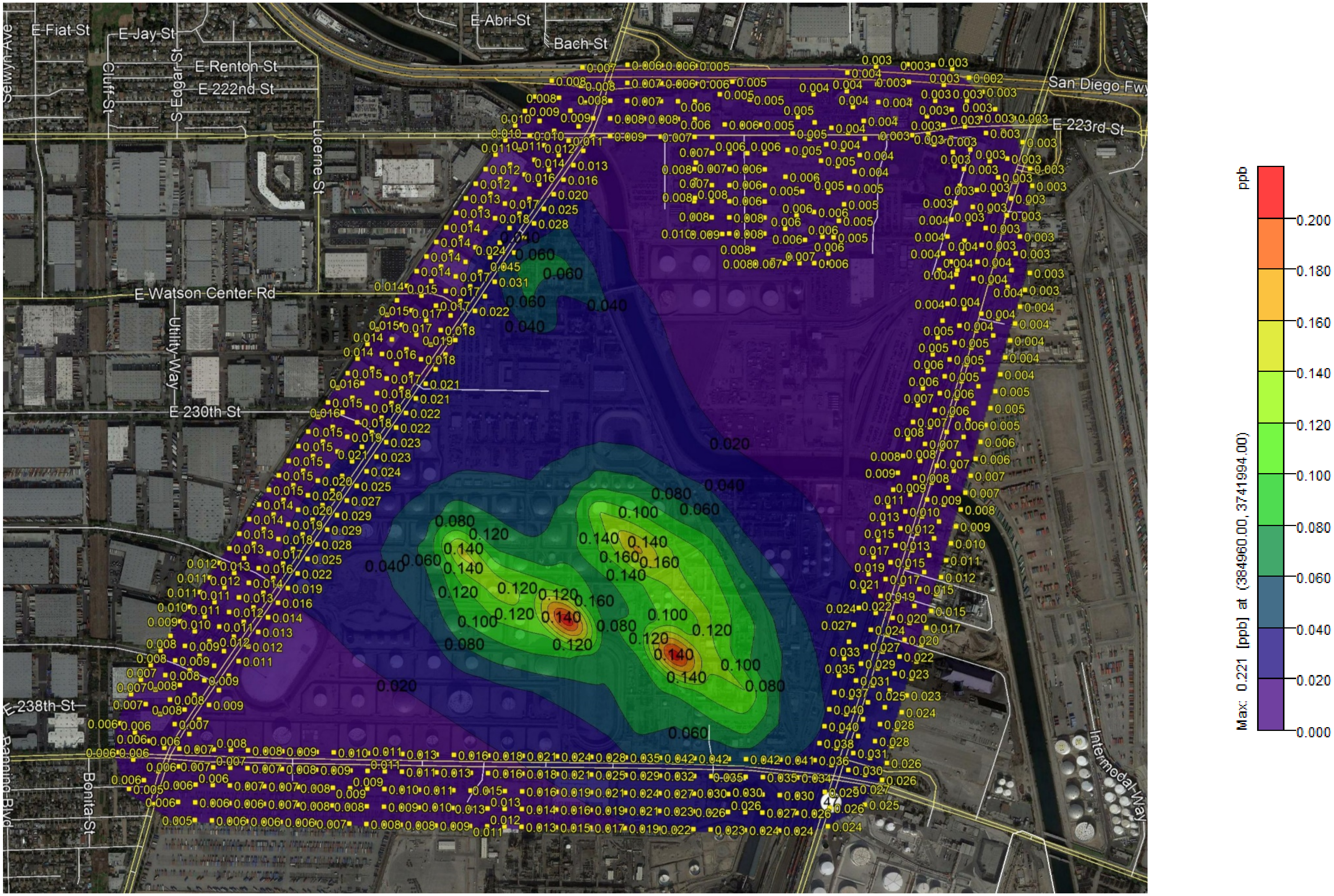
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Carbonyl Sulfide 5-Year Average Concentrations (ppb), Tesoro Refinery, Carson



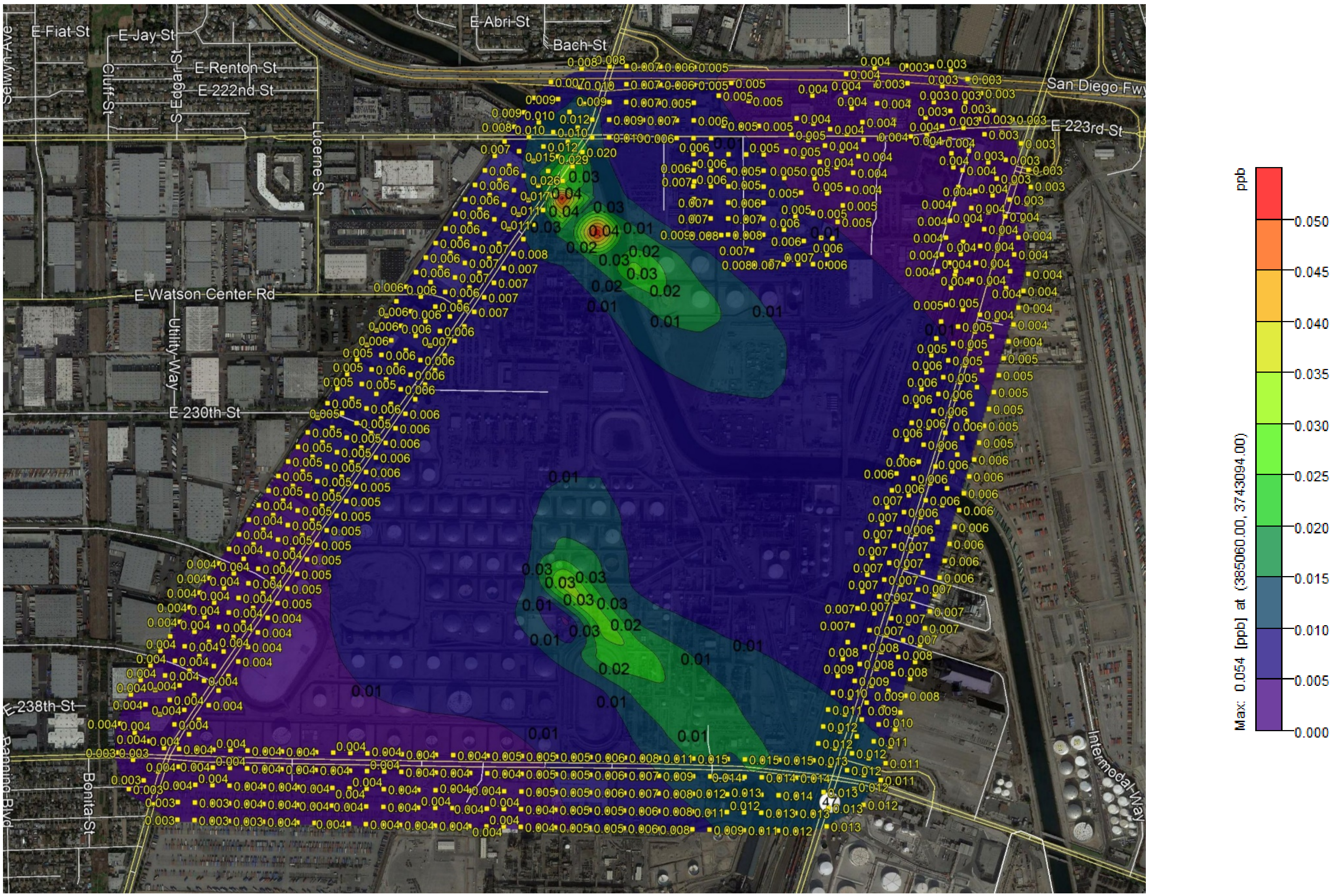
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Ethylbenzene 5-Year Average Concentrations (ppb), Tesoro Refinery, Carson



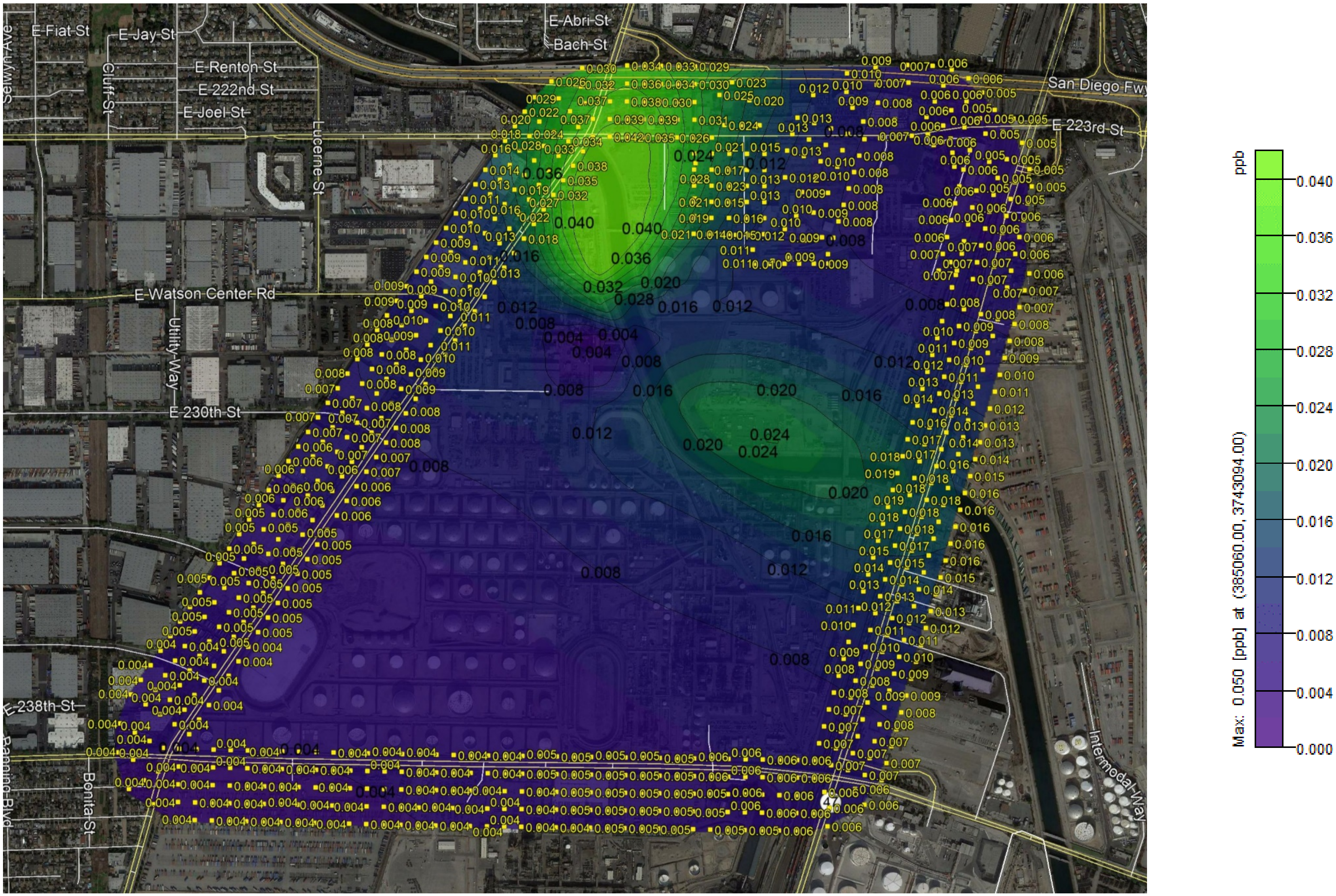
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Formaldehyde 5-Year Average Concentrations (ppb), Tesoro Refinery, Carson



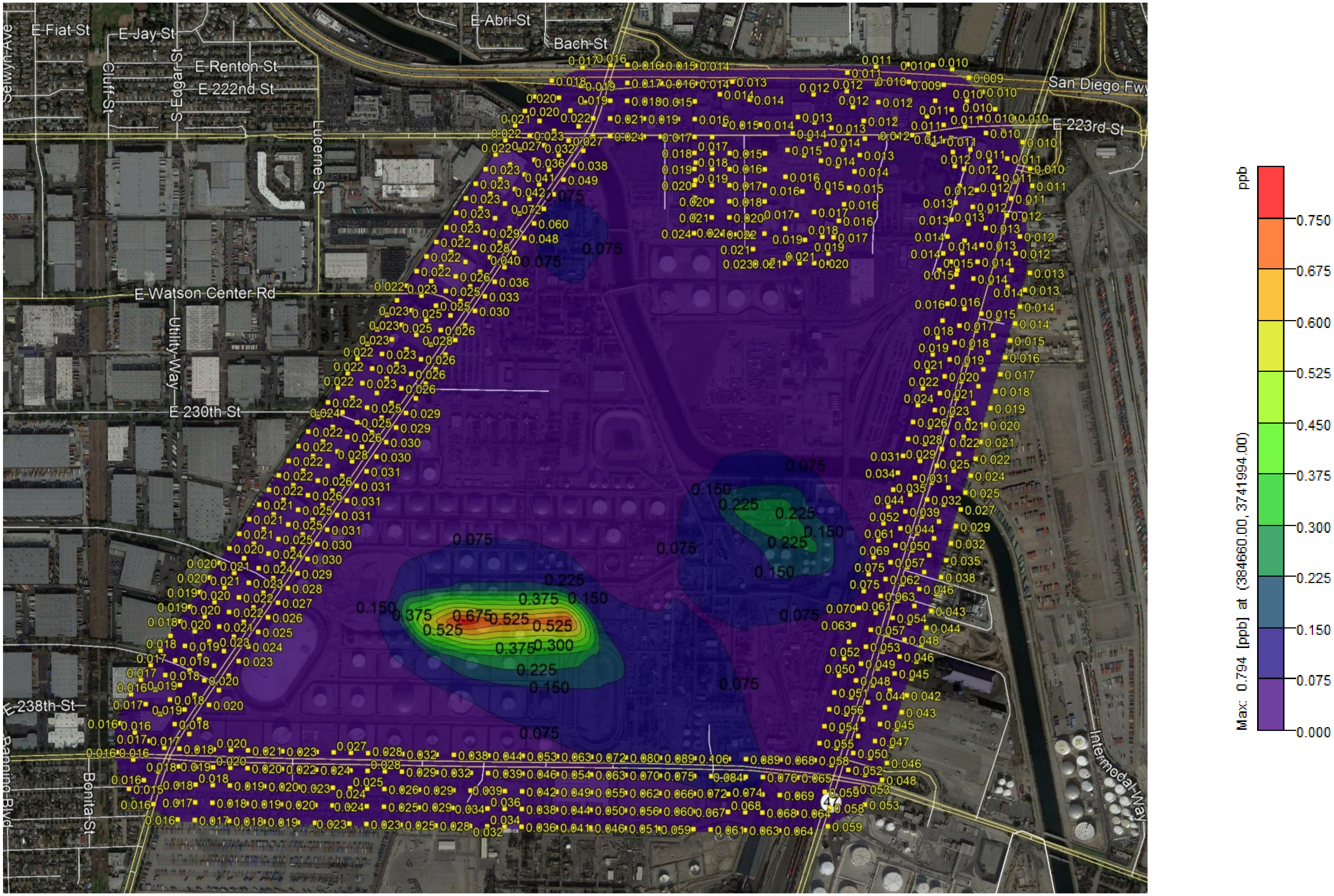
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Hydrogen Cyanide 5-Year Average Concentrations (ppb), Tesoro Refinery, Carson



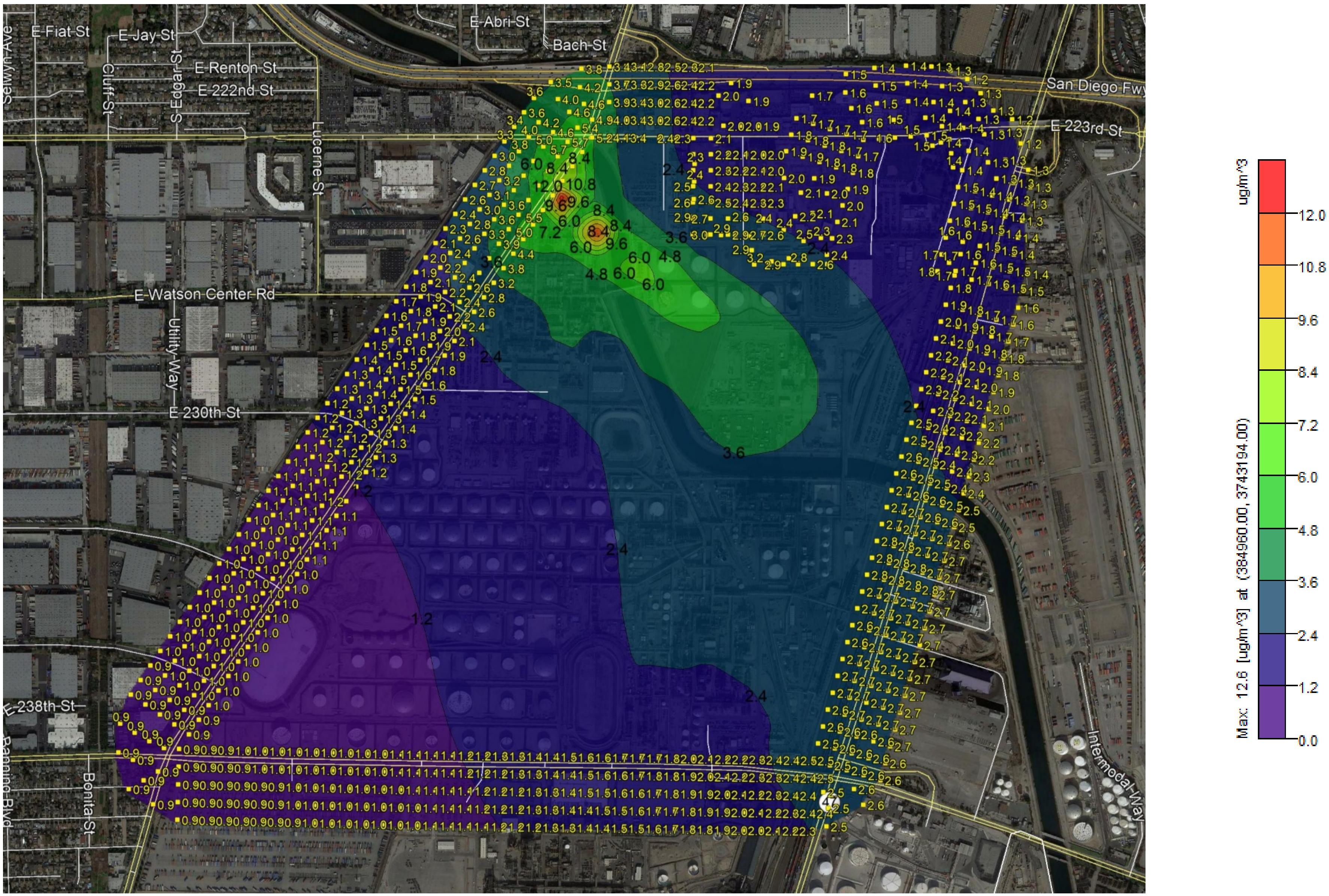
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Hydrogen Sulfide 5-Year Average Concentrations (ppb), Tesoro Refinery, Carson



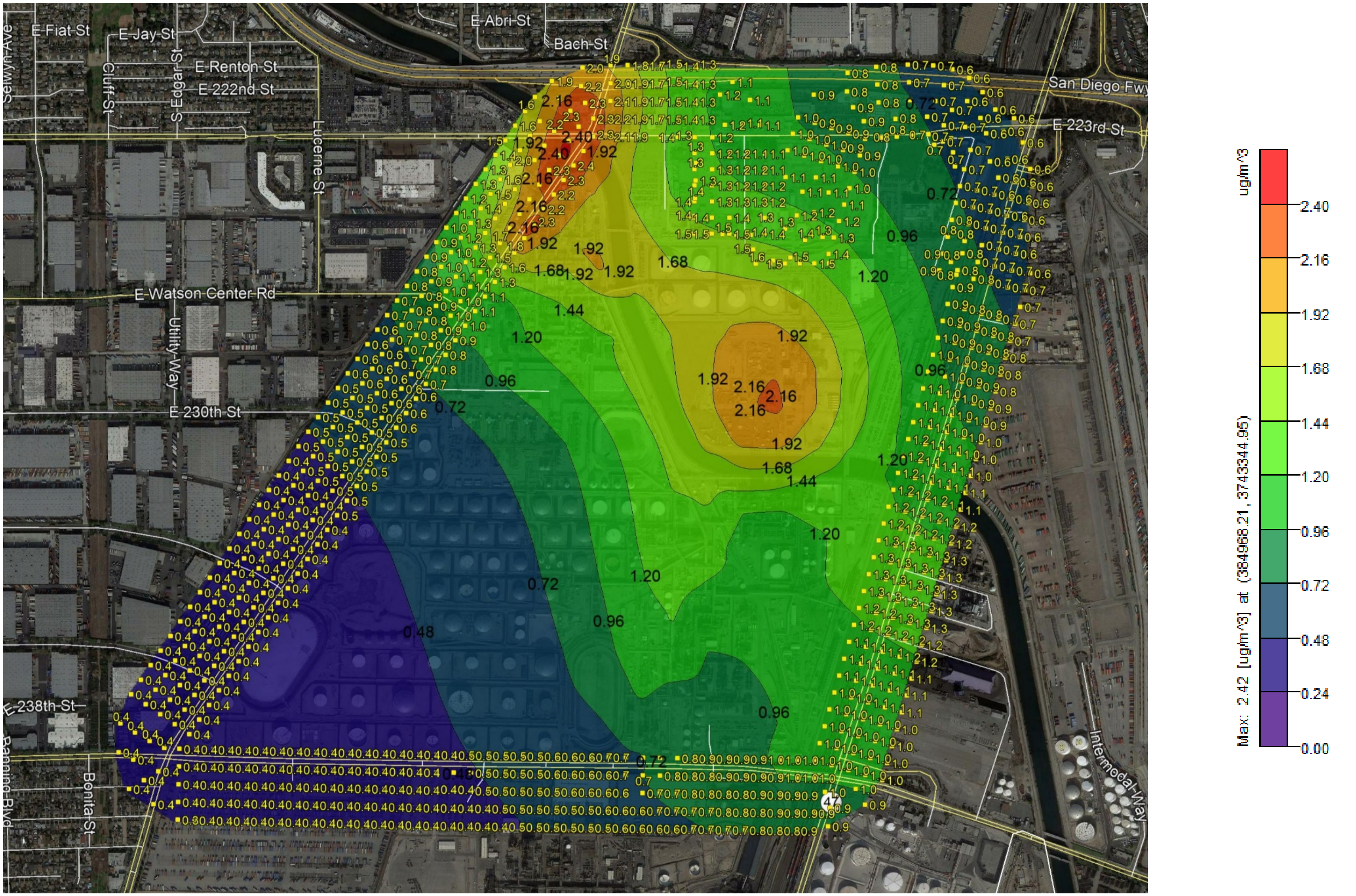
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

NOx 5-Year Average Concentrations (µg/m3), Tesoro Refinery, Carson



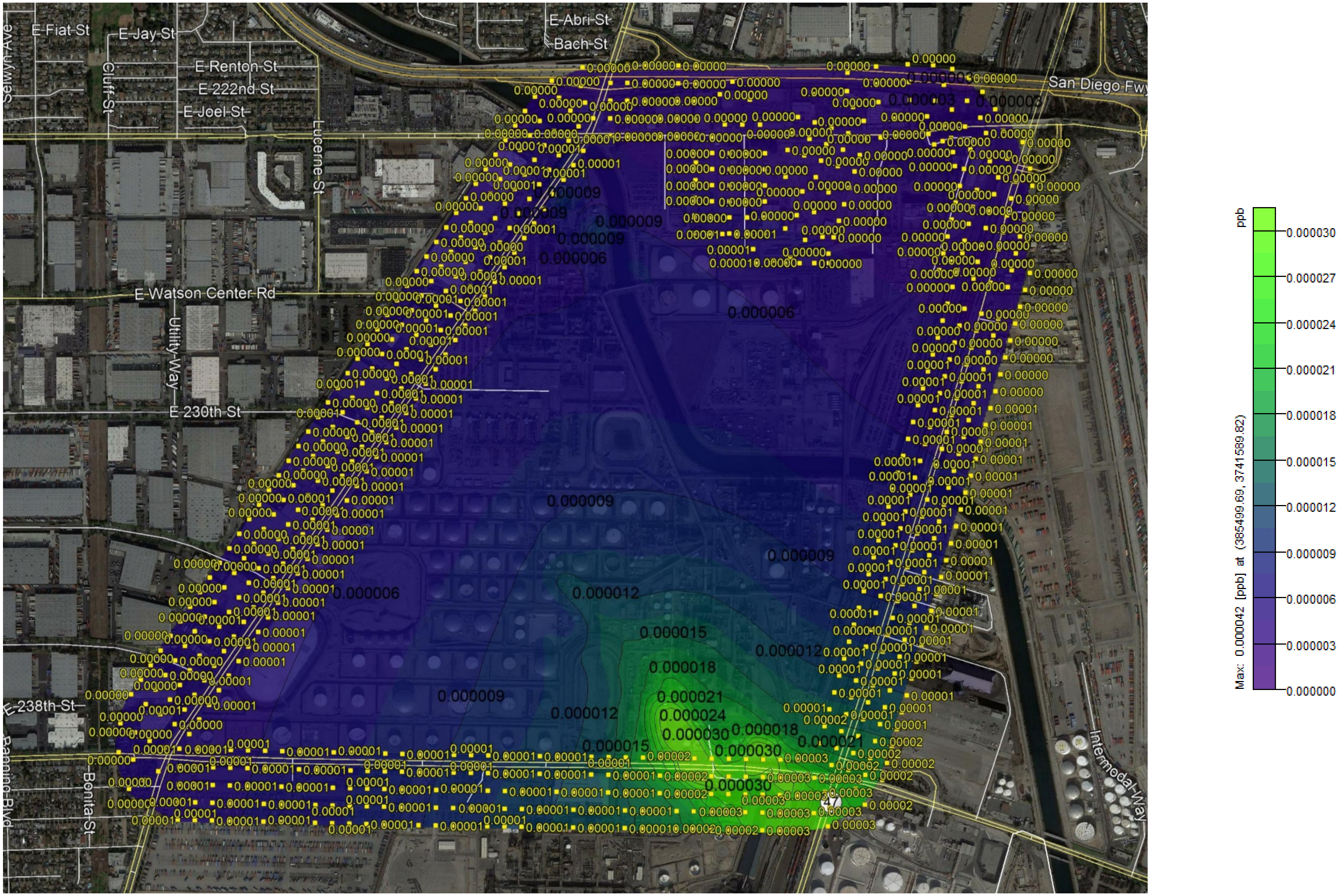
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

SOx 5-Year Average Concentrations (µg/m3), Tesoro Refinery, Carson



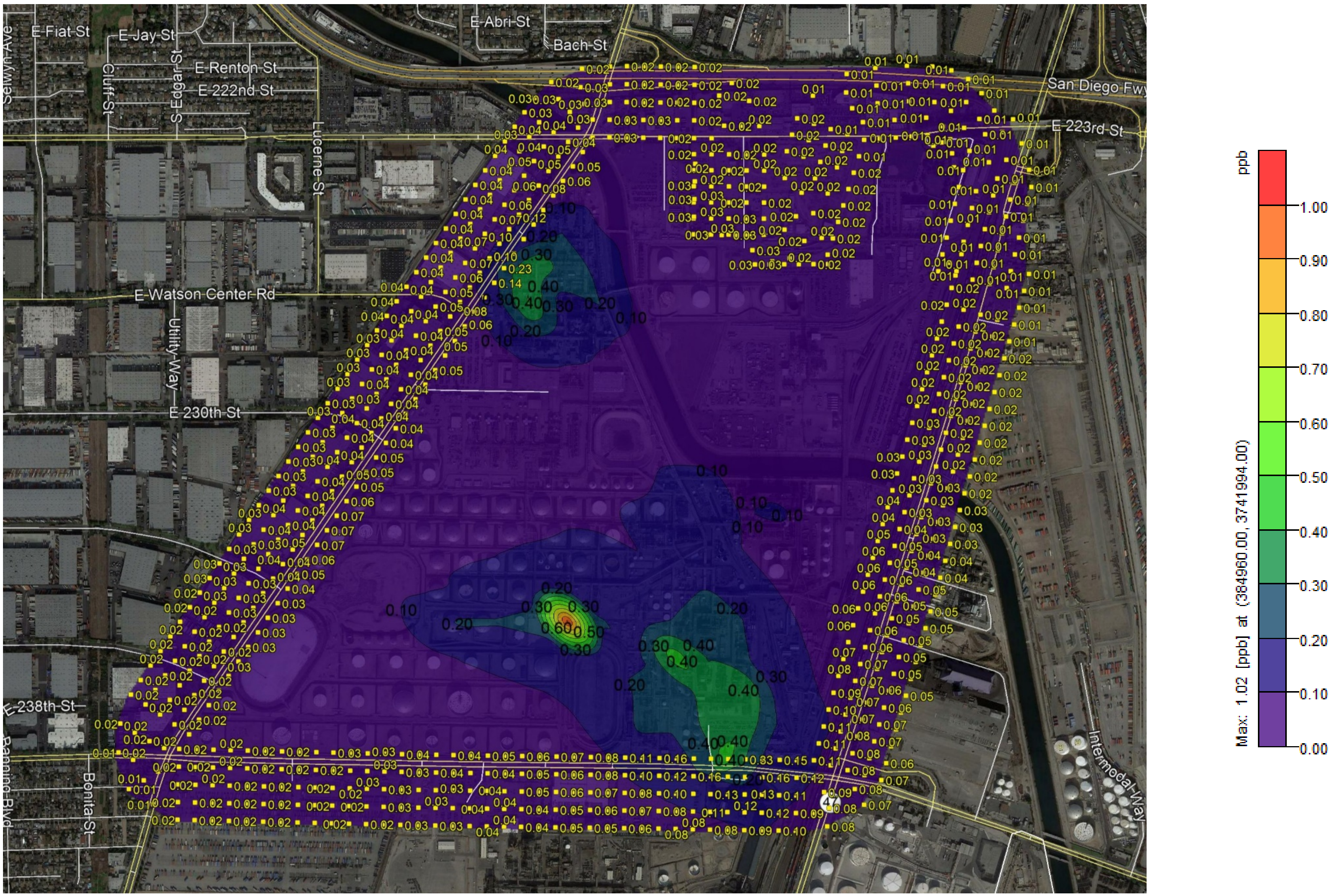
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Styrene 5-Year Average Concentrations (ppb), Tesoro Refinery, Carson



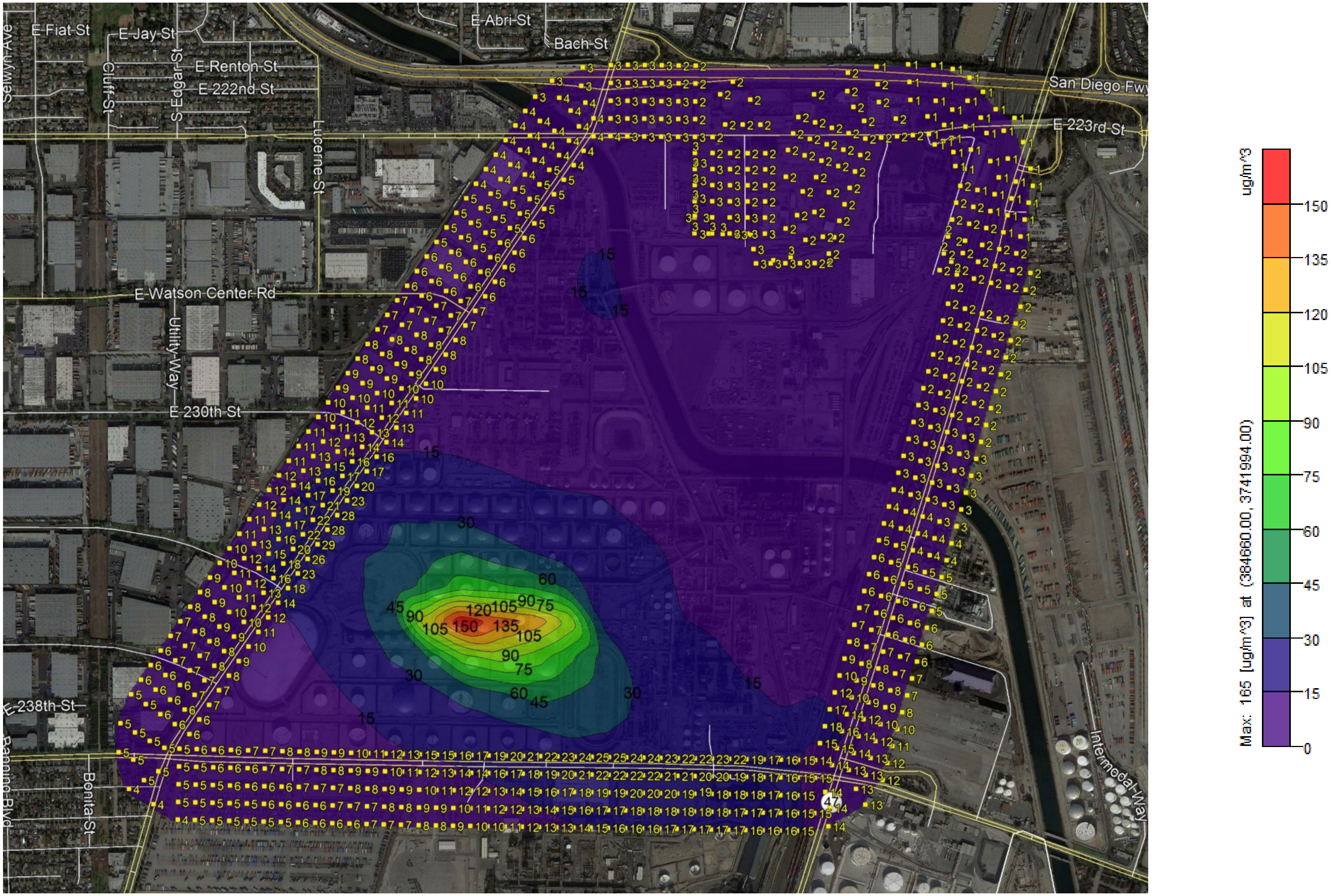
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Toluene 5-Year Average Concentrations (ppb), Tesoro Refinery, Carson



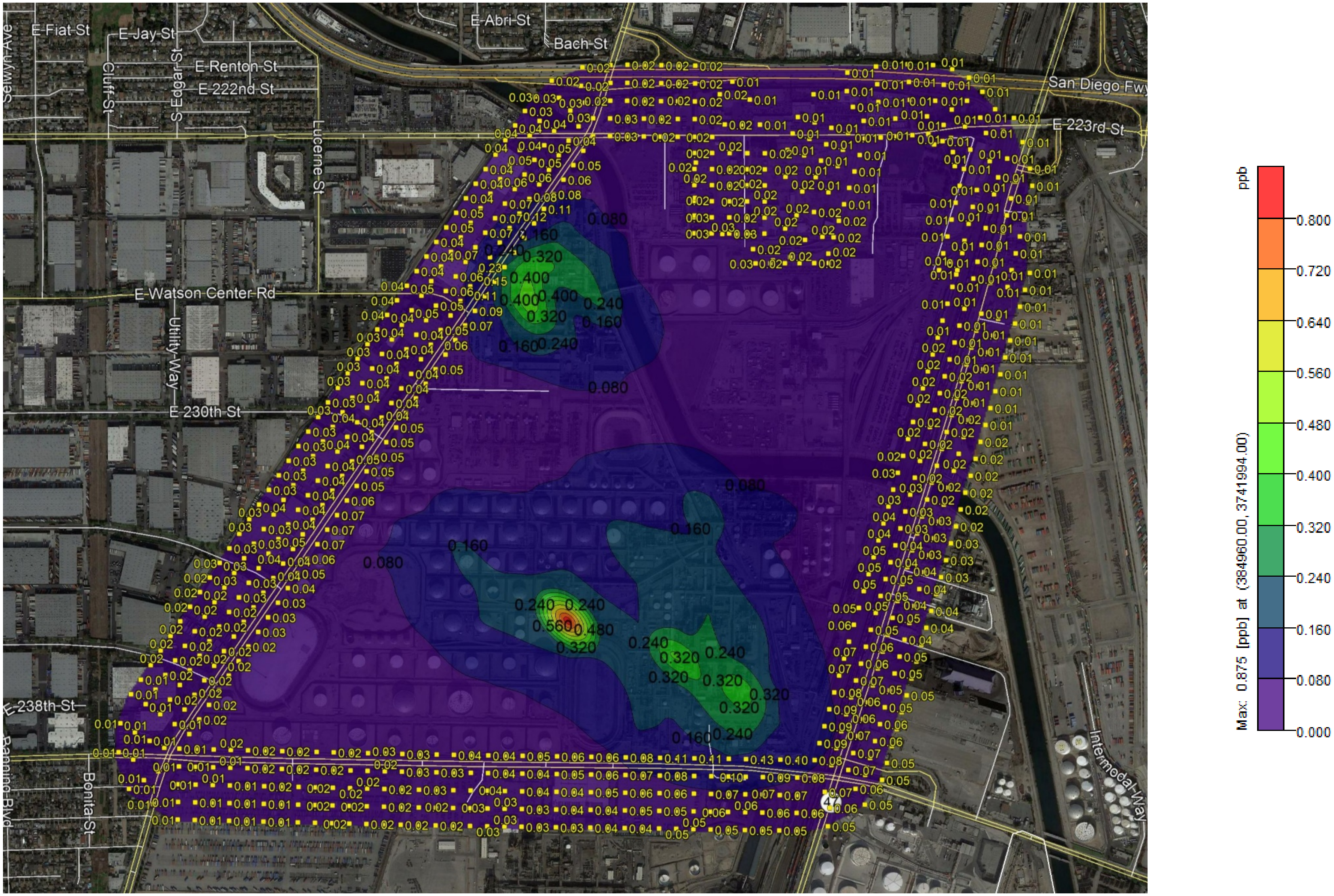
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

VOC 5-Year Average Concentrations (µg/m3), Tesoro Refinery, Carson



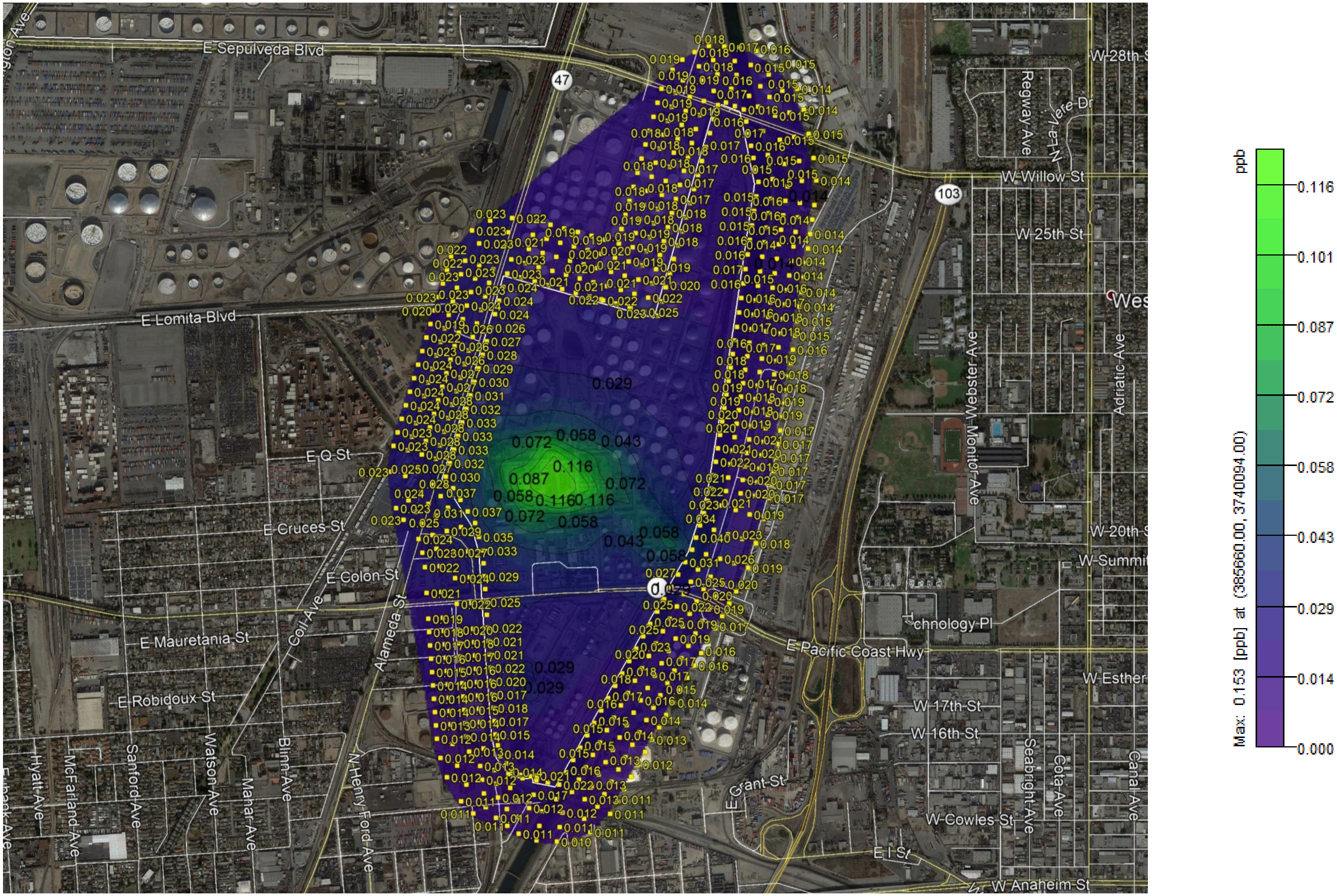
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Xylenes 5-Year Average Concentrations (ppb), Tesoro Refinery, Carson



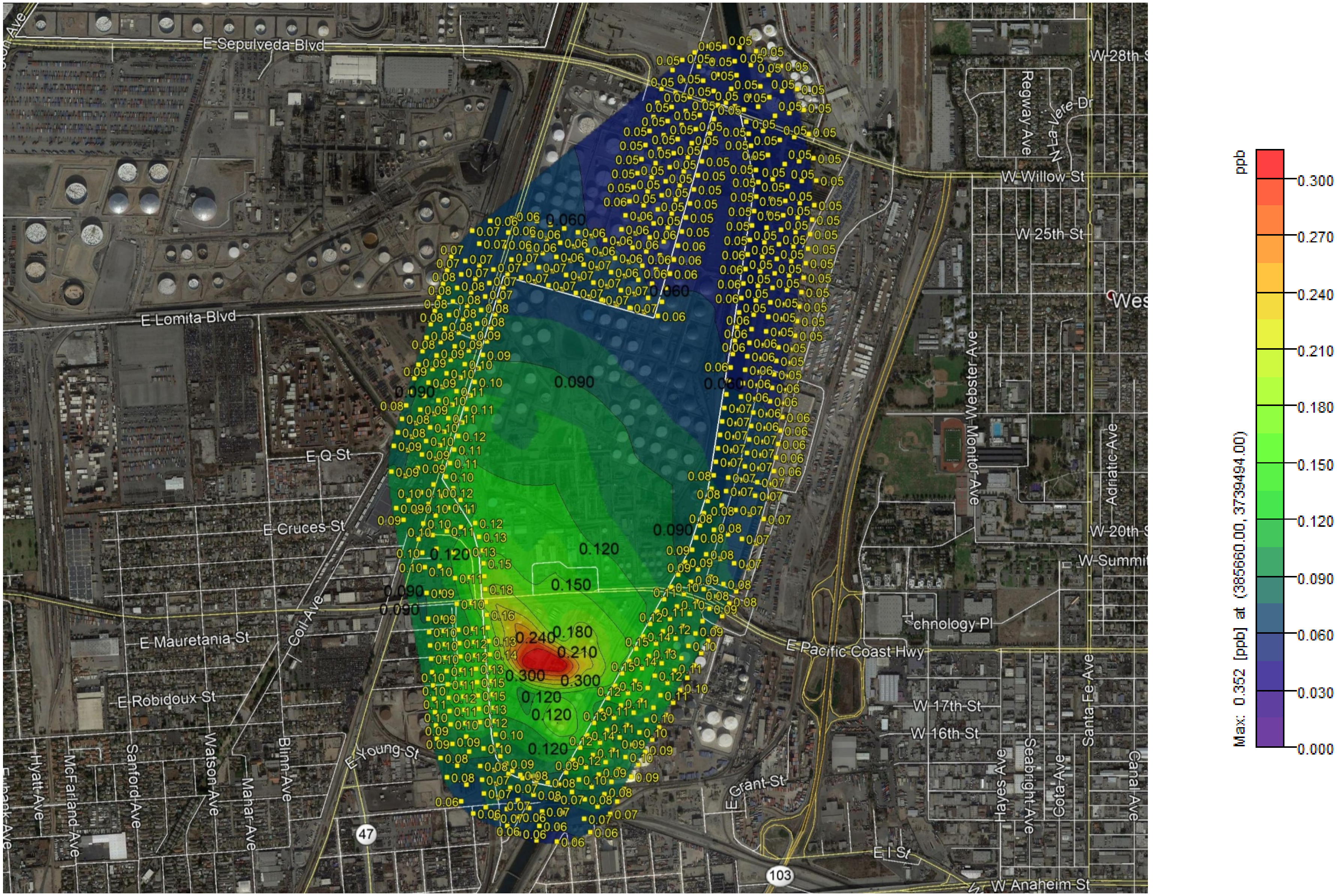
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

1,3-Butadiene Maximum 1-hour Average Concentrations (ppb), Tesoro Refinery, Wilmington



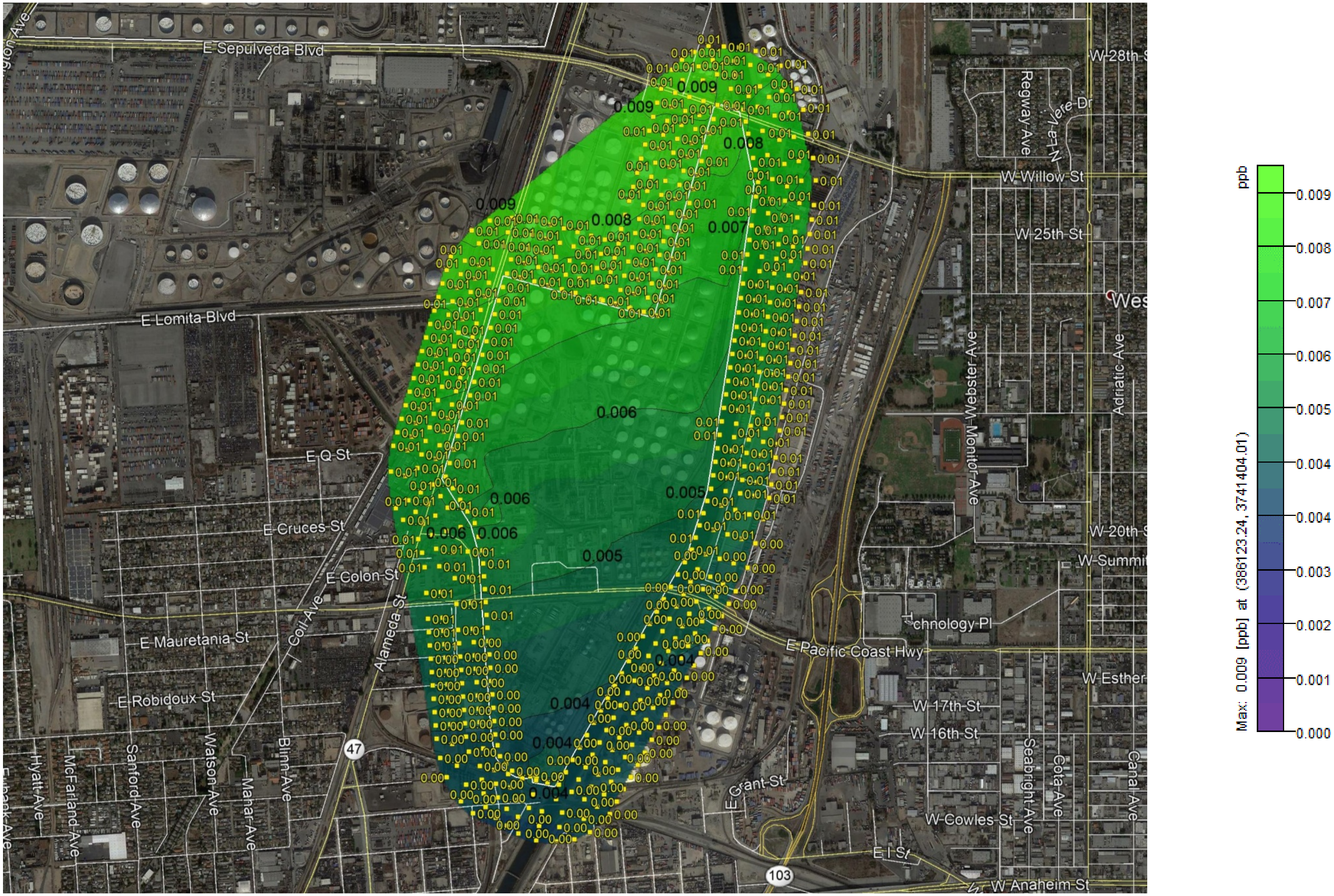
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Acetaldehyde Maximum 1-hour Average Concentrations (ppb), Tesoro Refinery, Wilmington



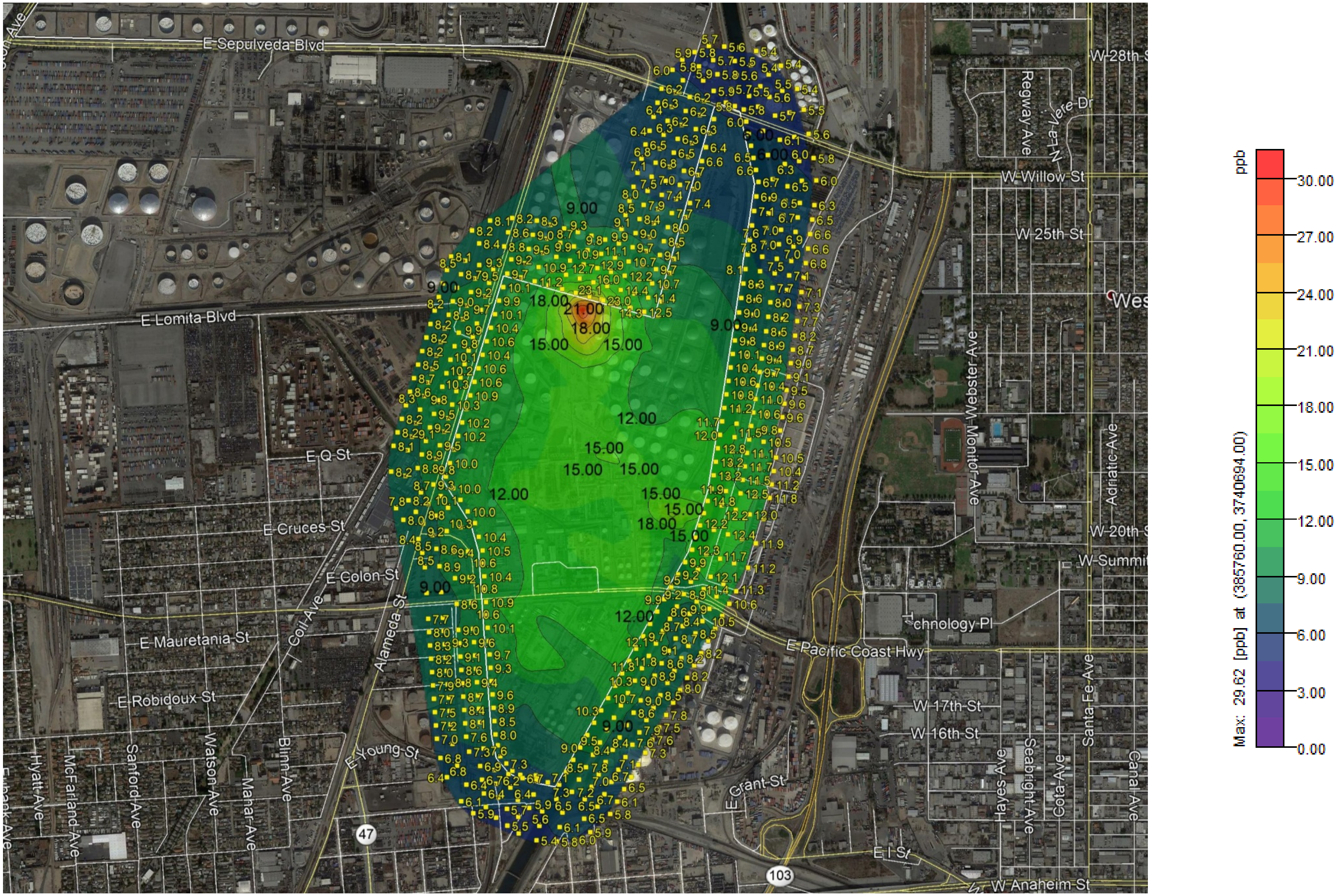
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Acrolein Maximum 1-hour Average Concentrations (ppb), Tesoro Refinery, Wilmington



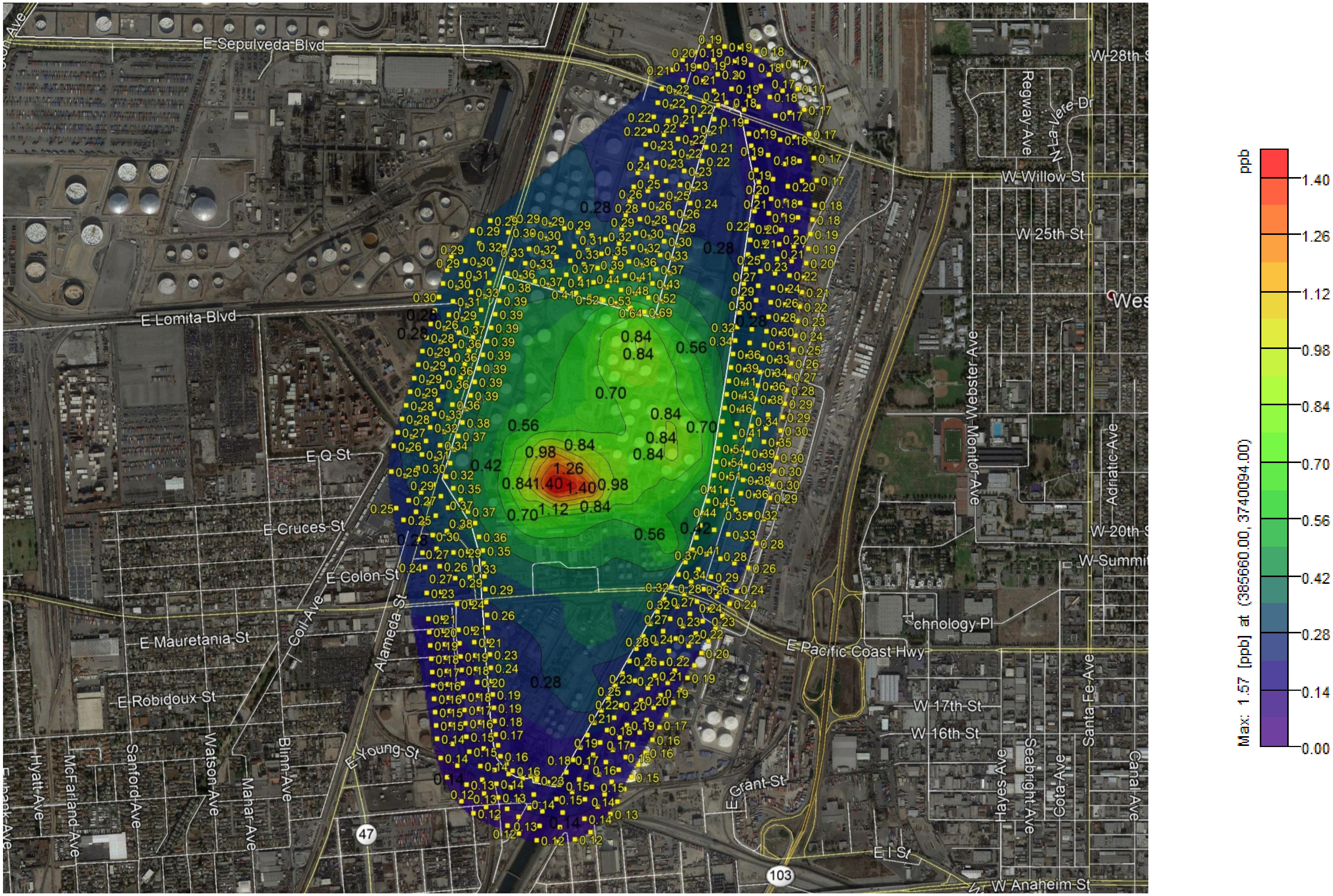
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Ammonia Maximum 1-hour Average Concentrations (ppb), Tesoro Refinery, Wilmington



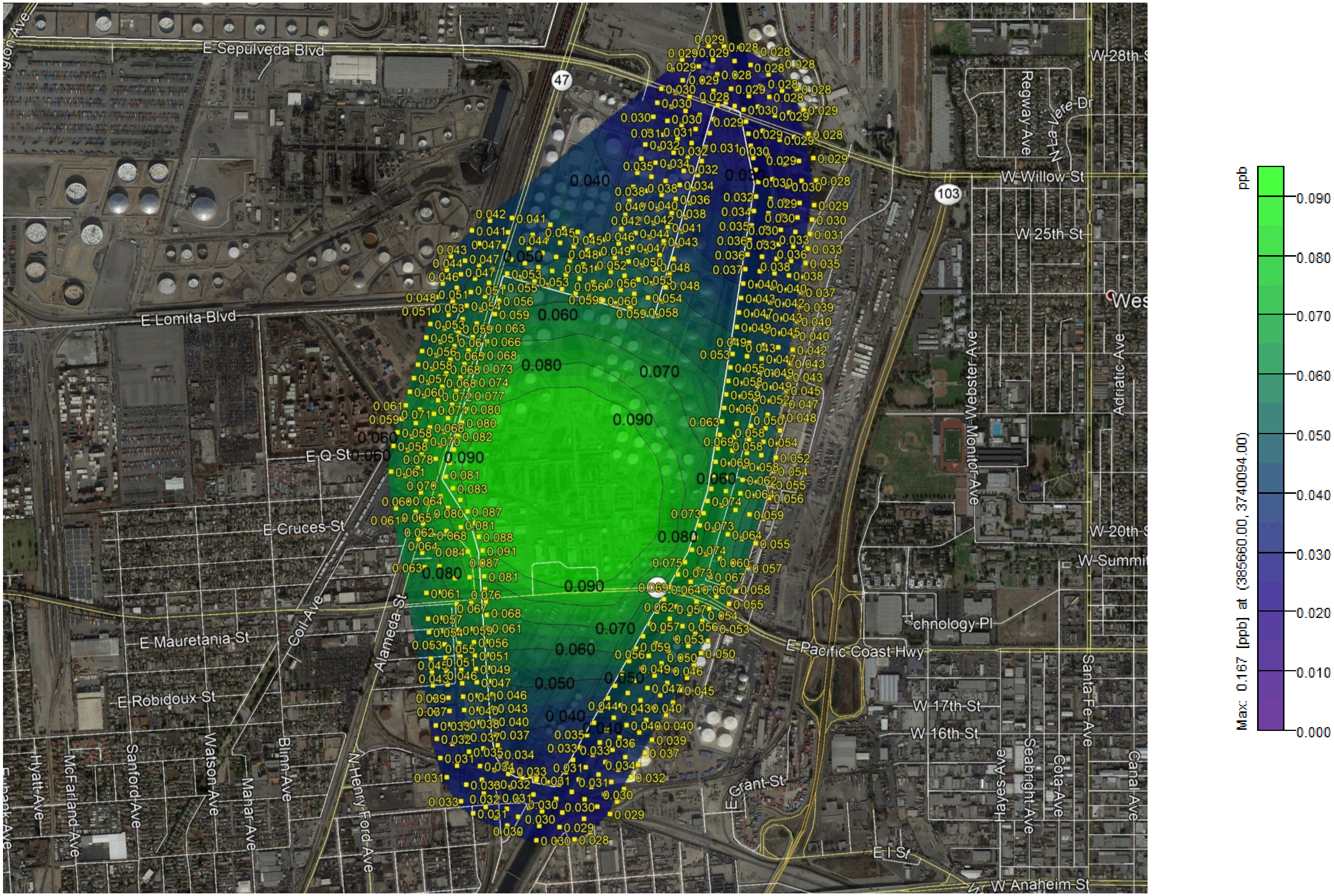
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Benzene Maximum 1-hour Average Concentrations (ppb), Tesoro Refinery, Wilmington



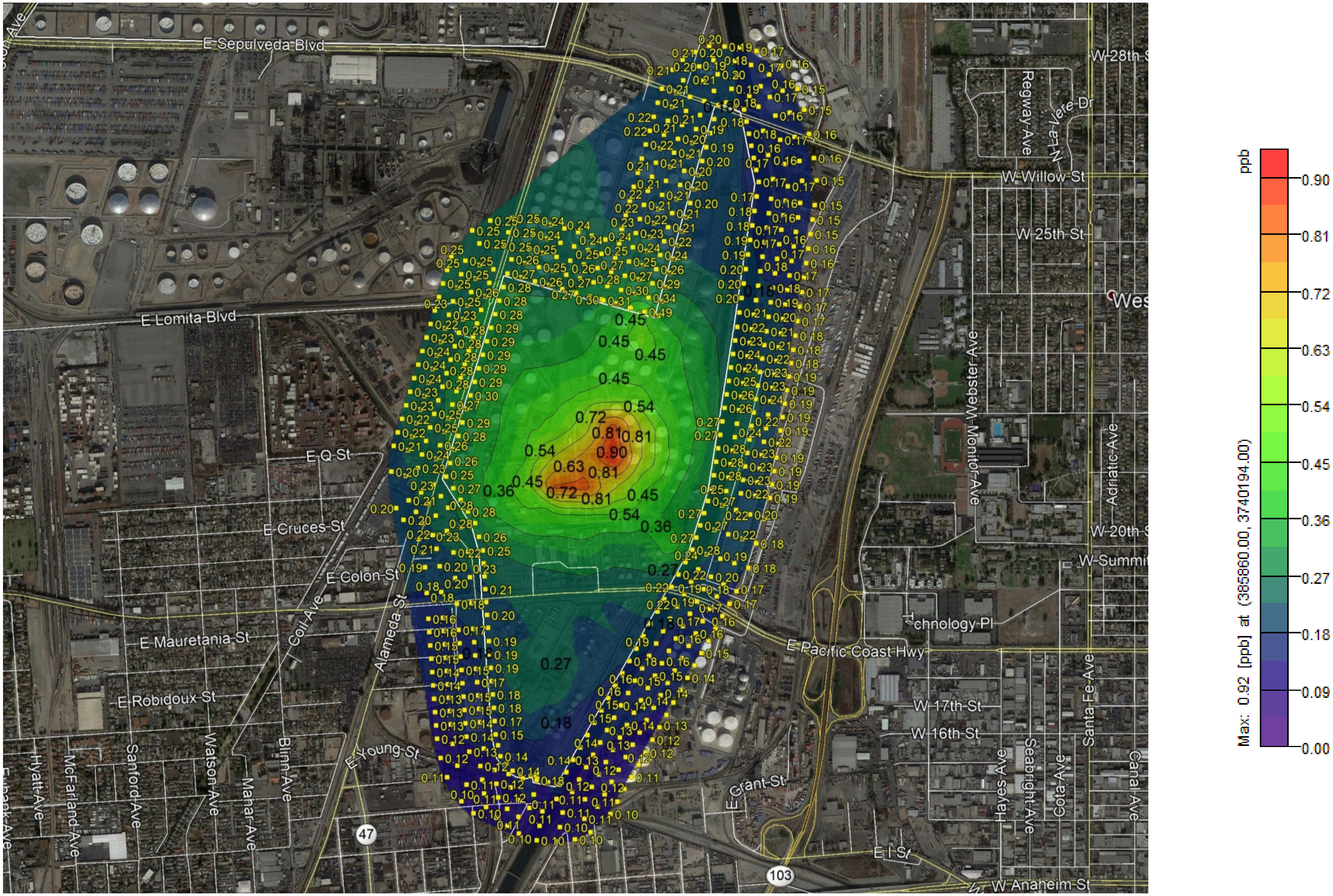
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Carbonyl Sulfide Maximum 1-hour Average Concentrations (ppb), Tesoro Refinery, Wilmington



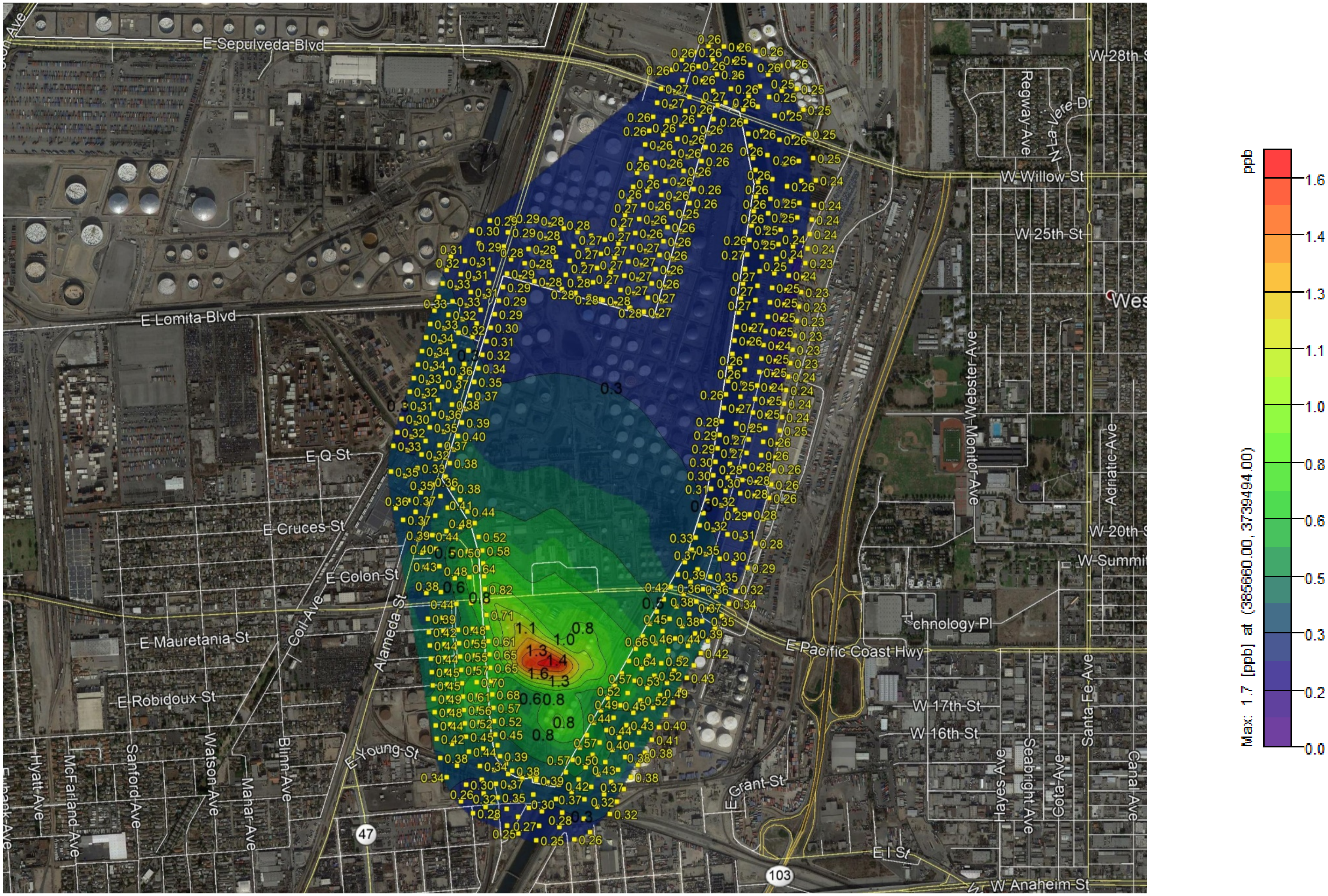
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Ethylbenzene Maximum 1-hour Average Concentrations (ppb), Tesoro Refinery, Wilmington



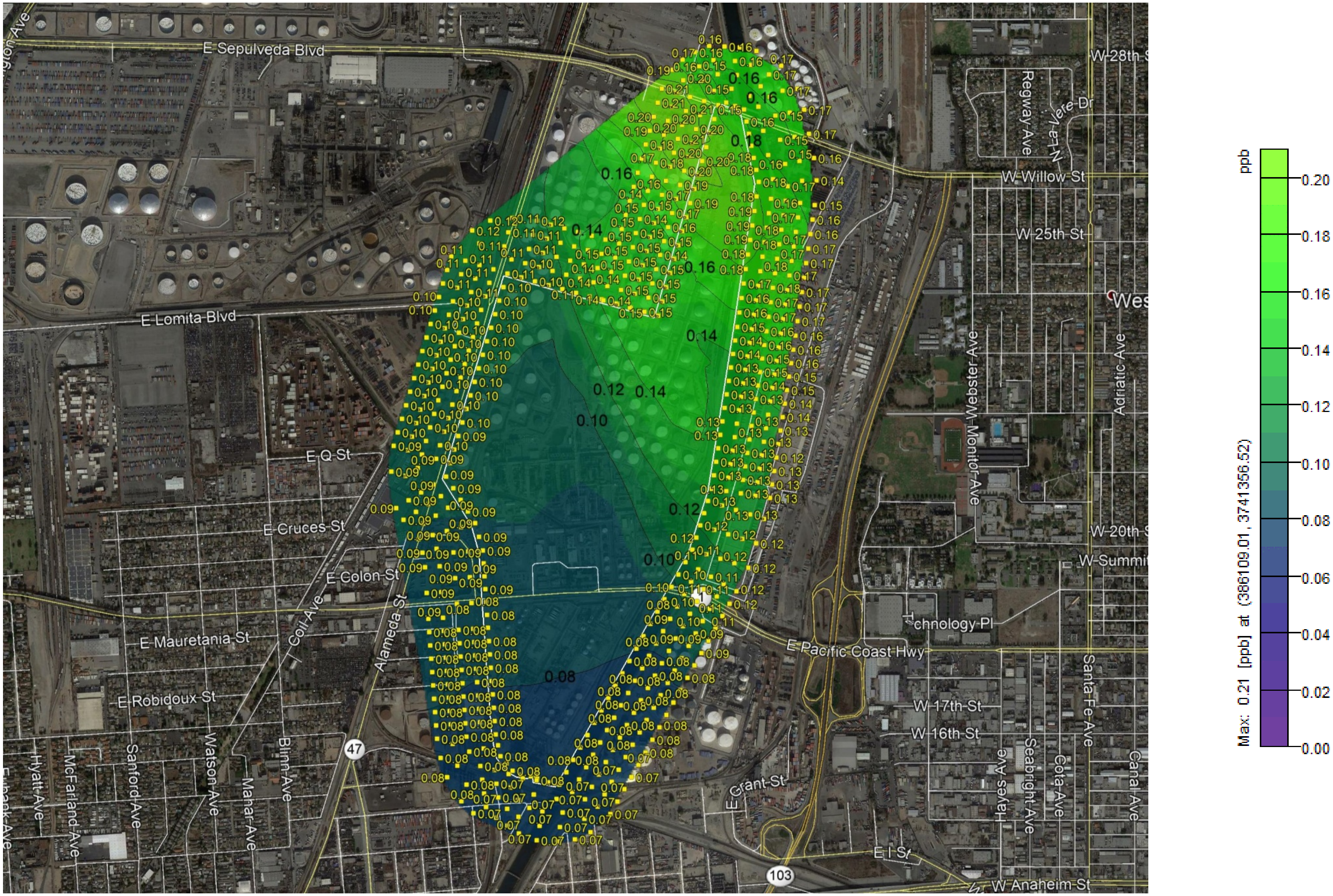
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Formaldehyde Maximum 1-hour Average Concentrations (ppb), Tesoro Refinery, Wilmington



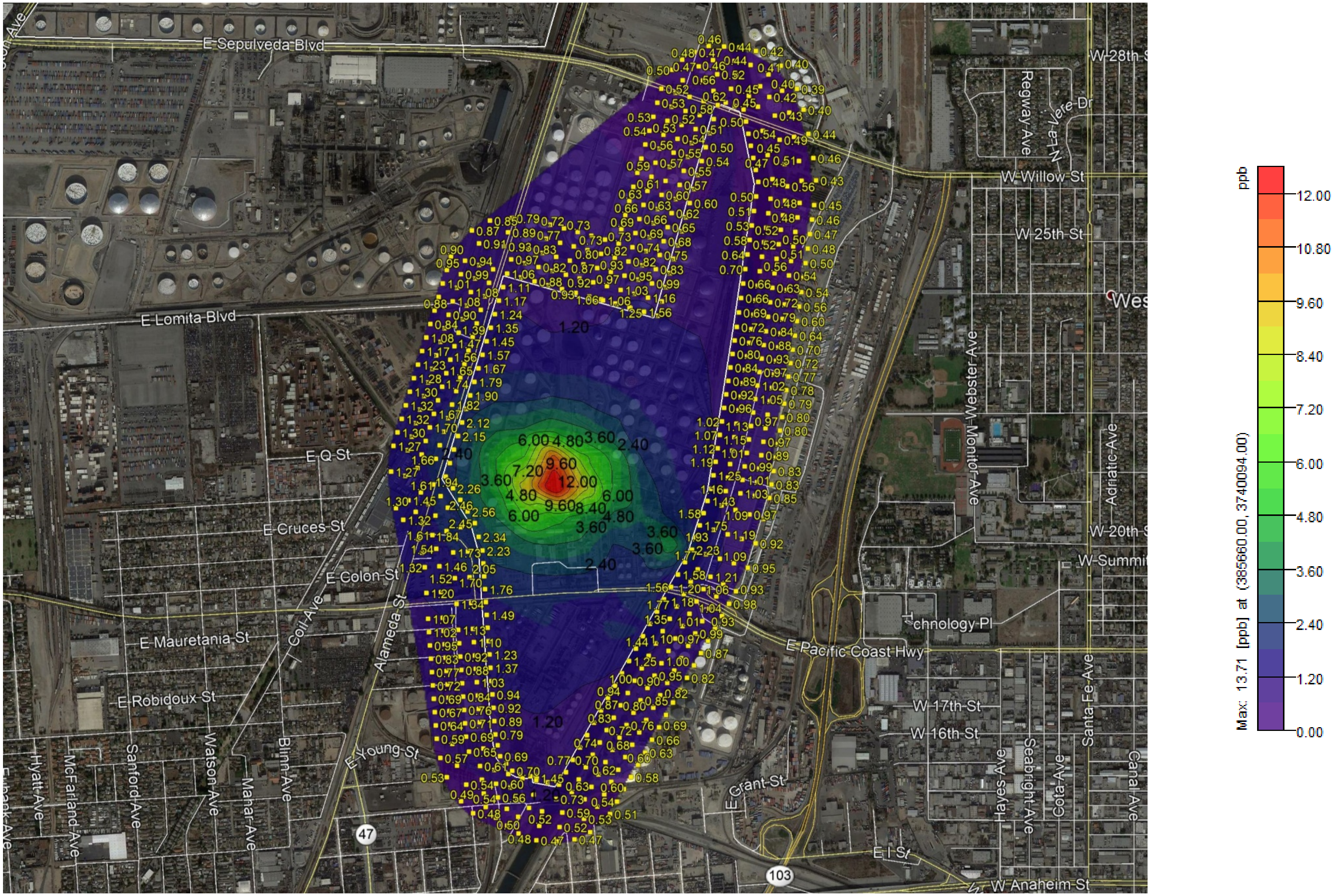
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Hydrogen Cyanide Maximum 1-hour Average Concentrations (ppb), Tesoro Refinery, Wilmington



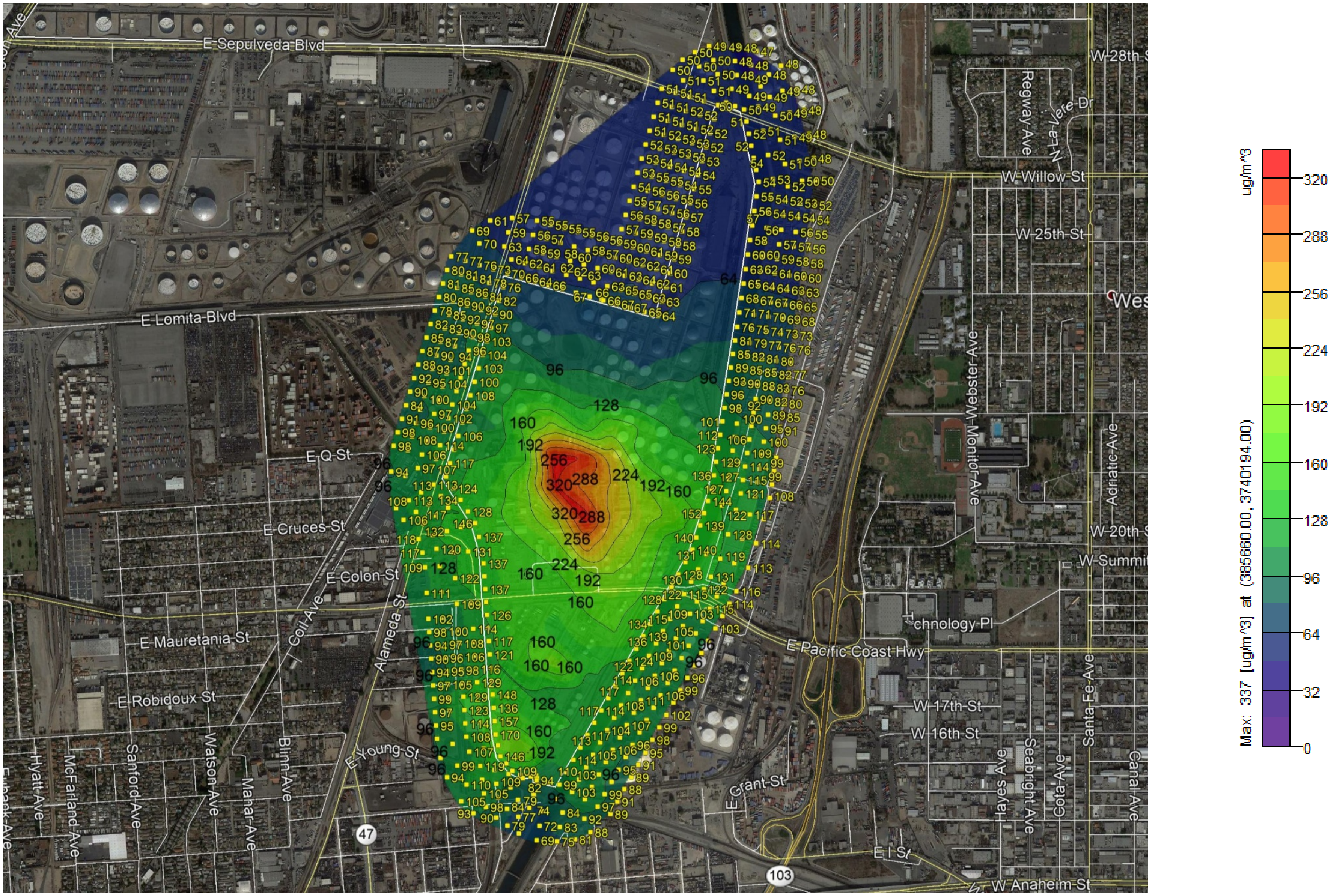
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Hydrogen Sulfide Maximum 1-hour Average Concentrations (ppb), Tesoro Refinery, Wilmington



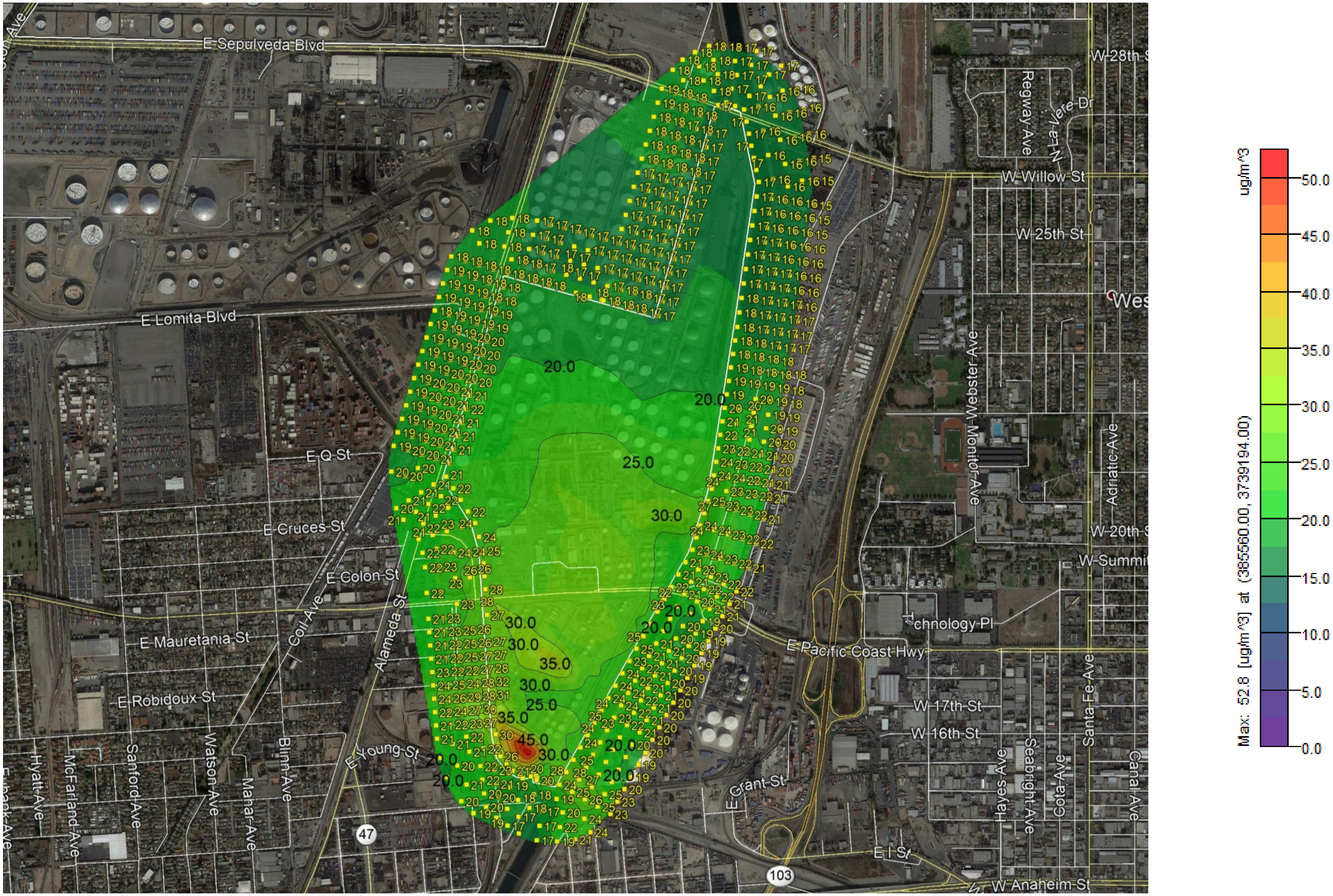
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

NOx Maximum 1-hour Average Concentrations (µg/m3), Tesoro Refinery, Wilmington



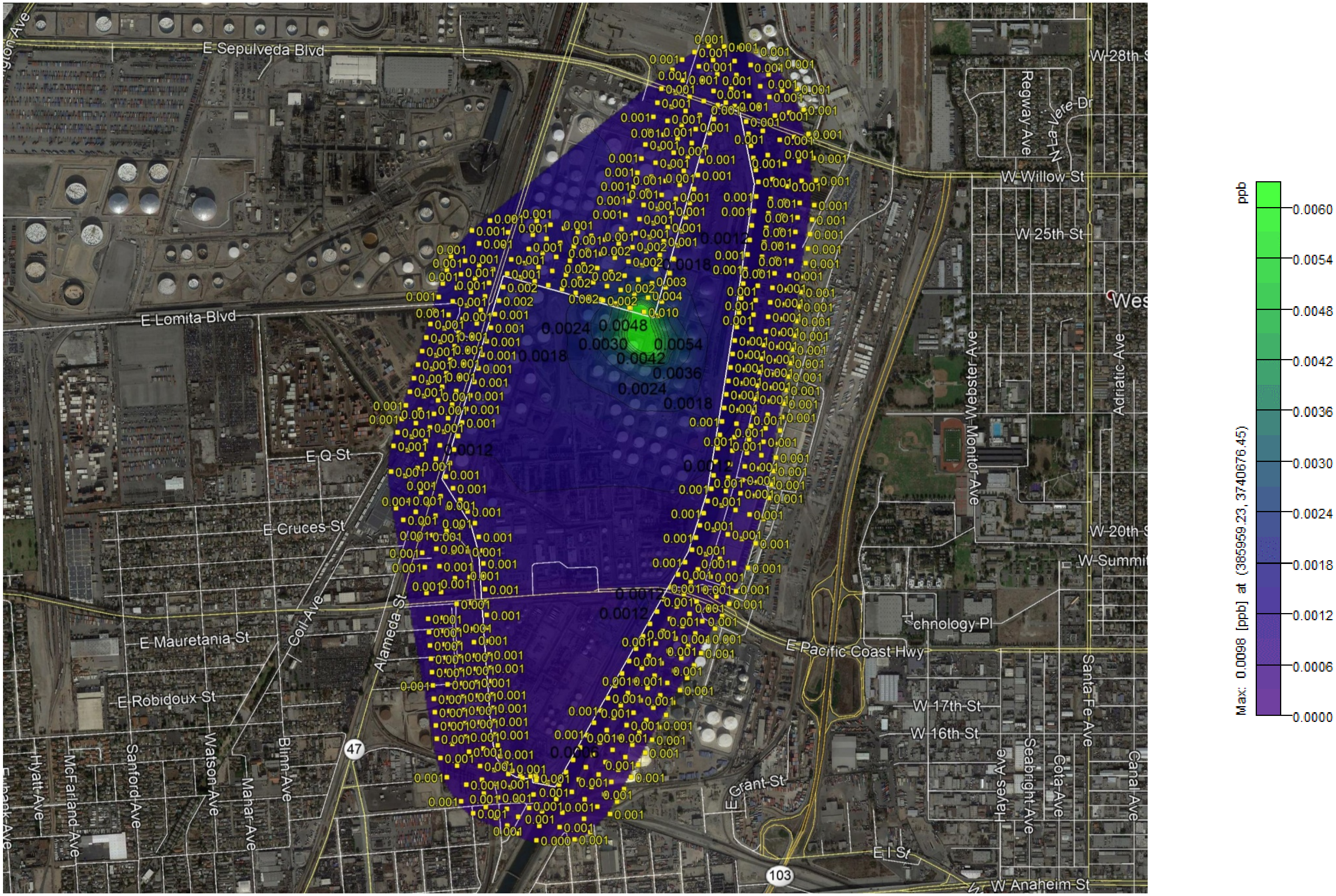
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

SOx Maximum 1-hour Average Concentrations (µg/m3), Tesoro Refinery, Wilmington



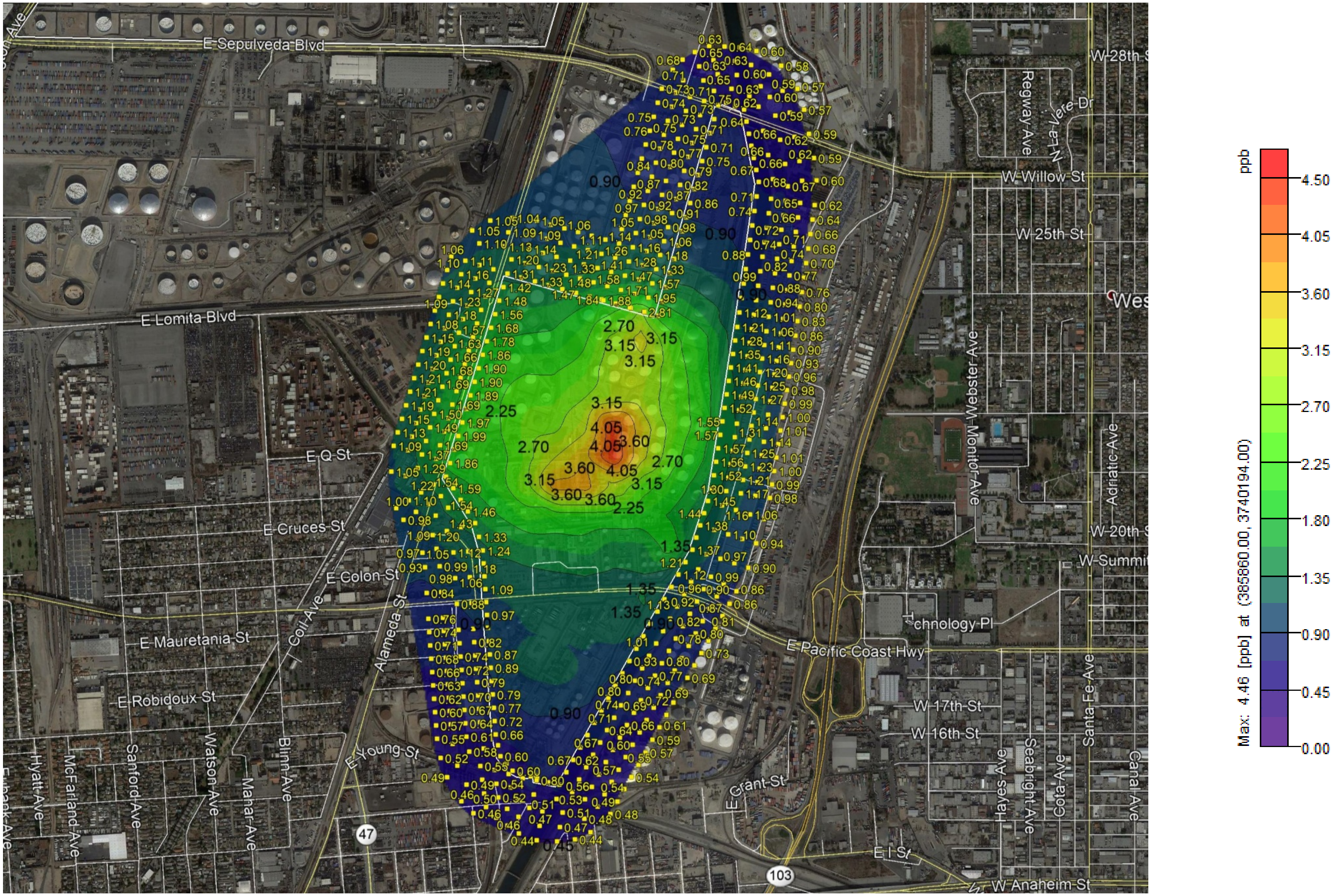
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Styrene Maximum 1-hour Average Concentrations (ppb), Tesoro Refinery, Wilmington



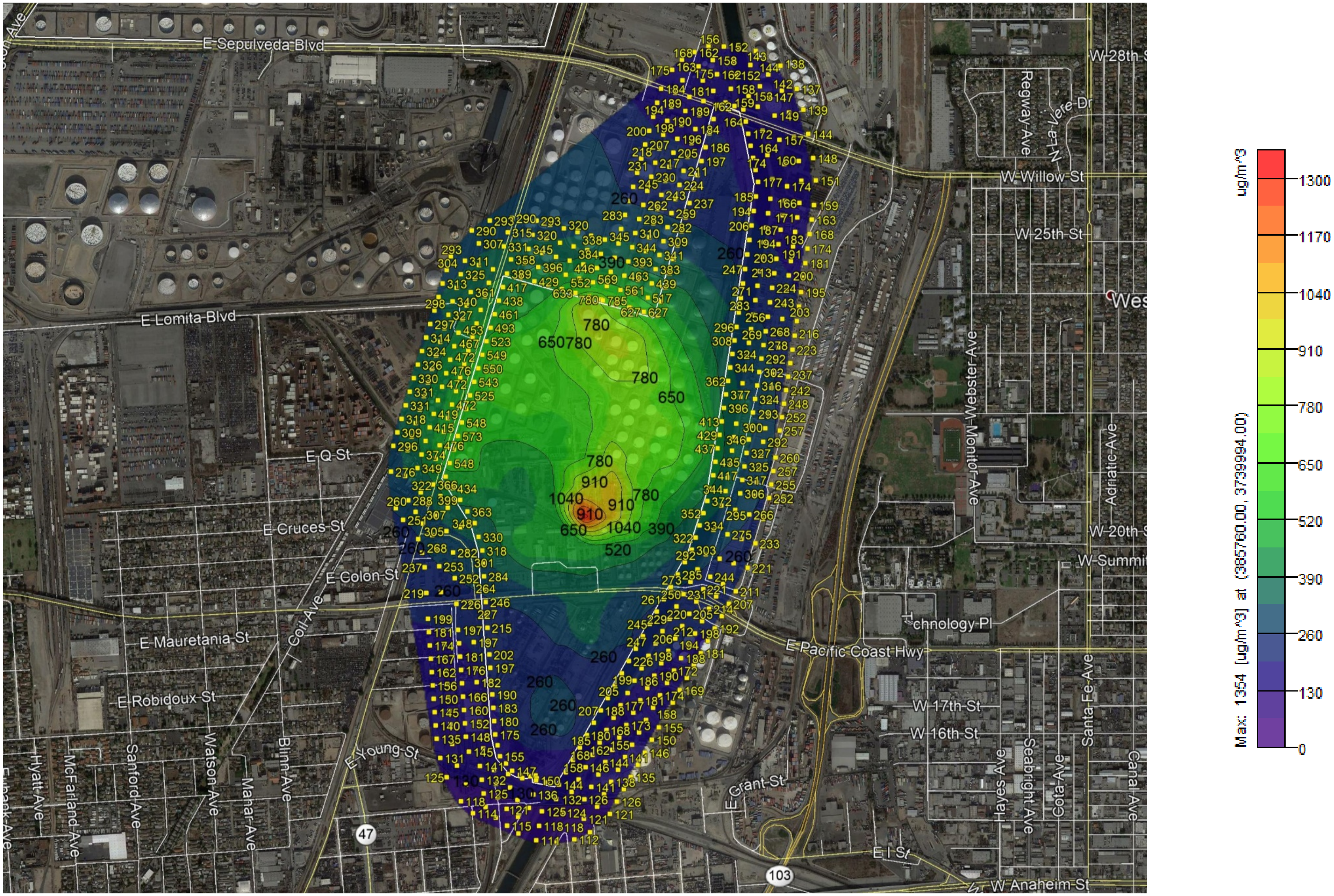
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Toluene Maximum 1-hour Average Concentrations (ppb), Tesoro Refinery, Wilmington



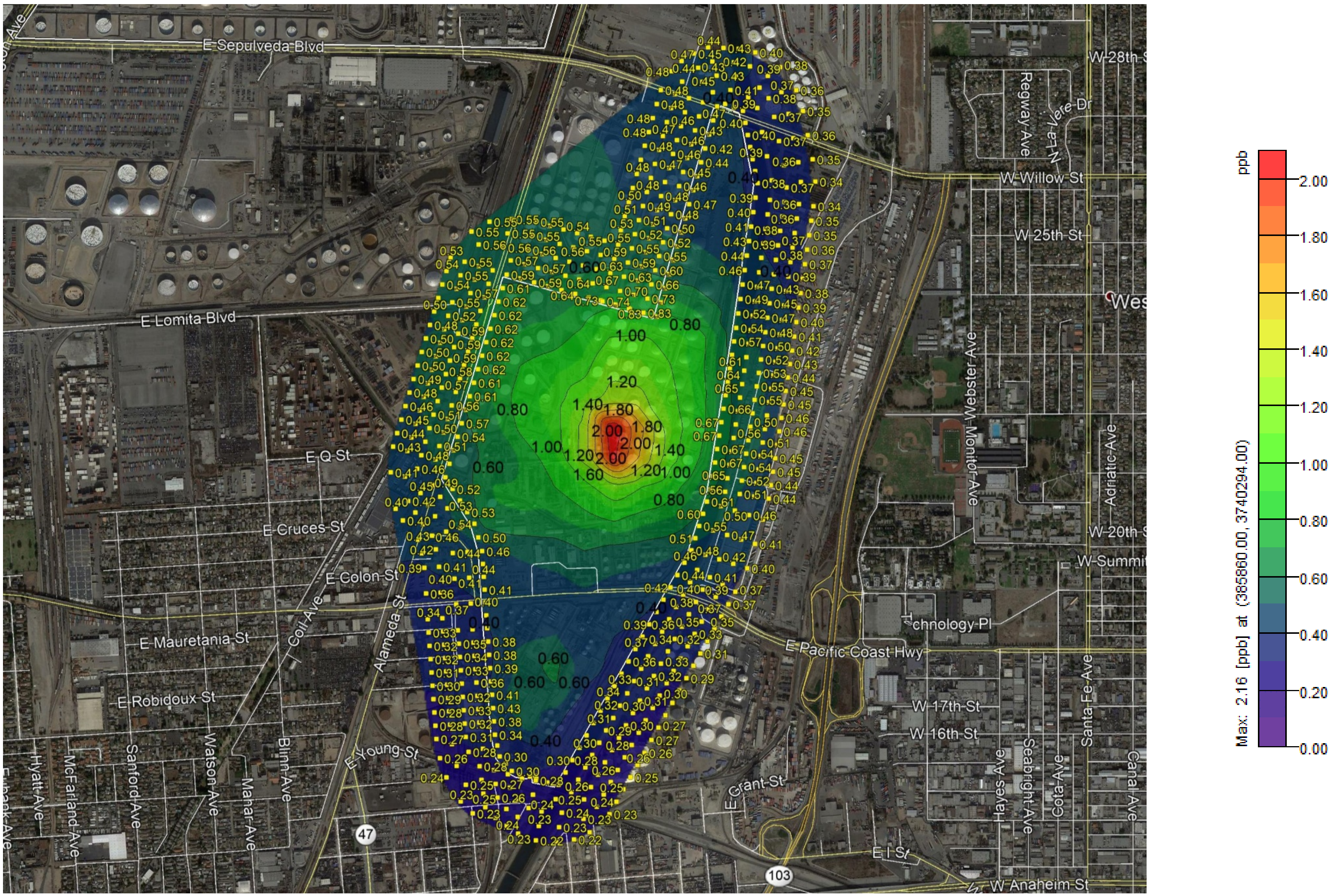
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

VOC Maximum 1-hour Average Concentrations (µg/m3), Tesoro Refinery, Wilmington



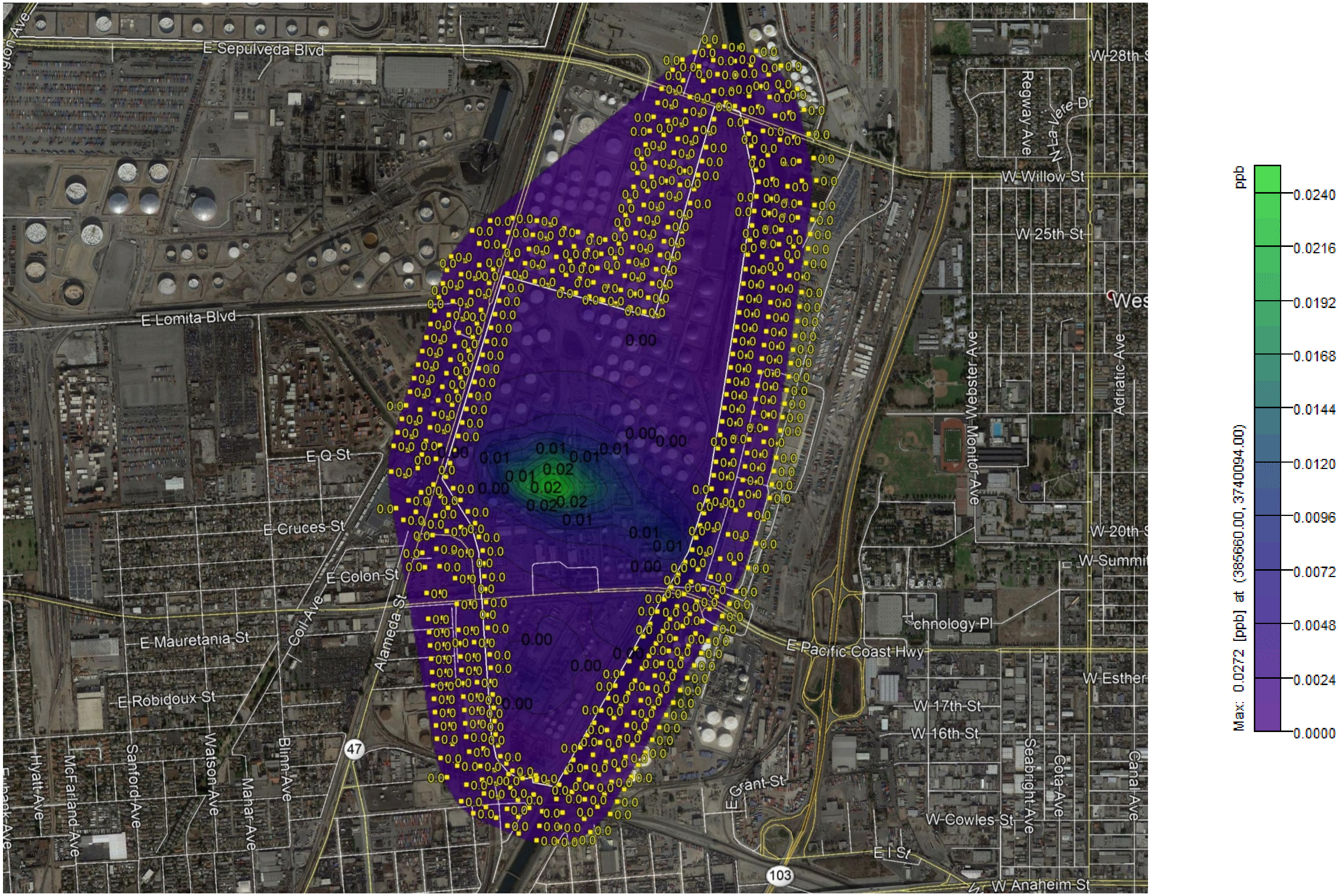
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Xylenes Maximum 1-hour Average Concentrations (ppb), Tesoro Refinery, Wilmington



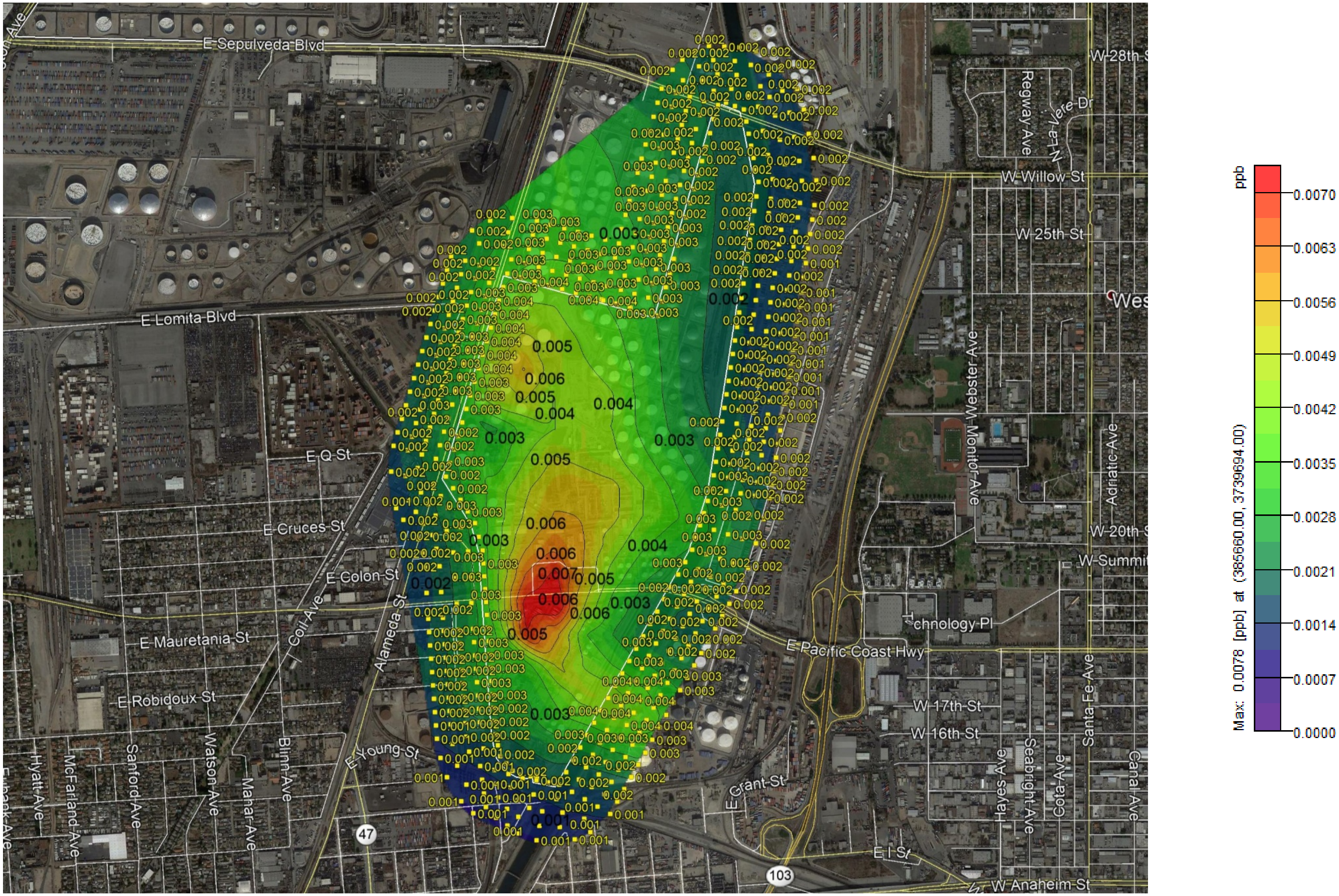
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

1,3-Butadiene 5-Year Average Concentrations (ppb), Tesoro Refinery, Wilmington



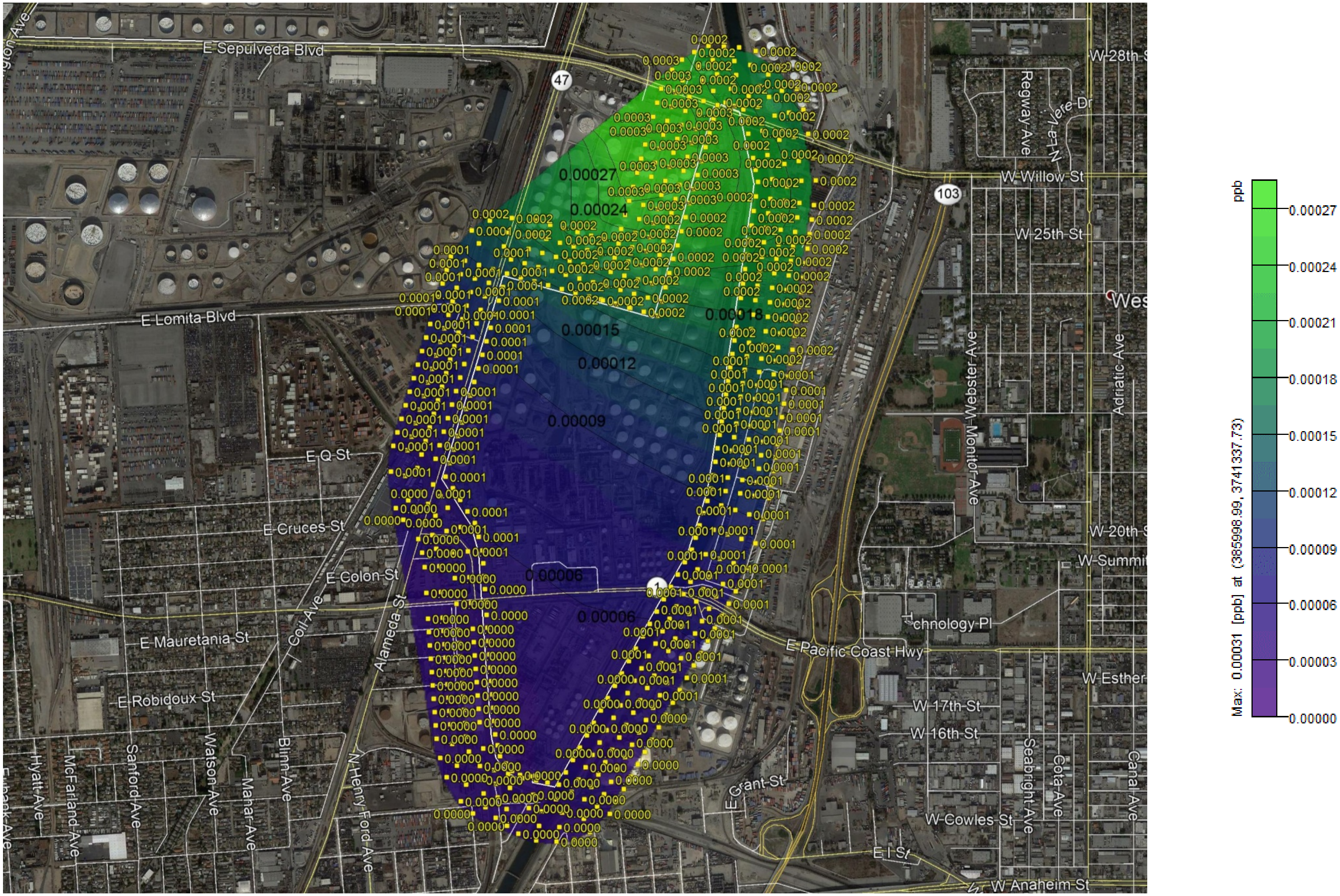
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Acetaldehyde 5-Year Average Concentrations (ppb), Tesoro Refinery, Wilmington



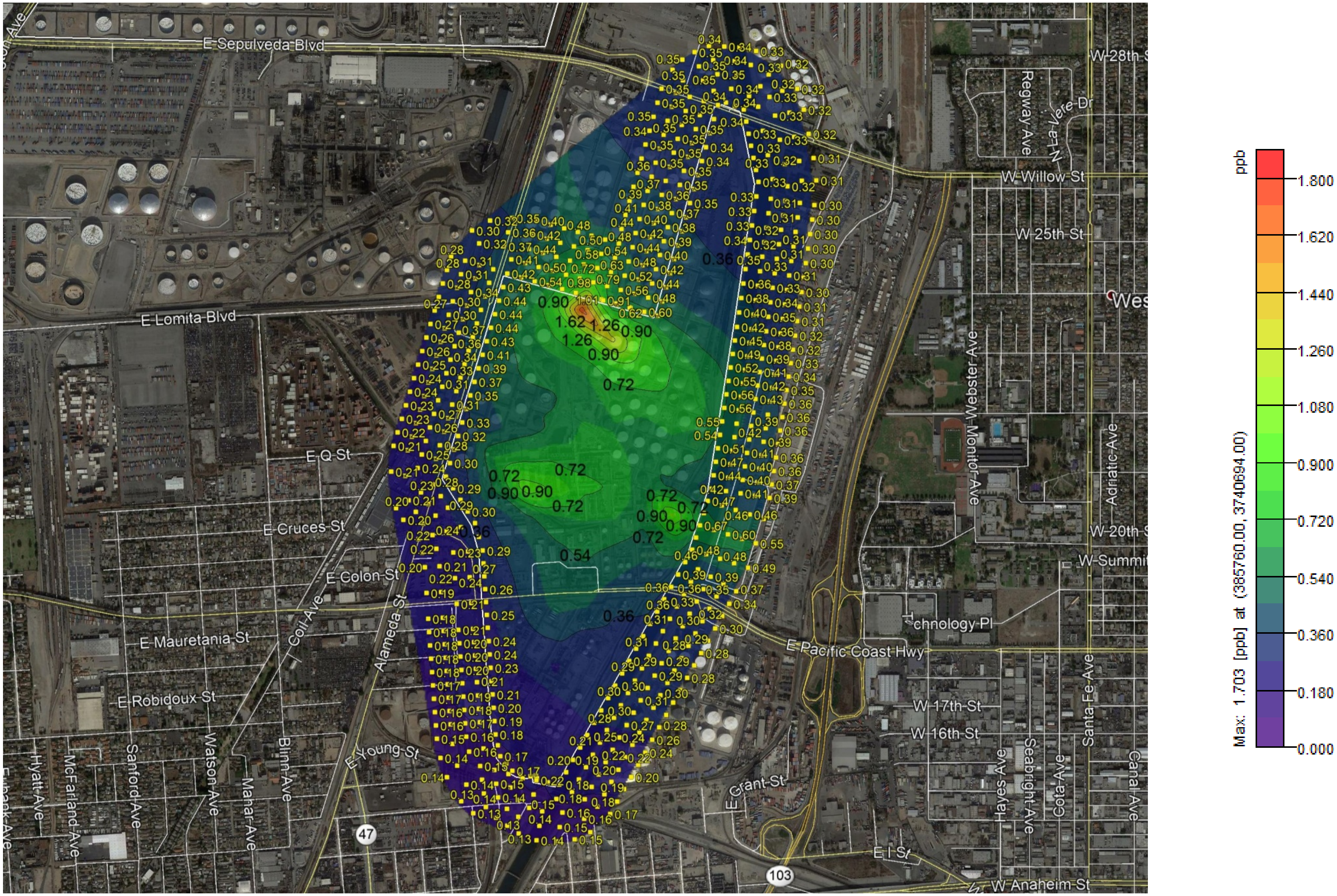
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Acrolein 5-Year Average Concentrations (ppb), Tesoro Refinery, Wilmington



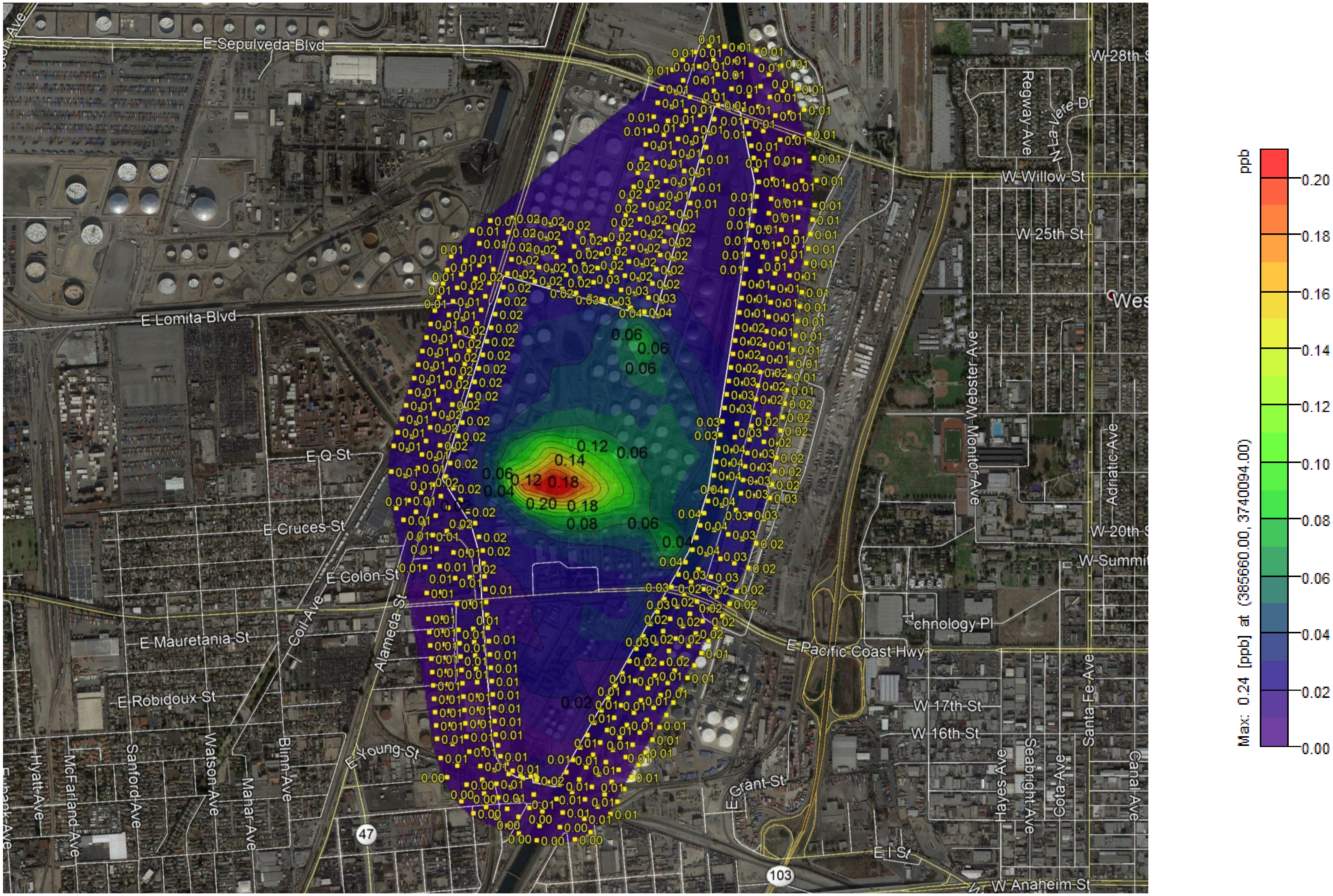
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Ammonia 5-Year Average Concentrations (ppb), Tesoro Refinery, Wilmington



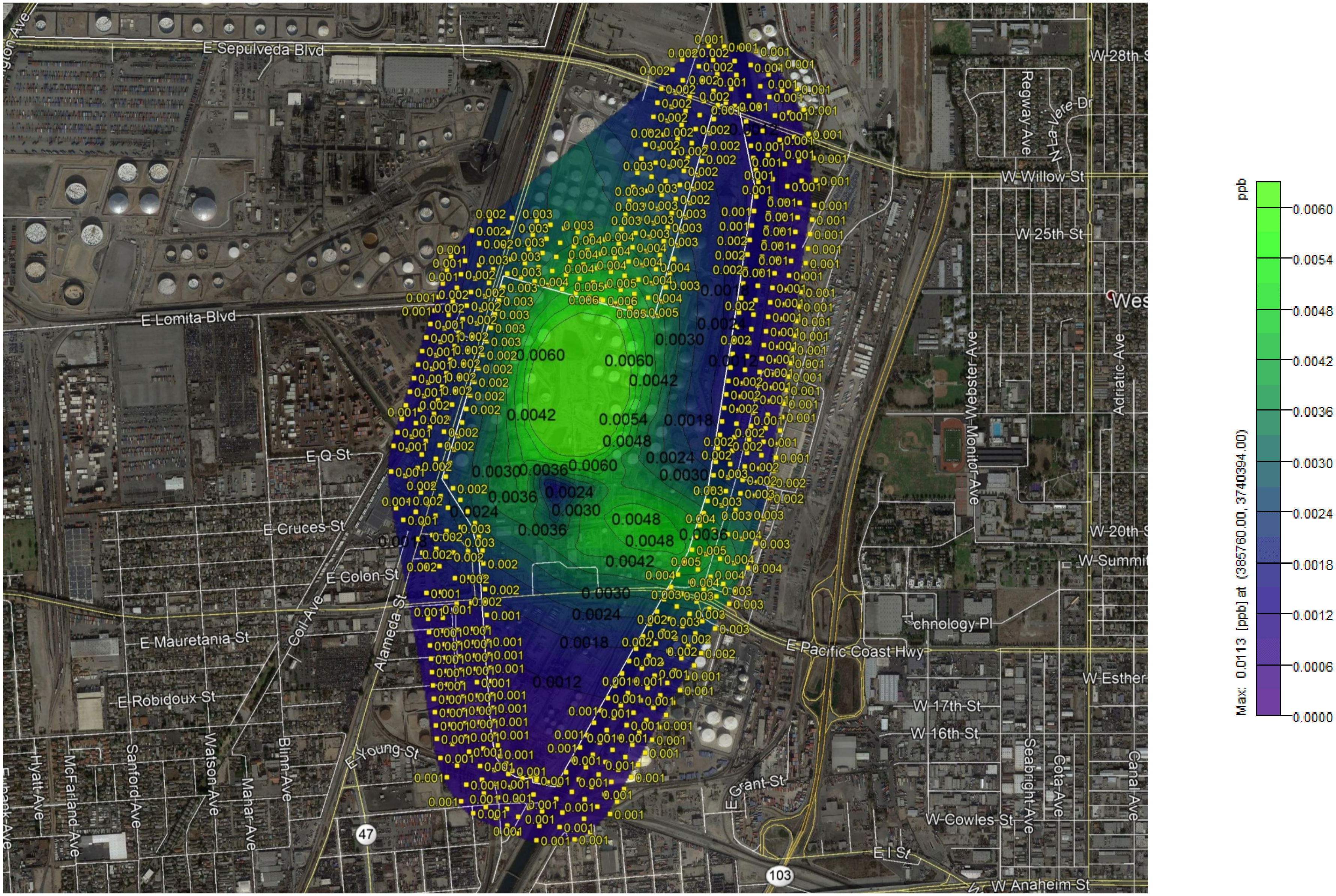
Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Benzene 5-Year Average Concentrations (ppb), Tesoro Refinery, Wilmington



Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Carbonyl Sulfide 5-Year Average Concentrations (ppb), Tesoro Refinery, Wilmington



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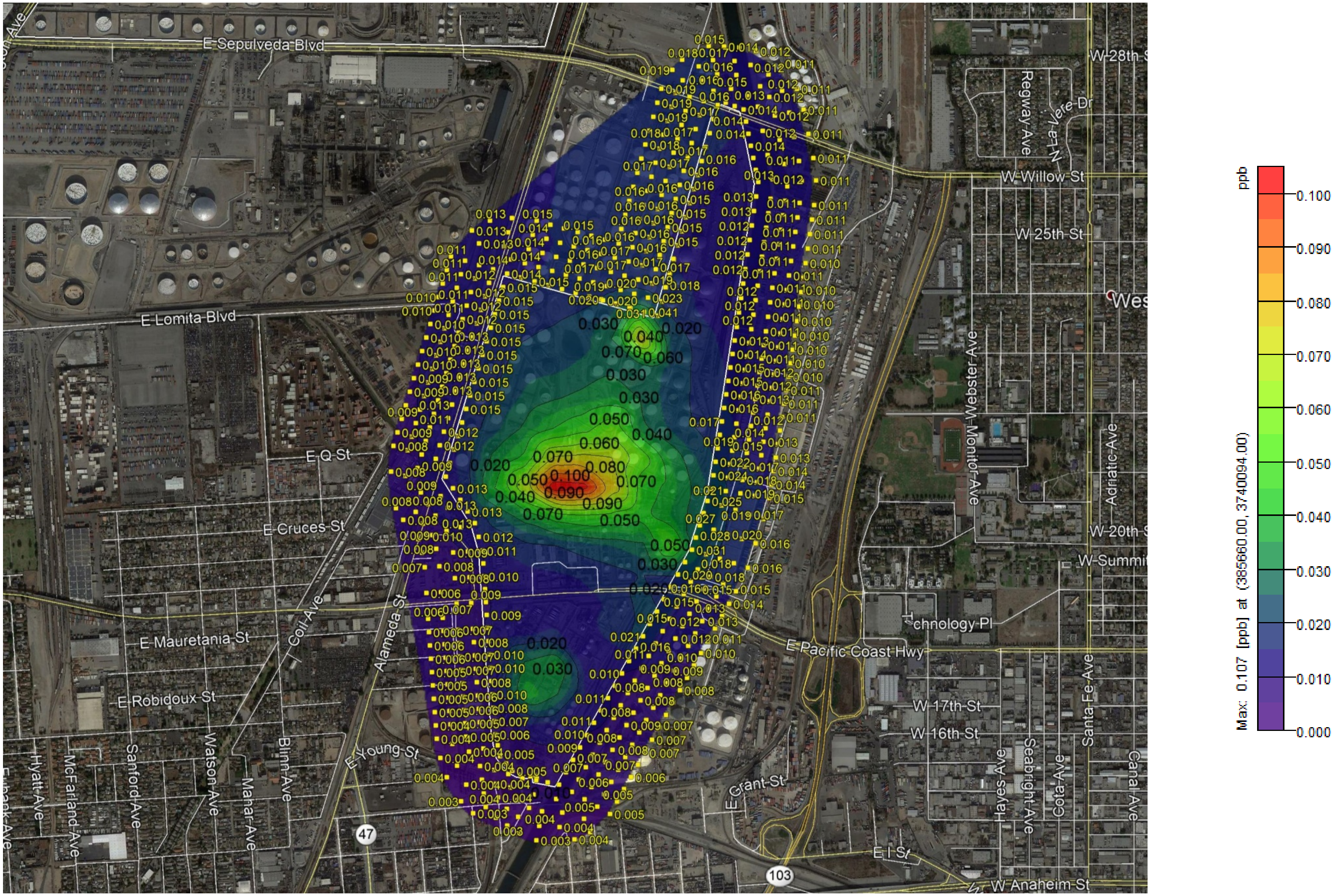
Ethylbenzene 5-Year Average Concentrations (ppb), Tesoro Refinery, Wilmington



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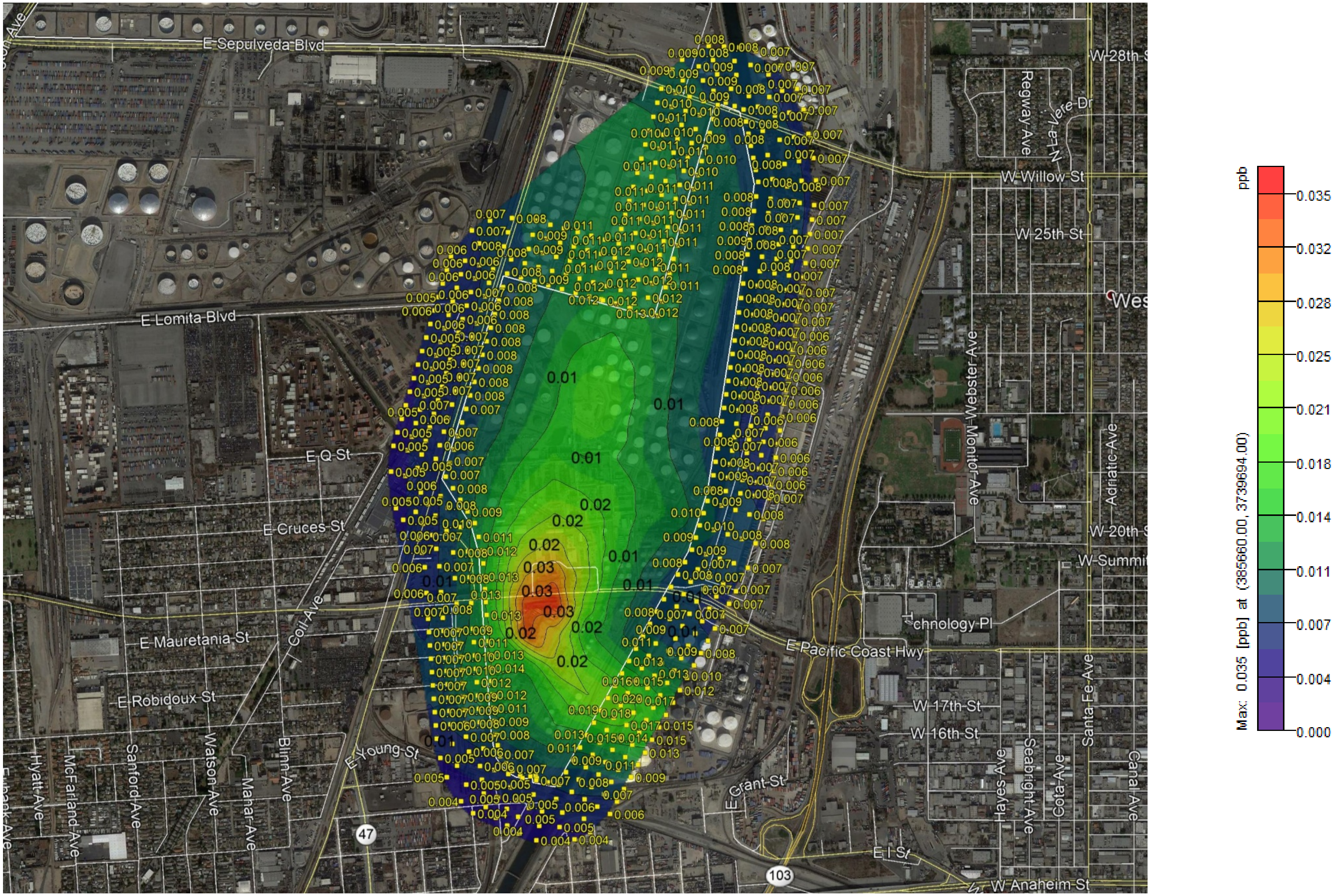
Formaldehyde 5-Year Average Concentrations (ppb), Tesoro Refinery, Wilmington



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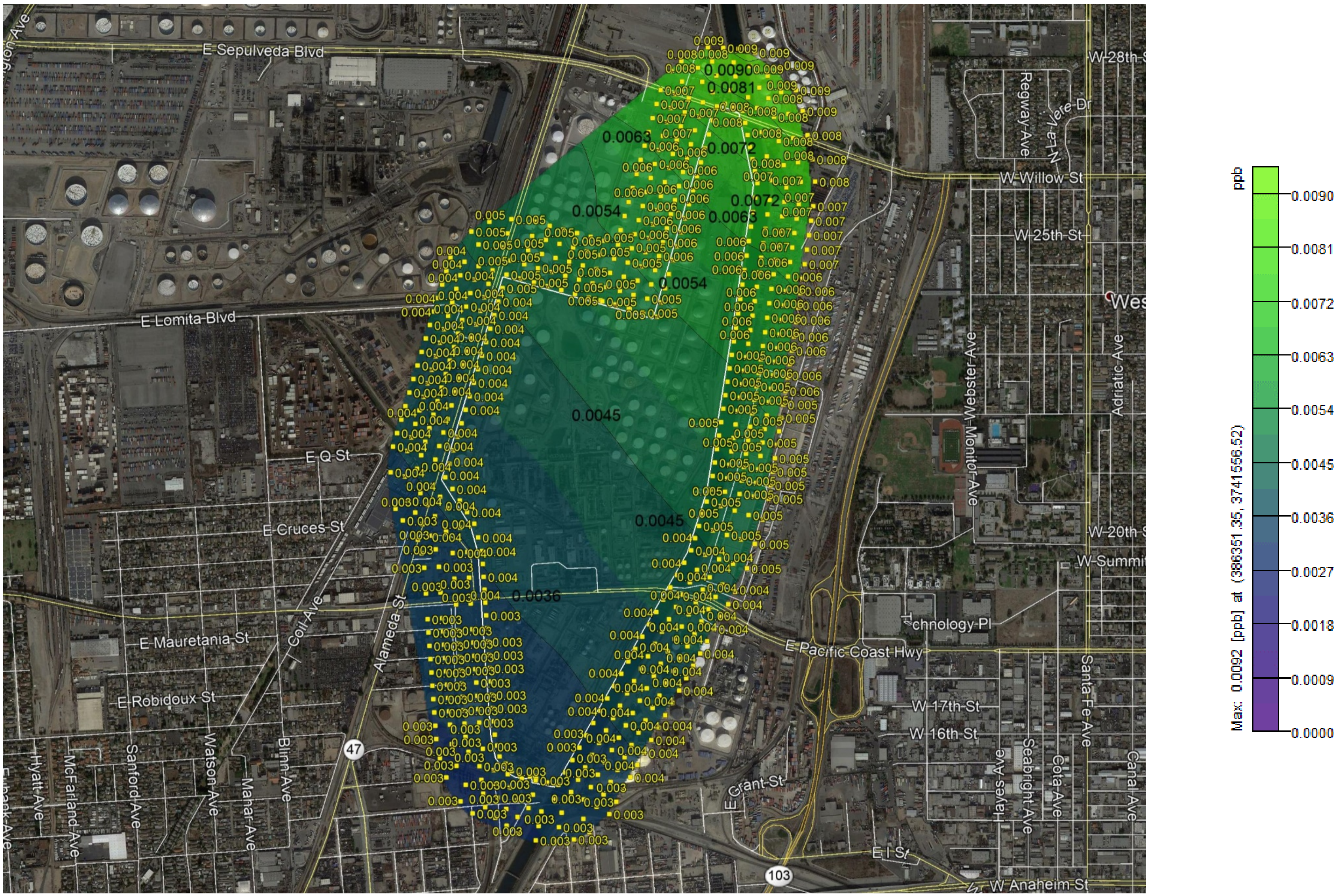
Hydrogen Cyanide 5-Year Average Concentrations (ppb), Tesoro Refinery, Wilmington



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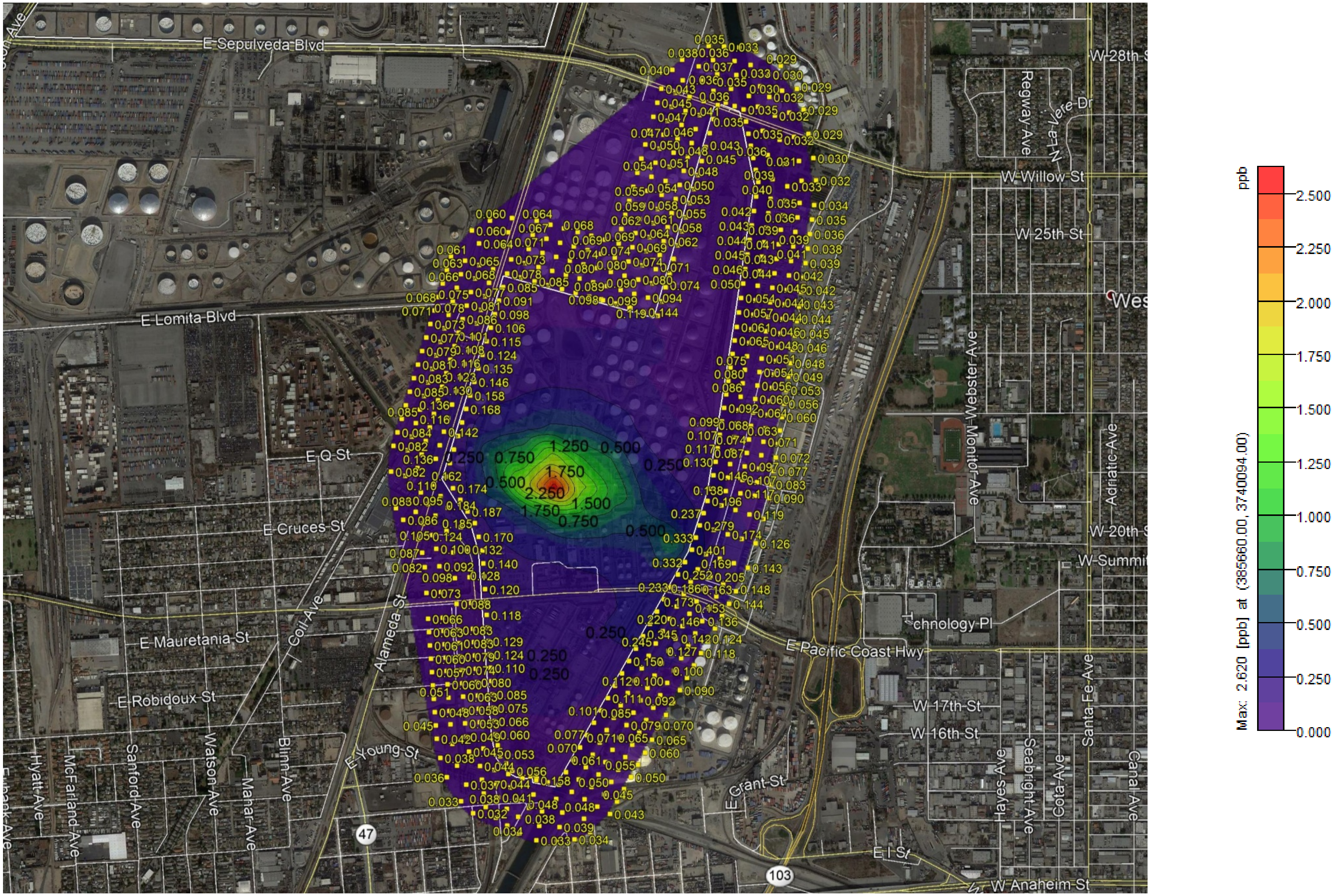
Hydrogen Sulfide 5-Year Average Concentrations (ppb), Tesoro Refinery, Wilmington



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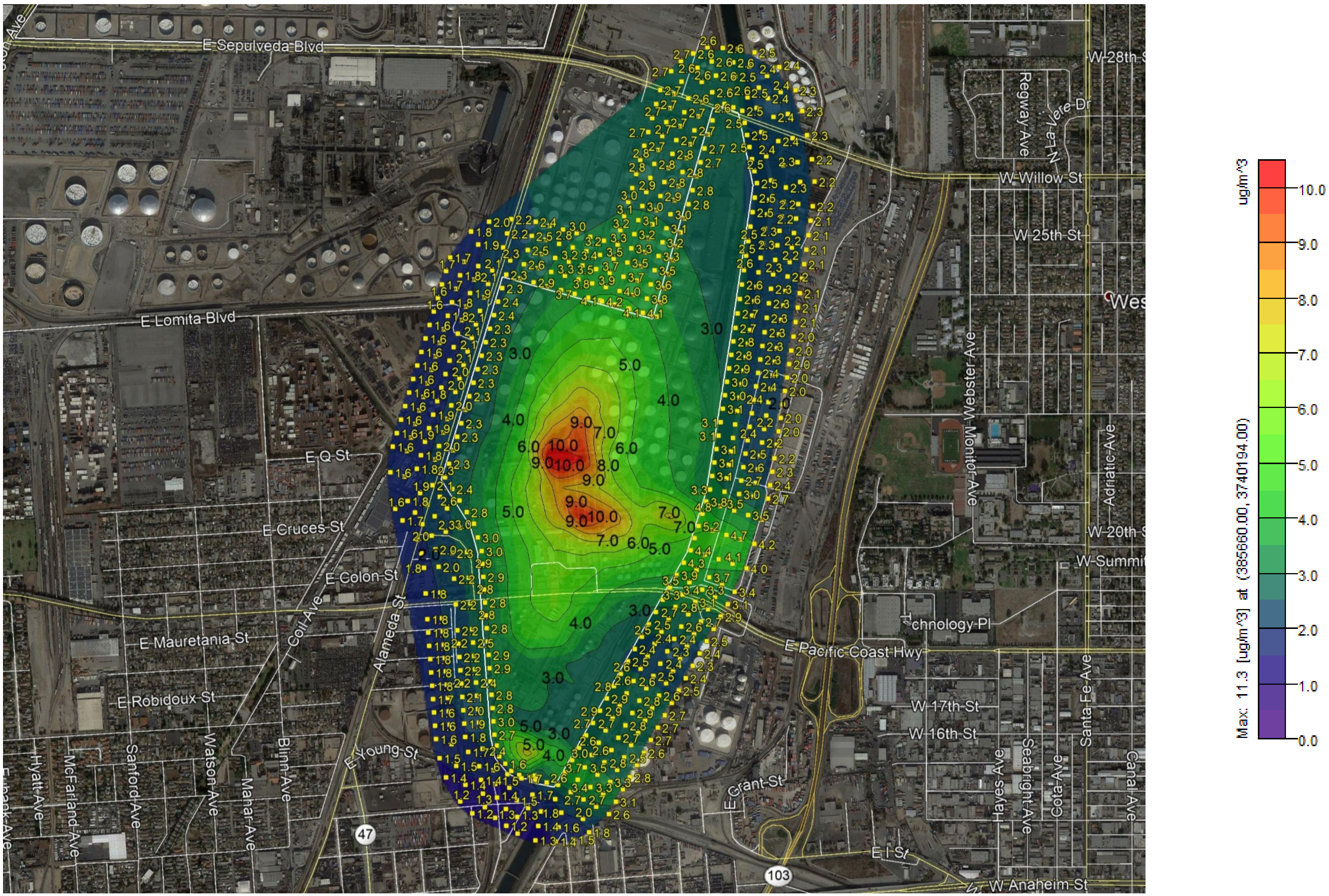
NOx 5-Year Average Concentrations (µg/m3), Tesoro Refinery, Wilmington



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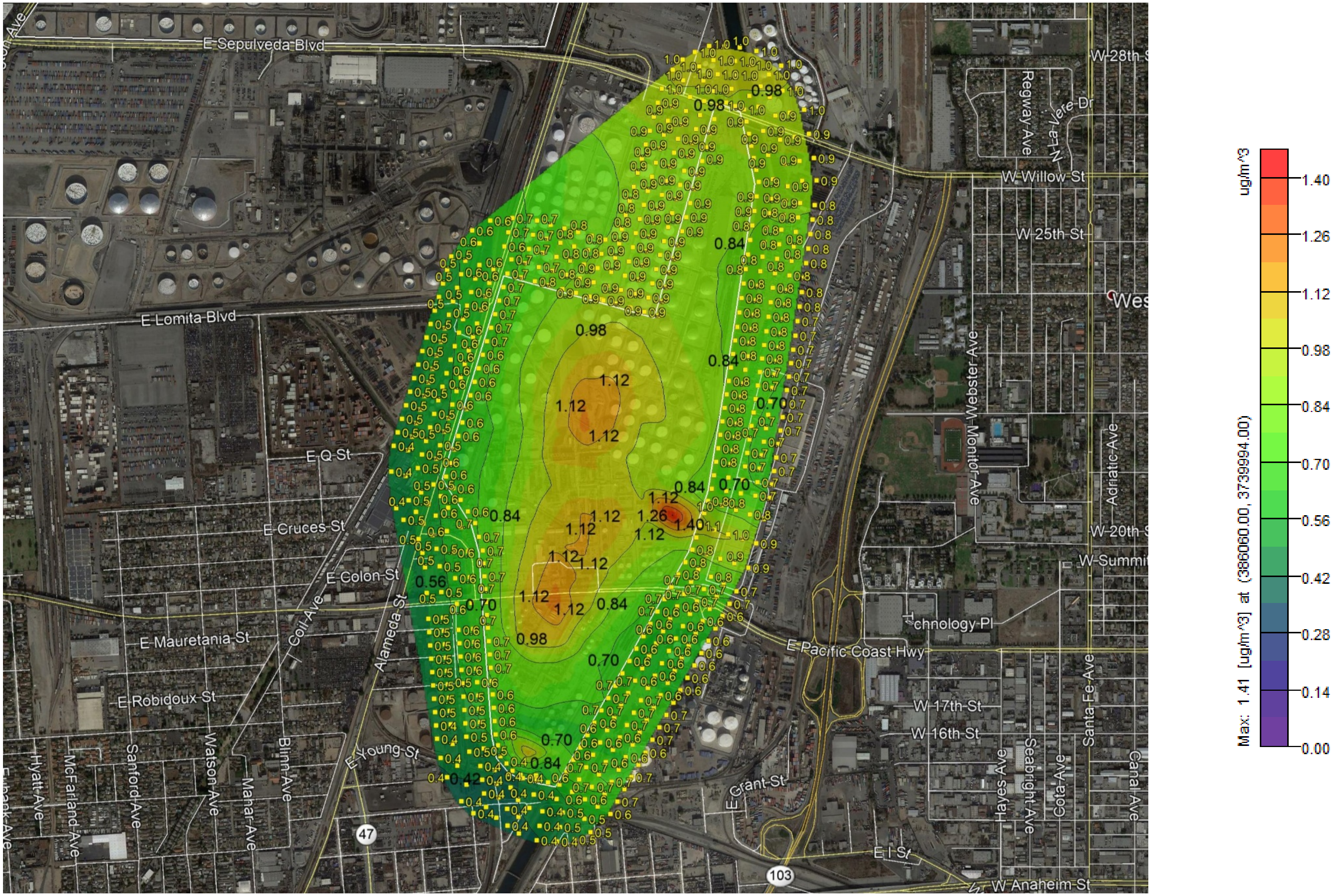
SOx 5-Year Average Concentrations (µg/m3), Tesoro Refinery, Wilmington



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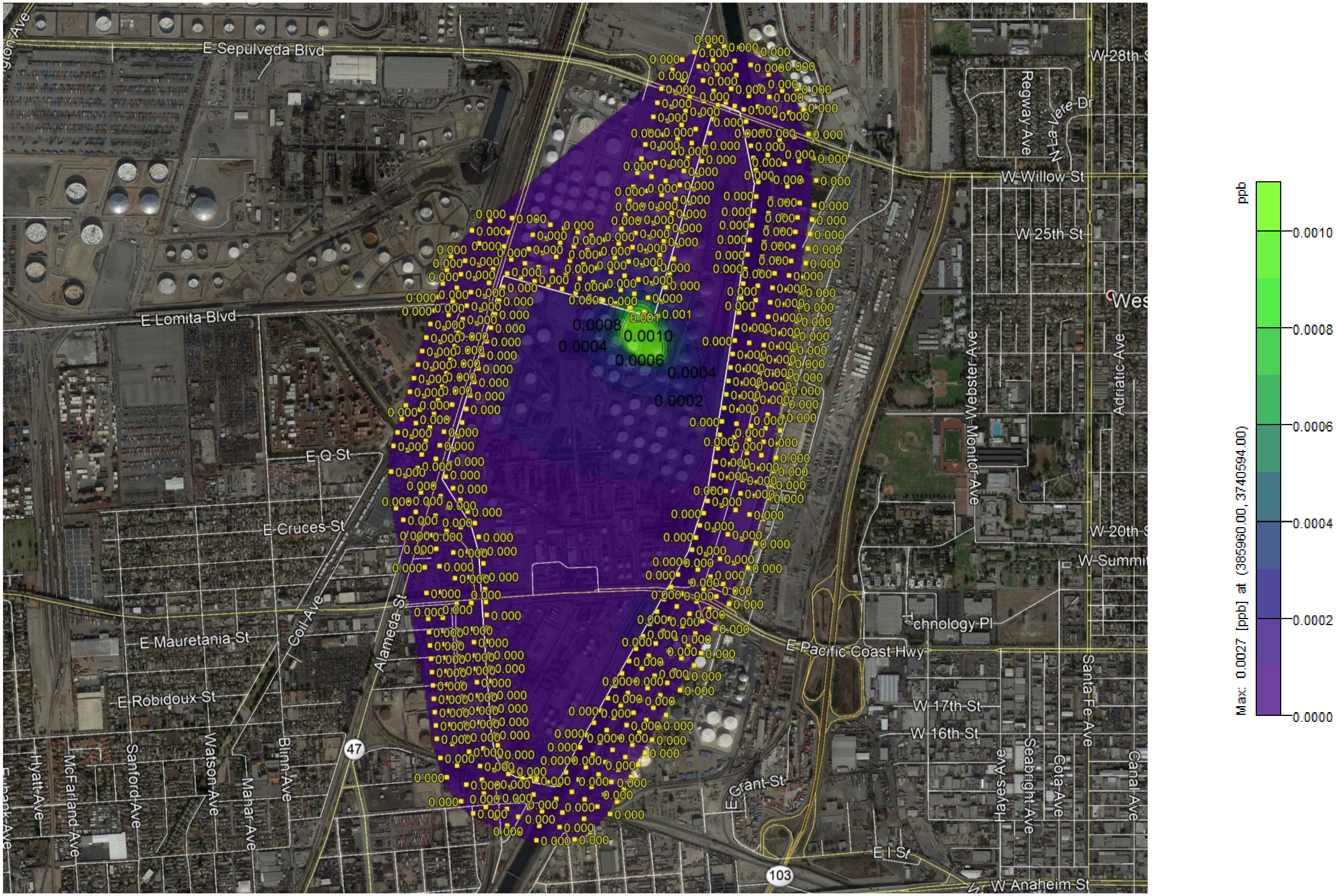
Styrene 5-Year Average Concentrations (ppb), Tesoro Refinery, Wilmington



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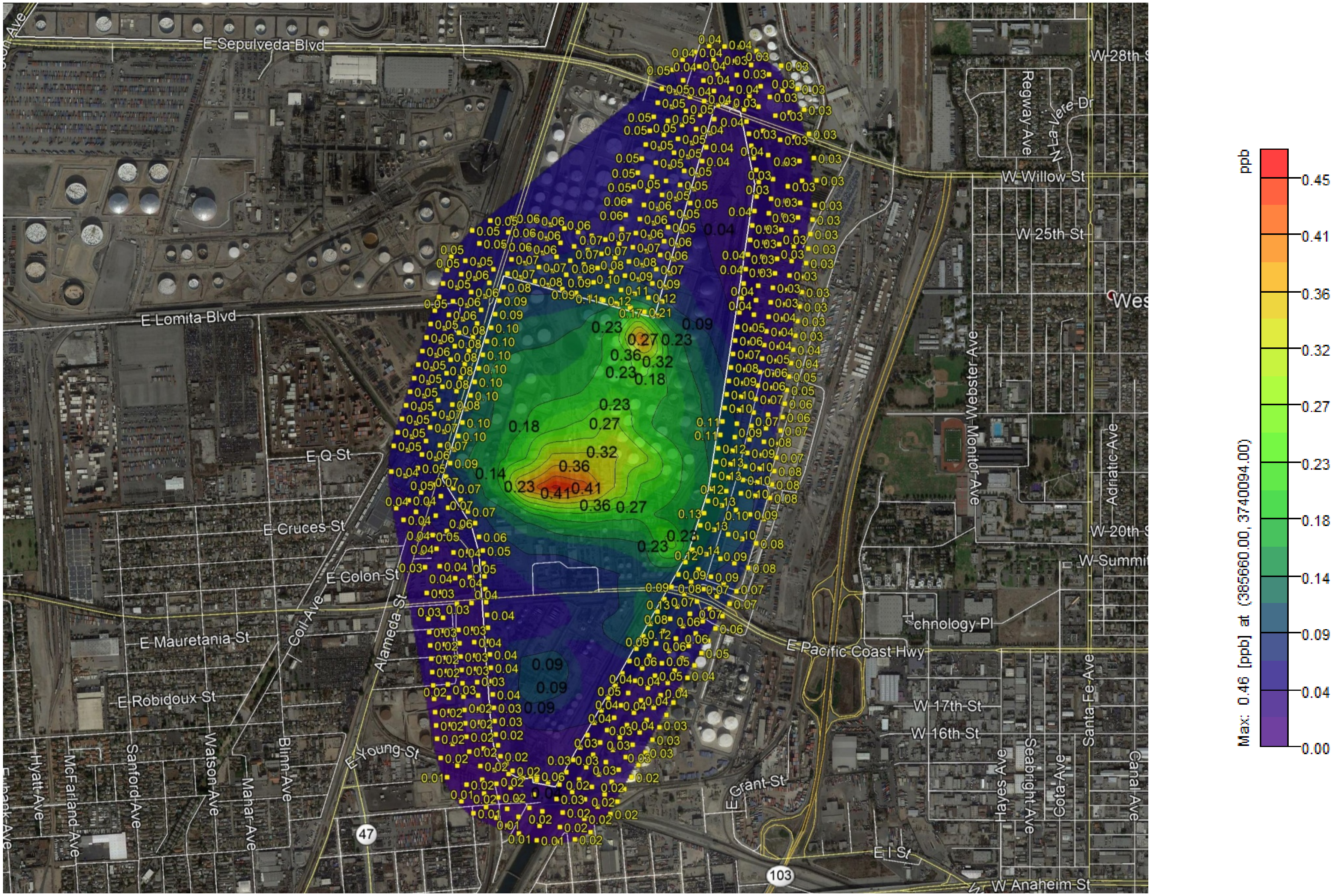
Toluene 5-Year Average Concentrations (ppb), Tesoro Refinery, Wilmington



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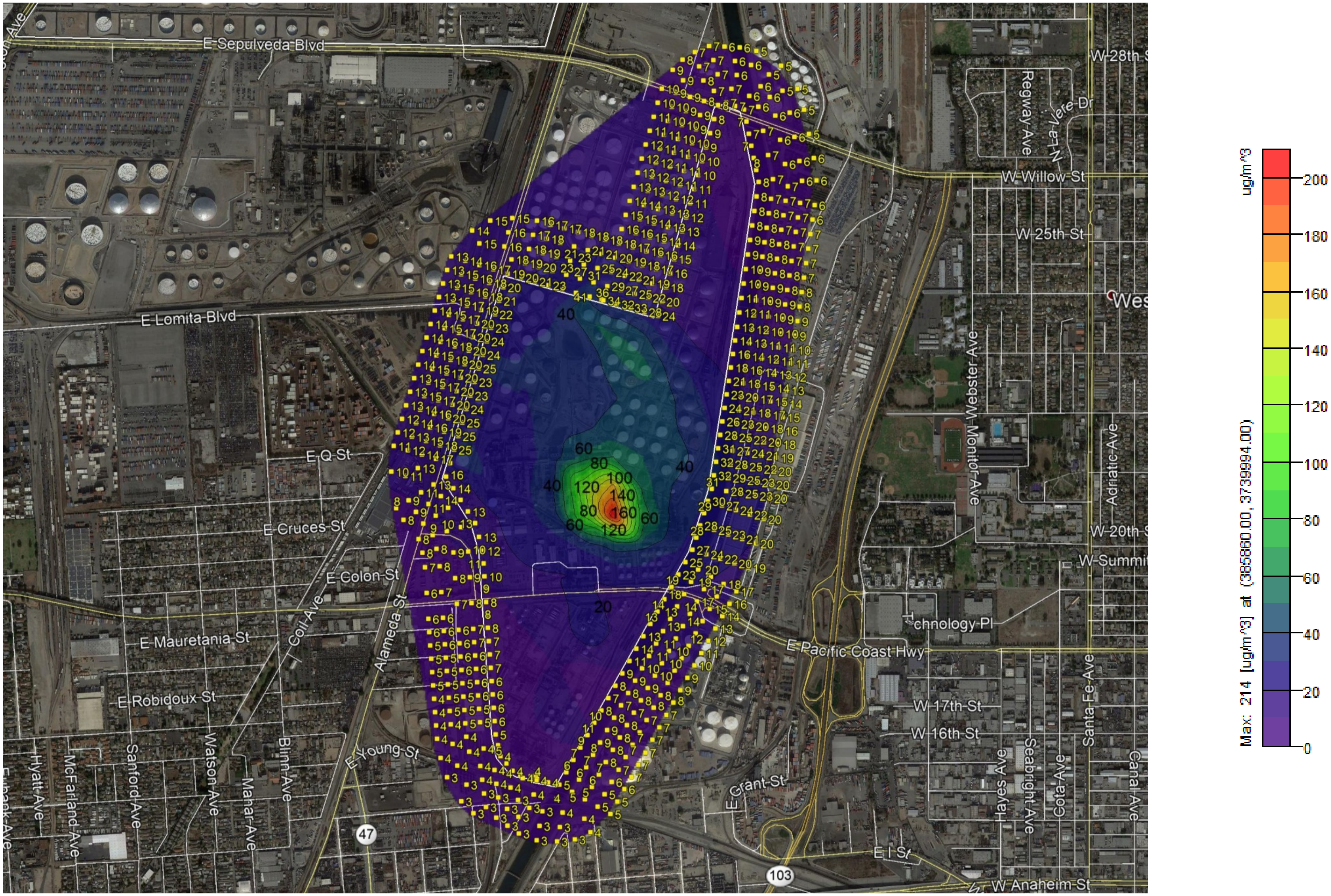
VOC 5-Year Average Concentrations (µg/m3), Tesoro Refinery, Wilmington



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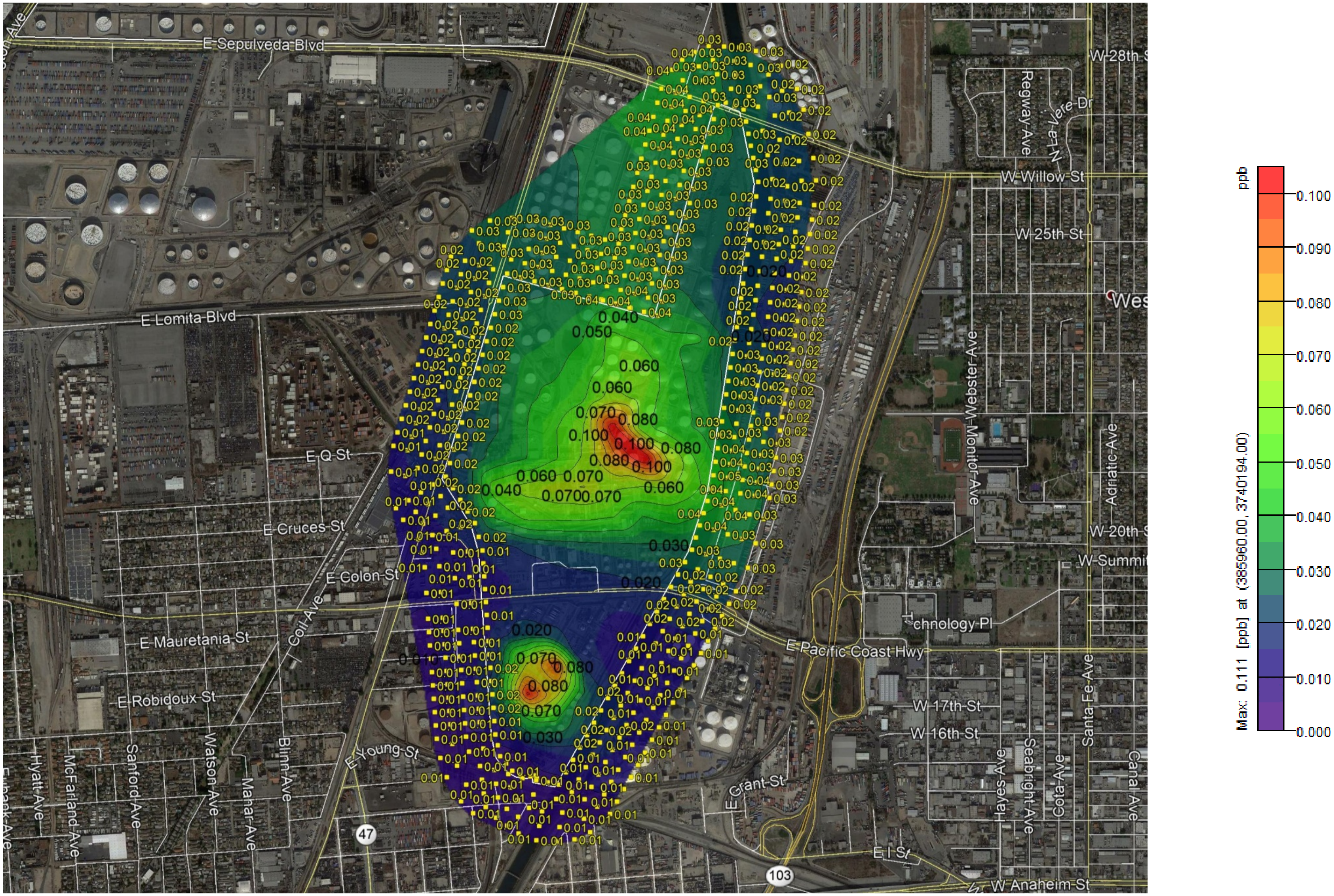
Xylenes 5-Year Average Concentrations (ppb), Tesoro Refinery, Wilmington



Worst-Case Scenario Using 2015 Emissions and 2012-2016 MET Data

Appendix D. Quality Assurance Project Plan

Quality Assurance Project Plan

Prepared by

Tesoro Refining & Marketing Company LLC
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STI-919048-7037-QAPP

November 15, 2019

Approvals

Quality Assurance Project Plan

Fenceline Monitoring for the Tesoro Refinery in Carson and Wilmington, California

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Signature	Date
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South Coast Air Quality Management District	

Contents

Figures

Tables

1. Project Background and Management

1.1 Background

1.1.1 Purpose

Tesoro Refining & Marketing Company will conduct air quality monitoring at its Los Angeles Refinery in Carson and Wilmington, California, in response to the South Coast Air Quality Management District's (SCAQMD) Rule 1180.[1] The monitoring will follow a facility-specific air monitoring plan consistent with the SCAQMD's Refinery Fenceline Air Monitoring Plan Guidelines.[2] Rule 1180 requires routine monitoring near the fencelines of all South Coast refineries for specific air compounds, with data reported to the public.

1.1.2 Rationale

Rule 1180 requires fenceline monitoring of multiple compounds to "provide air quality information to the public about levels of various criteria Rule 1180 (R1180) compounds, volatile organic compounds, and other compounds, at or near the property boundaries of petroleum refineries and in nearby communities."[1] In its monitoring plan, Tesoro will conduct open-path and point compound monitoring and meteorological measurements to meet the regulations.

This quality assurance project plan (QAPP) documents the measures that the project team will take to ensure that the data collected meet quality requirements. This document will be reviewed annually and updated as needed.

1.2 Roles and Responsibilities

This project involves refinery staff; contractors; and quality-assurance, field, and website personnel. Figure 1 shows an organization chart for the project.

[1] Refinery Fenceline and Community Air Monitoring (Rule 1180; approved by the SCAQMD on December 1, 2017). Available at http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/r1180.pdf?sfvrsn=9.

[2] South Coast Air Quality Management District SCAQMD (2017) Refinery Fenceline Air Monitoring Plan Guidelines. December. Available at http://www.aqmd.gov/docs/default-source/rule-book/support-documents/1180/rule-1180-guidelines.pdf.

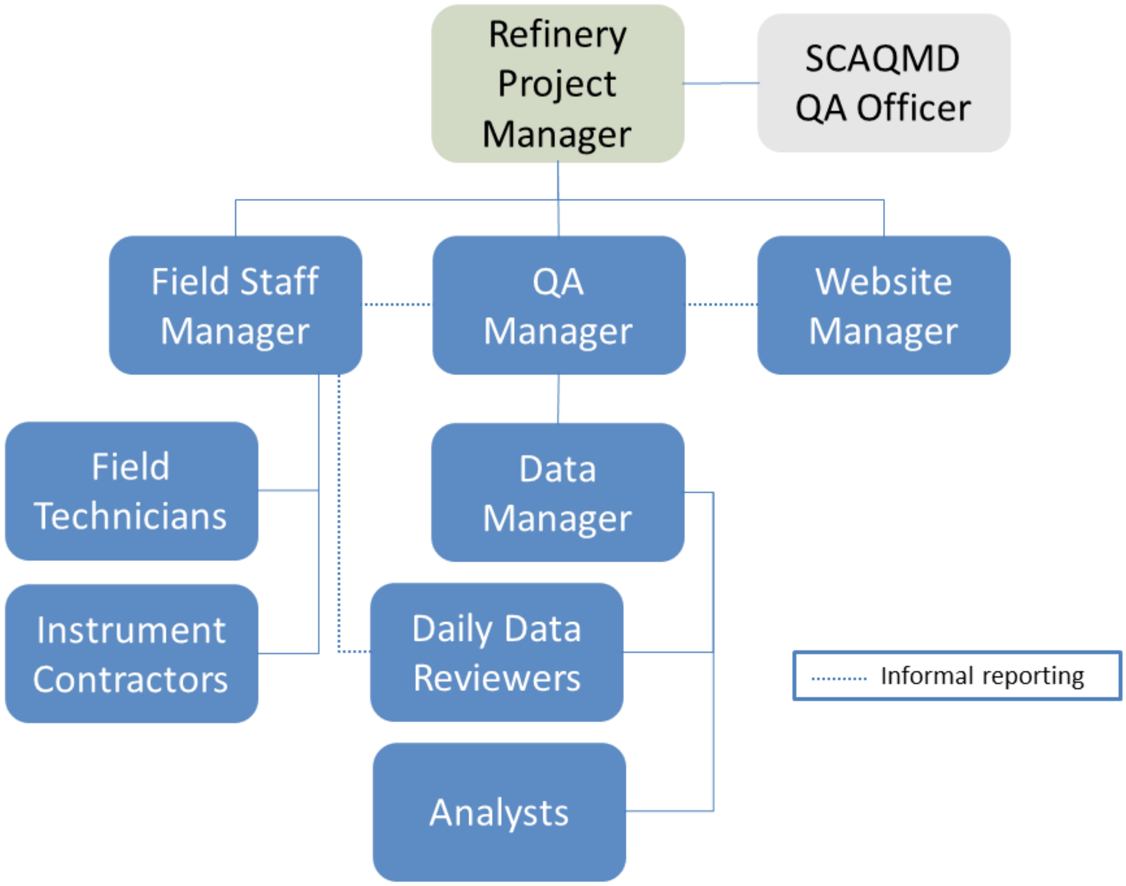

Figure 1. Organizational chart for the Tesoro LAR refinery fenceline monitoring project.

The overall project will be run by a **Project Manager** appointed by the refinery. This PM acts as the central point of contact for the SCAQMD and the QA Manager, Field Staff Manager, and Website Manager. The PM is responsible for overseeing the project and reporting directly to the SCAQMD.

The **QA Manager** is responsible for ensuring the quality of data collected in this project. The QA Manager oversees data collection and review, provides QA oversight during the study, and oversees and reports on QA activities to the Refinery PM and SCAQMD QA Officer. The QA Manager oversees daily data review and data management; works with the Field Staff Manager to ensure that any data issues are addressed promptly by the field technicians; and works with the Website Manager to ensure that data provided to the public are of high quality.

The **Field Staff Manager** ensures that field technicians (site operators) are meeting the requirements of the project. The Field Staff Manager coordinates staff coverage and serves as a technical resource for site measurements.

Field Technicians/Site Operators perform instrument maintenance. The technicians ensure that all measurements are collected in accordance with standard operating procedures (SOPs), standard methods, and regulations, where applicable. Technicians perform the required quality checks on instruments and document all work in site logs.

The **Instrument Contractors** provide technical support for the instruments deployed in the field.

The **Data Manager** is responsible for ensuring that daily data review is conducted, that data that fail auto-screening are inspected, and that data validation follows the proper schedule and procedures. The Data Manager is also responsible for delivering the validated data to the PM.

Daily data review and data validation are conducted by experienced air quality analysts. The **Data Reviewers** communicate with the Data Manager when there are issues and may also interact with the Field Technicians when they notice an issue that needs to be addressed.

The **Website Manager** is responsible for properly displaying data on the website, managing inquiries from the public, and ensuring that validated data are available for download on a quarterly basis. Automated alerts will notify the Website Manager when the real-time data are not available on the website. This manager will be responsible for assessing and fixing data communication and other information technology–related issues concerning the website and data system.

2. Measurements

2.1 Instrument Selection and Descriptions

The required list of compounds to be measured is presented in Table 1. These compounds will be measured at a 5-minute resolution. Because of the distances that need to be covered by measurements (hundreds of meters), the data time-resolution requirements (5 minutes), and current state of measurement technology, open-path instruments (UV-DOAS and FTIR) were selected for measuring all compounds except for black carbon and H_2S, which will be measured by point instruments.

Table 1. Compounds listed in Table 1 of Rule 1180.

Air Pollutants
Criteria Air Pollutants
Sulfur Dioxide
Nitrogen Oxides
Volatile Organic Compounds (VOCs)
Total VOCs (Non-Methane Hydrocarbons)
Formaldehyde
Acetaldehyde
Acrolein
1,3-Butadiene
Styrene
BTEX Compounds (Benzene, Toluene, Ethylbenzene, Xylenes)
Other Compounds
Hydrogen Sulfide
Carbonyl Sulfide
Ammonia
Black Carbon
Hydrogen Cyanide

Along all measurement paths (see Section 2.2), SO_2 and benzene, toluene, ethylbenzene, and xylenes (BTEX) will be measured by monostatic *Ultra Violet-Differential Optical Absorption Spectroscopy* (*UV-DOAS*) with a xenon light source. The xenon light is required to achieve measurements over paths that are about 300 to 600 meters long and to achieve the minimum detection limits (MDL) for BTEX, as required by SCAQMD. The analyzer records the intensity of light at discrete wavelengths. Any UV-absorbing gas that is present in the beam absorbs at a specific wavelength of light. Each gas has a unique absorbance fingerprint (i.e., the ratios between the absorbance at several different wavelengths are unique to that gas). The analyzer compares regions within the sample absorbance spectra to the same regions within the reference absorbance spectra. The analyzer uses a classical least squares regression analysis to compare the measured absorption spectrum to calibrated reference absorption spectra files. Beer's Law is used to report gas concentrations. Though not written specifically for UV-DOAS, this approach is the same as that specified in the U.S. Environmental Protection Agency's (EPA) TO-16 Methodology.[3] Closeness of fit is indicated by the correlation coefficient (R^2) of agreement between the measured spectra and the reference spectra. The R^2 is provided with each concentration so that interference can be detected if it is present. Selection of regions of analysis that are free of absorbance due to other gases within the sample is the primary means of avoiding cross-interference. Spectral subtraction is used in cases with overlapping absorbance features; the subtraction technique is proprietary to the instrument manufacturer.

Total VOCs (non-methane hydrocarbons), formaldehyde, acetaldehyde, acrolein, styrene, carbonyl sulfide, hydrogen cyanide, NH_3, 1,3-butadiene, and BTEX will be measured with a *Fourier Transform Infrared spectroscopy (FTIR)* instrument. The FTIR operates by sending a beam of infrared light through the open air. The IR beam is reflected back to the analyzer by a retro-reflector array (monostatic), where the absorption due to target gases is measured and recorded. The analyzer uses a classical least squares regression analysis to compare the measured absorption spectrum to calibrated reference absorption spectra files according to the EPA's TO-16 Methodology. Beer's Law is used to report accurate gas concentrations. The FTIR operates on a similar premise as the UV-DOAS by using reference spectra. There are a variety of industry standard methods to mitigate interference from both water vapor and interference gases, including spectral subtraction, path length adjustments, and selecting isolated absorbance peaks for the gases of interest. Proprietary methods include multi-peak analytics.

Heavy fog may entirely block the signal from an open-path instrument and prevent data collection; however, even light fog can absorb the signal partially and interfere with measurements. Given that the refinery is near the coast, and some of the fenceline measurements are near cooling towers, fog events may impact open-path measurements at times, especially during the nighttime and early morning hours. Visibility measurements will be made at four representative locations in order to provide operational verification of fog events.

[3] Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air. Compendium Method TO-16. Long-Path Open-Path Fourier Transform Infrared Monitoring Of Atmospheric Gases (1999) EPA/625/R-96/010b.

Hydrogen sulfide will be measured by a Picarro G2204 H_2S analyzer. Black carbon will be measured by Magee Scientific AE33 Aethalometers.

Table 2 summarizes the estimated range of MDL and upper detection limits (UDL) for each R1180 compound by open-path instrument. The MDL is the lowest path-average concentration that can be measured at the path length, and the UDL is the highest path-average concentration that can be measured at the path length. Detection limits are approximate and are based on the theoretical capabilities of the instruments; however, they are supported by manufacturers' lab tests and real-world applications. Actual detection limits depend on atmospheric conditions and on the specific instrument used. The detection limits are for the average R1180 compound concentration along a path; narrow plumes that cover only a portion of the path would only be detected at a higher concentration than the MDL.

The MDL for the Picarro point H_2S monitor is listed by the manufacturer as 3 ppb. The detection limit for black carbon is less than 0.5 µg/m^3.

Table 2. Range of approximate open-path instrument minimum detection limits (MDL) and upper detection limits (UDL) in parts per billion (ppb) by technology, R1180 compound, and path length. Actual detection limits depend on atmospheric conditions.

		Shortest Path (244 m)		Longest Path (603 m)	
Technology	1180 Compound	MDL (ppb)	UDL (ppb)	MDL (ppb)	UDL (ppb)
FTIR	1,3-Butadiene	8	20,000	3	7,900
	Acetaldehyde	10	410,000	4	170,000
	Acrolein	31	180,000	12	74,000
	Ammonia	6	110,000	3	45,000
	Benzene	61	61,000	25	25,000
	Carbonyl Sulfide	2	TBD*	1	TBD*
	Ethylbenzene	51	77,000	21	31,000
	Formaldehyde	2	51,000	1	21,000
	Hydrocarbons	12	12,000	5	5,000
	Hydrogen Cyanide	3	41,000	1	17,000
	Nitrogen Dioxide	12	TBD*	5	TBD*
	Styrene	16	23,000	7	9,500
	Total Xylenes	610	150,000	250	62,000
UV-DOAS	Acrolein	17	390,000	7	160,000
	Benzene	1	65,000	0.2	26,000
	Ethylbenzene	4	45,000	2	18,000
	Sulfur Dioxide	6	85,000	2	34,000
	Toluene	2	92,000	1	37,000
	Total Xylenes	2	15,000	1	6200

*To be determined.

2.2 Monitor Siting Overview

2.2.1 Rationale

Tesoro will monitor concentrations across 21 paths (shown in Figure 2 and detailed in Table 3). The type of measurement for each path is indicated by the colored legend in Figure 2. H_2S and BC will be monitored separately, with point monitors located at seven locations near the open path monitoring sites. The two existing meteorological stations, which measure wind, temperature, relative humidity, solar radiation, and rain, are indicated in Figure 2. Tesoro selected these locations after considering dominant wind patterns, sources of potential air emissions on the refinery property, and nearby local receptors. Transmitter-detectors/analyzers will be located at sites labeled "A" (identified in Figure 2), and retroreflectors will be placed at the sites labeled "R". The exact paths may be adjusted, depending on final site logistics and exact instrument capabilities, particularly in regard to the maximum path lengths for which the instruments can reliably measure the compounds of interest.

2.3 Instrument Operations and Maintenance

Five instrument systems are included in this project: UV-DOAS, FTIR, point instruments for H_2S, black carbon, visibility measurements, plus meteorological data will be obtained from existing equipment at two locations in the refinery. Quality assurance is built into operations and maintenance. For all instruments, scheduled maintenance will occur monthly, quarterly, and/or annually. Emergency maintenance will occur as needed when problems are identified during daily data review and auto-screening of real-time data.

2.3.1 UV-DOAS

The Cerex UV-DOAS system is designed to require only modest service and maintenance. **Table 4** summarizes typical UV-DOAS maintenance activities as recommended by the manufacturer. These actions help ensure data integrity and maximize up-time. Table 10 (see Section 3) lists performance criteria related to the maintenance activities.

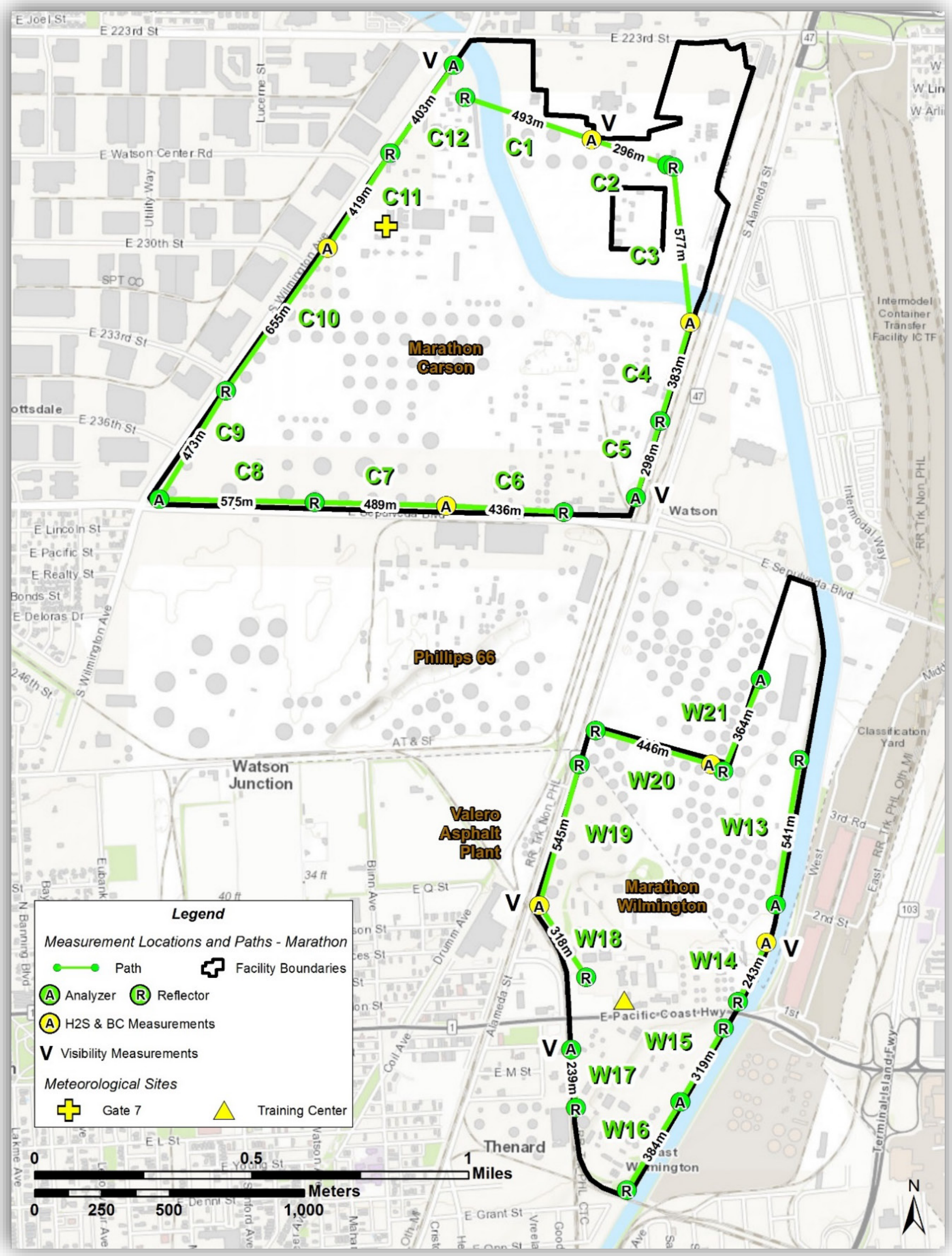

Figure 2. Location of sensors and measurement paths. Each path consists of a transmitter-detector (A) and a retroreflector (R).

Table 3. Location of the equipment to be used along the 21 paths.

		Skid floor	Skid/Analyzer GPS		Reflector GPS			Path	FTIR	UVDOAS	Points	Visibility	
PathID	DESCRIPTION	Elev(ft)	A-Lat	A-Long	Elev(ft)	R-Lat	R-Long	Length (m)			H_2S and BC		PathID
C1	PATH 1-2 SKID	12'	33°49'15.21"N	118°14'14.38"W	39'	33°49'20.13"N	118°14'32.67"W	493	√ *	√	√	√	C1
C2		12'	33°49'15.21"N	118°14'14.38"W	25'	33°49'12.30"N	118°14'3.39"W	296	√ *	√			C2
C3	PATH 3-4 SKID	10'	33°48'53.32"N	118°13'59.79"W	25'	33°49'12.03"N	118°14'2.55"W	577	√	√	√		C3
C4		10'	33°48'53.32"N	118°13'59.79"W	20'	33°48'41.40"N	118°14'3.95"W	383	√	√			C4
C5	PATH 5 SKID	12'	33°48'32.15"N	118°14'7.34"W	20'	33°48'41.40"N	118°14'3.95"W	298	√	√			C5
C6	PATH 6/7 SKID	18'	33°48'30.88"N	118°14'34.69"W	27'	33°48'30.30"N	118°14'17.72"W	436	√	√	√		C6
C7		18'	33°48'30.88"N	118°14'34.69"W	20'	33°48'31.13"N	118°14'53.72"W	489	√	√			C7
C8	PATH 8/9 SKID	18'	33°48'31.28"N	118°15'16.15"W	20'	33°48'31.13"N	118°14'53.72"W	575	√	√			C8
C9		18'	33°48'31.28"N	118°15'16.15"W	30'	33°48'44.45"N	118°15'6.74"W	473	√	√			C9
C10	PATH 10/11 SKID	30'	33°49'1.79"N	118°14'52.26"W	30'	33°48'44.45"N	118°15'6.74"W	655	√	√	√		C10
C11		30'	33°49'1.79"N	118°14'52.26"W	20'	33°49'13.28"N	118°14'43.38"W	419	√	√			C11
C12	PATH 12 SKID	12'	33°49'24.00"N	118°14'34.37"W	20'	33°49'13.28"N	118°14'43.38"W	403	√	√		√	C12
W13	PATH 13 SKID	12'	33°47'43.31"N	118°13'46.49"W	20'	33°48'0.81"N	118°13'43.30"W	541	√	√		√	W13
W14	PATH 14 SKID	12'	33°47'38.73"N	118°13'47.76"W	20'	33°47'31.59"N	118°13'51.79"W	243	√	√	√		W14
W15	PATH 15/16 SKID	18'	33°47'19.44"N	118°13'59.92"W	20'	33°47'28.37"N	118°13'53.74"W	319	√	√			W15
W16		18'	33°47'19.44"N	118°13'59.92"W	20'	33°47'8.72"N	118°14'7.46"W	384	√	√			W16
W17	PATH 17 SKID	12'	33°47'25.61"N	118°14'15.73"W	20'	33°47'18.55"N	118°14'14.98"W	239	√	√		√	W17
W18	PATH 18/19 SKID	18'	33°47'42.85"N	118°14'20.61"W	25'	33°47'34.28"N	118°14'13.72"W	318	√	√	√	√	W18
W19		18'	33°47'42.85"N	118°14'20.61"W	20'	33°47'59.95"N	118°14'15.02"W	545	√	√			W19
W20	PATH 20 SKID	12'	33°48'0.12"N	118°13'56.03"W	20'	33°48'4.02"N	118°14'12.78"W	446	√	√	√		W20
W21	PATH 21 SKID	12'	33°48'10.47"N	118°13'49.00"W	20'	33°47'59.33"N	118°13'54.28"W	364	√	√			W21

* panning head for one FTIR.

Table 4. Typical schedule of maintenance activities for the UV-DOAS.

Activity	Monthly	Quarterly	Annually
Visually inspect the system.	✓		
Inspect optics on detector and retro-reflector; clean if necessary.	✓		
Inspect system filters.	✓		
Confirm the alignment to verify there has not been significant physical movement. Note: this is automatically monitored as well.	✓		
Download data from detector hard drive and delete old files to free space, if needed.	✓		
Ensure there are no obstructions between the detector and the retro-reflector (such as equipment, vegetation, vehicles).	✓		
Change out the UV source.		✓	
Replace ventilation exit and intake filters.		✓	
Clean optics on detector and retro-reflector.		✓	
Realign system after service.		✓	
Check system performance indicators.		✓	
Perform bump test (simulates system-observed gas content at the required path average concentration) to verify the system can detect at or below a lower alarm limit.		✓	
Review and test light and signal levels. Check average light intensity to establish baseline for bulb change frequency.		✓	
Verify system settings.			✓

2.3.2 H_2S Analyzer

Table 5 describes maintenance actions for the Picarro G2204 H_2S analyzer, including cleaning and inspections and their required frequencies for routine system management. The frequency of preventive maintenance depends on the operating environment and may be adjusted beyond manufacturers' recommendations once the instruments are deployed in the field. On an as-needed basis, system status alarms will alert operators to specific issues needing to be addressed.

Table 5. Typical schedule of maintenance activities for the Picarro G2204.

Maintenance Action	Frequency
Inspect sample line tubing	Monthly, or during a site visit
Inspect and clean sample inlet	Monthly, or during a site visit
Inspect and clean insect/moisture trap	Monthly, or during a site visit
Backup data to external storage	Monthly
Gas verification test	Quarterly
Replace particulate filter	Annually

2.3.3 FTIR

Maintenance activities for the FTIR and the UV-DOAS are similar. The Cerex FTIR system is also designed to require only modest service and maintenance. Table 6 summarizes FTIR maintenance activities, as recommended by the manufacturer. Preventative maintenance frequency depends on the operating environment and may need to be adjusted. On an as-needed basis, system status alarms may alert operators to specific issues that need to be addressed.

Table 6. Typical schedule of maintenance activities for the FTIR.

Activity	Monthly	Quarterly	Semi-Annually	Annually	~18 months	Five Years
Visually inspect the system.	✓	✓		✓		
Inspect and clean AC system exterior heat sink.			✓			
Inspect and clean AC system interior heat sink.				✓		
Confirm the alignment to verify there has been no significant physical movement. [a]	✓					
Download data from detector hard drive and delete old files to free space, if needed.	✓					
Ensure there are no obstructions between the detector and the retro-reflector (such as equipment, vegetation, vehicles).	✓					
Change out the IR source.						✓
Realign system after service.		✓				
Check system performance indicators.		✓				
Perform bump test.		✓				
Review and test light and signal levels. Check average light intensity to establish baseline for IR Source change frequency and retro-reflector wear.				✓		
Verify system settings.		✓				
Replace cryocooler or swap detector module assembly.					✓	

[a] This is monitored both manually and automatically.

2.3.4 Aethalometer

The Magee AE33 Aethalometer system is designed to require only modest service and maintenance. Table 7 summarizes typical Aethalometer maintenance activities as recommended by the manufacturer. Preventive maintenance frequency depends on the operating environment and may need to be adjusted beyond manufacturers' recommendations once the instruments are deployed in the field. On an as-needed basis, system status alarms will alert operators to specific issues needing to be addressed.

Table 7. Typical schedule of maintenance activities for Aethalometers.

Activity	Monthly	Semiannual	Annual
Visually inspect the system	✓		
Inlet flow check	✓		
Clean size selective inlet	✓		
Clean cyclone	✓		
Verify date and time	✓		
Inspect optical chamber and clean as necessary		✓	
Calibrate flow		✓	
Change bypass cartridge filter			✓
Install new tape roll	✓		
Calibrate tape sensor		✓	

2.3.5 Visibility Sensor

Table 8 depicts the maintenance activities that will be performed during each site visit to ensure the visibility instruments are performing correctly.

Table 8. Routine maintenance checklist.

Item	Action
Visibility Sensors	Inspect the sensor for dirt, spider webs, birds' nests, or other obstructions. Clean the glass windows.
	Check that the cable connections are secure.
	Perform the zero and light-level calibration every quarter

2.3.6 Overview of Data Flow, Spectrum Generation, and Quality Control Parameters for Open-Path Instruments

This section provides context for some of the parameters used in QA/QC procedures for open-path systems. Most open-path monitors generate an absorption spectrum; from this spectrum, concentrations are derived. Generation of spectra using UV-DOAS and FTIR is a distinctly different process that is dependent on the hardware used. However, in all cases the result is similar: a spectral file containing absorbance as a function of wavelength. To generate absorbance using FTIR and DOAS, the logarithm of the ratio of two "single beam" transmission spectra is calculated (one being the sample and the other being the "background"). For ambient open-path measurements, one single beam must be measured or estimated using a spectrum that does not contain the analyte of interest—this is the so-called "background." In practice, the single gas MDL for one gas in otherwise clean air will be lower than that for air that contains interfering gases (gases that absorb in the same spectral region as the target gas). Also affecting the MDLs is the total averaging time. The greater the number of scans averaged, the lower the MDL due to the reduction of noise. Several other parameters obtained during the collection of spectra may be used to quality-control the data.

For DOAS measurements, light is collected for a period of time (the so-called "integration time"). The instrument software determines the integration time, based on a minimum amount of light needed. Long integration times can indicate low light levels and can be used to flag data as questionable (due to the presence of fog or an object blocking the beam). For example, each manufacturer specifies a range of acceptable integration times for their system. A related metric that is applicable to all open-path measurements is the overall intensity of the light received at the analyzer; this is termed "signal strength." For certain DOAS measurements, signal strengths greater than 92% are generally acceptable; below these values, the data will be flagged as questionable. For typical FTIR measurements, the values are generally lower because of absorption by atmospheric gases (CO_2,

H_2O, etc.). For example, acceptable values for a manufacturer's FTIR system may be between 10% and 100%.

In order to derive concentrations, spectra must be fit using a least squares procedure. A "library" spectra of known compounds is used to best fit the experimental spectra collected at the monitoring site. The goodness of fit is quantified using the well-known R^2 value which is equal to 1 for a perfect fit and zero for a measurement that is not correlated to the library spectra. Some instrument manufacturers use the term "percent match," which is $100*R^2$. Therefore, a positive detection of an analyte must satisfy an R^2 threshold value. For example, the fit to methane might have an R^2 of 0.70 or greater to be considered a valid detection.

2.4 System Corrective Actions

Corrective action will be taken to ensure that data quality objectives are met. Table 9 lists the types of issues that require corrective actions. (This table is not all-inclusive; additional checks may be added as the project progresses.) The daily data reviewers will review data to identify issues and will work with the field technicians and instrument contractors to resolve issues that need to be addressed on site.

Table 9. Potential sampling and data reporting problems and corrective actions.

Item	Problem	Action	Notification	Person Responsible
Erratic data	Possible instrument malfunction	Contact Field Manager and Instrument Contractor	Document in logbook, notify Field Manager	Field technician
Power	Power interruptions	Check line voltage, reset or restart instruments	Document in logbook, notify Field Manager	Field technician
Data downloading	Data will not transfer to the DMS	Contact Field Manager and Instrument Contractor	Document in logbook, notify Field Manager and Website/Data System Manager	Field technician
Supplies and consumables	Essential supplies run low	Contact Field Manager	Document in logbook, notify Field Manager	Field technician
Access to sites	Technician cannot access the sites	Contact Project Manager	Document in logbook, notify Project Manager	Field technician

Item	Problem	Action	Notification	Person Responsible
Instrument Light level	A low light level alert is observed	Site visit for realignment or source replacement - possible manufacturer support	Document in logbook, notify Field Manager	Field Technician
Website	Website is down	Contact Website Manager	Notify Project Manager	Website Manager

3. Quality Objectives and Criteria

3.1 Data and Measurement Quality Objectives

3.1.1 Discussion

To ensure quantitative accuracy of field measurements, measurement performance criteria are established as part of the monitoring design. These criteria specify the data quality needed to minimize decision errors based on the data. Data quality is defined in terms of the degree of precision, accuracy, representativeness, comparability, and completeness needed for the monitoring. Of these five data quality indicators, precision and accuracy are quantitative measures, representativeness and comparability are qualitative measures, and completeness is a combination of quantitative and qualitative measures.

The quantitative performance criteria for the data collected by the fenceline measurement systems are provided in the following tables. The principal quantitative indicators of data quality for this study are data completeness, precision, and accuracy. Table 10 shows the data completeness objectives for all collected data for several time intervals. For communication purposes, the Percent Data Valid—the percentage of data values that are valid divided by the number of captured data values, corrected for low-visibility conditions—will also be computed. The FTIR analyzer at location C1/C2 is using a panning head to do measurements on both paths with the same analyzer; thus data is collected on each path during every other 5-minute period and fewer data points are collected each hour.

Table 10. Data completeness objectives.

Completeness Requirement	Relevant to
75% of scans (open-path) or of data (point monitors)	5-minute average data
75% of 5-minute data	1-hr average data
75% of daily data	Monthly, quarterly, or annual average data

Other factors that affect data availability include instrument bump tests (approximately every quarter for a few hours), annual maintenance, and other maintenance (e.g., replacement of UV bulbs for the UV-DOAS after every 2,000 hours of use, roughly quarterly, and replacement of the FTIR cryocoolers every 18 months). Regular maintenance and careful, responsive operation will minimize instrument downtime. Table 11 shows the performance criteria for the fenceline monitoring systems.

Table 11. Performance criteria for the fenceline monitoring systems.

Sensor	Test	Acceptance Criteria for Precision and Accuracy
UV-DOAS	100 ppm p-Xylene; internal flow-through QA cell	±25%
FTIR	100 ppm isobutylene; internal flow-through QA cell	±25%
H_2S Point Monitor	0, 250, 150, 50 ppb	±20%
Aethalometer	Flow meter, internal leak check	±10%
Temperature	Two-point test	±0.5°C
Relative Humidity	Hygrometer	±7%
Wind Speed	Starting threshold test; transfer function test	±0.25 m/s below 5 m/s and ± 5% above 5 m/s
Wind Direction	Angle verification	±5 degrees
Visibility	Extinction	±10%

3.2 Precision Checks, Bump Tests, and Verification

All measurements outlined here are subjected to precision and accuracy tests. During these tests, a number (N) of replicated measurements (x_i) of a standard reference material of known magnitude (x_{std}) will be measured. Here, an acceptable number if trials will be defined as N≥15. The average value of these measurements is calculated as

$$\bar{x} = \frac{\sum_i x_i}{N} \quad (1)$$

and the standard deviation (σ) as:

$$\sigma = \sqrt{\frac{\sum_i (x_i - \bar{x})^2}{N-1}}. \quad (2)$$

From these definitions, %Accuracy is defined as:

$$\%Accuracy = \frac{\bar{x} - x_{std}}{x_{std}} \times 100\% \quad (3)$$

and precision as the coefficient of variation (CV) expressed as a percentage:

$$Precision \equiv \%CV = \frac{\sigma}{\bar{x}} \times 100\% \quad (4)$$

3.2.1 Open-Path Instruments

For the UV-DOAS system, a bump test will be performed quarterly the first year or so and semi-annually in later years as high-quality, reliable system performance is confirmed. In the field, a bump test (simulates system-observed gas content at the required path average concentration) is used to verify that the system can detect concentrations at or below a set level of concern.

For the FTIR, bump tests will be performed onsite quarterly the first year or so and semi-annually in later years as high-quality, reliable system performance is confirmed.

For the open-path systems, precision will be measured by evaluating the variance of R1180 compound concentrations during a period of low variability, when atmospheric influence on variability is assumed to be minimal. Five-minute data will be selected during periods of low variability, but when concentrations are well above the MDL. The precision can then be evaluated by calculating the coefficient of variation (CV) during the period of low variability, as shown in **Equation 4** on the previous page. If there are no periods of low variability with concentrations above the MDL, bump test data will be used to calculate precision.

3.2.2 Point Instrument for H_2S

Either a standard gas calibrator or a permeation device will be used to generate the zero and span checks for the Picarro G2204. Either the gas calibrator or a portable calibration gas generator with the permeation device to generate the zero and span checks. Permeation devices contain the pure calibration chemical in a two-phase equilibrium between the gas and liquid phases. The permeation device emits the calibration compound through a semi-permeable membrane at a known constant rate, provided the temperature is constant. One of the main functions of the Dynacal 120 is to keep the permeation device at a fixed temperature with a known carrier gas flow so that a constant, known gas concentration is generated. When the permeation devices are not being used, they will be stored under dry nitrogen at a temperature between 20° and 25°C. Prior to calibration, the permeation device will be allowed to equilibrate for 24 hours. The permeation devices will be certified every six months either gravimetrically or against an acceptable reference method.

3.2.3 Black Carbon

The Aethalometers will subjected to both a leak check and flow rate check once per month. Every six months, the neutral-density filter kit will be used to confirm the absorption constant for the monitor.

3.2.4 Meteorological Equipment

Annual audits will be conducted for the meteorological stations. The meteorological instrumentation calibrations will be conducted with reference to the recommendations in the EPA's *Quality Assurance Handbook for Air Pollution Measurement Systems (QA Handbook), Volumes I, II, and IV.*[4, 5, 6]

As part of the calibration process, each instrument will be first tested to determine whether it is operating within the prescribed operational limits and whether non-routine maintenance or adjustments are required. Based on an instrument's response to the initial performance test with respect to the minimum acceptable performance criteria, the instrument would then be repaired, calibrated, or in rare cases, replaced. A standard form will be used to document the performance of each sensor before and after any adjustments.

Wind Speed

An anemometer drive will be used to simulate known wind speeds. The propeller torque disc will be used to determine the anemometer starting threshold. Sensor starting threshold is a shaft-bearing efficiency measurement only.

The wind speed propeller and tail assembly will be visually inspected to ensure that they are not cracked or damaged. The propeller will be removed and the sensor shaft immobilized to simulate zero wind speed. The anemometer drive will be connected to the sensor shaft to simulate wind speeds between 0 and 44.1 m/s. The wind speed will be determined from wind speed coefficients provided by the manufacturer. The remote processing unit (RPU) responses will then be compared to the calculated values.

Wind Direction

A vane angle fixture will be used to set the vane to known directions at 45-degree intervals, moving clockwise and then counter-clockwise, through the full 360-degree range of the monitor. A pocket transit mounted on a tripod will be used in conjunction with a vane alignment rod to determine the

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[4] U.S. Environmental Protection Agency (1994) Quality assurance handbook for air pollution measurement systems, Volume I: a field guide to environmental quality assurance. Report prepared by the U.S. Environmental Protection Agency, Research Triangle Park, NC, EPA/600/R-94/038a. Available at https://www3.epa.gov/ttn/amtic/qalist.html.

[5] U.S. Environmental Protection Agency (2008) Quality assurance handbook for air pollution measurement systems, Volume IV: meteorological measurements version 2.0 (final). Prepared by the U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Air Quality Assessment Division, Research Triangle Park, NC, EPA-454/B-08-002, March. Available at https://www3.epa.gov/ttn/amtic/qalist.html.

[6] U.S. Environmental Protection Agency (2017) Quality assurance handbook for air pollution measurement systems, Volume II: ambient air quality monitoring program. Prepared by the U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Air Quality Assessment Division, Research Triangle Park, NC, EPA-454/B-17-001, January. Available at https://www3.epa.gov/ttnamti1/qalist.html.

orientation of the wind monitor on the tower mast. A vane torque gauge will be used to determine the vane starting threshold.

Ambient Temperature

A NIST-traceable thermometer will be used as the calibration transfer standard. The ambient temperature sensor will be tested by comparing the current ambient temperature, as measured by the digital thermometer, to the temperature reading from the RPU. The transfer standard will be placed near the temperature probe in a shaded location. Both sensors will be allowed to reach equilibration before the responses of the respective sensors are recorded.

Relative Humidity

A NIST-traceable psychrometer will be used as the calibration transfer standard. The relative humidity sensor will be tested by comparing the current relative humidity as measured by the psychrometer to the relative humidity reading from the RPU. The psychrometer will be placed near the temperature probe in a shaded location. Both sensors will be allowed to reach equilibration before their responses are recorded.

Visibility Sensors

A calibration kit for the Campbell 120A visibility sensor will be used to test the visibility sensors. The calibration kit consists of foam blocks for checking the sensor zero, and a scatter plate for checking the sensor span. The calibration fixture is assigned a factory-traceable extinction coefficient used to calculate the expected values during calibrations.

3.2.5 Instrument or Standards Certifications

For factory calibrations, a certification of the standard gases used will be requested from the manufacturer. Standards will not be used past their expiration date. If an expired standard is used, it shall be recertified by the manufacturer. The spectral file generated during tests will be documented and archived.

4. Data Management

Data quality criteria are evaluated through (1) automatic data checks conducted through the data management system and (2) data review by trained analysts (daily data review and periodic, more thorough validation).

4.1 Data Acquisition and Communications

In near-real time, data are transferred from in-field instruments through a data acquisition system (DAS) to a Data Management System (DMS) using cellular modem. Data are also stored onsite on instrument computers in case of cell modem failure. The DMS uses a Microsoft SQL relational database with stored procedures. These raw data are not yet intended for the public website.

The DMS automatically quality controls data, detects outliers and problems, generates reports, and creates alerts. The auto-screening and graphical capabilities will be used for continuous examination of data quality. The DMS will feed auto-screened data to the field operations website and notification system to inform/alert project and facility staff. The operations website will show maps and time series plots of all R1180 compounds listed in Table 1.

The automatically quality-controlled air quality data will be fed to the public website within 10 minutes after collection.

4.2 Automated Data Screening

Automated data screening is conducted within the DMS upon data ingest. Automated screening checks of data feeds are used to screen out invalid data for public display and are helpful to focus the data reviewer's efforts on the data that need the most attention. Initial screening checks, along with actions to be taken, are summarized in Table 12. The screening check concentration criteria are based on an analysis of expected instrument performance, concentration levels of concern by compound, and typical ambient concentrations by compound. All screening criteria (flags and rates of change) are preliminary and will be refined during the project based on actual observations. The DMS auto-screening checks that will be used include:

- **Range.** These checks will verify that the instrument is not reporting values outside of reasonable minimum and maximum concentrations.
- **Sticking.** If values are repeated for a number of sampling intervals, data will be reviewed for validity. Four or more repeated values may indicate that investigation is needed. Sticking checks will not be applied to data below the instrument detection limit.

- **Rate of Change.** Values that change rapidly without reasonable cause will be flagged and reviewed.
- **Missing.** If data are missing, data during those time periods will be coded as missing.
- **Sensor OP codes and alarms**. If the instrument assigns operation (OP) codes to data automatically (e.g., for bump tests or internal flow rate checks), the data will be reviewed, codes confirmed, and data flags checked.
- **Visibility impairment.** While the exact relationship between visibility and open-path measurements is not established, the expectation is that there would be no measurements when visibility is less than the twice the path length (two times the path length is used because the open-path sensor light travels to the mirror and back to the analyzer).

Additional parameters that may be monitored as indicators of data quality include data quality value for each concentration as reported by the instrument (i.e., correlation between measured and reference spectra), signal strength, wavelength versus intensity, and visual review of peaks. The data quality objectives will be developed after operating the monitoring system for one year. The automated data quality screening tool for data reliability will be modified after one year.

Data flags identified through auto-screening will be graphically reviewed internally during data validation (i.e., not in real time), and QC flags will be updated with daily and quarterly actions. DMS keeps track of data changes in its chain-of-custody feature—i.e., raw data are preserved as well as all changes.

Table 12. Initial screening checks for 5-minute data. All valid and flagged data values will be displayed to the public in real time. If data are invalid, they will not be included in the public display. All screening values below (flags and rates of change) are preliminary and will be refined during the project. During data validation, flagged data will be further investigated.

<table>
<tr><th rowspan="2">Measurement Compounds (units)</th><th colspan="7">Checks</th></tr>
<tr><th>Minimum Detection Limit (MDL):
If concentration is below MDL, flag as below MDL</th><th>Range:
If concentration is above value listed, flag as suspect and conduct investigation</th><th>Sticking:
If same value observed for four or more intervals, flag as suspect and conduct investigation</th><th>Rate of Change Between Intervals:
If concentration changes by more than value listed, flag as suspect and conduct investigation</th><th>Missing:
If data are missing, flag as missing and investigate cause</th><th>Sensor OP Code/Alarm:
If sensor indicates malfunction or bump test data, flag as appropriate</th><th>Visibility:
If visibility is less than 1,000 m and data are missing, flag as appropriate</th></tr>
<tr><td>SO_2 (ppb)</td><td rowspan="16">SAME FOR ALL COMPOUNDS</td><td>750</td><td rowspan="16">SAME FOR ALL COMPOUNDS</td><td>250</td><td rowspan="16">SAME FOR ALL COMPOUNDS</td><td rowspan="16">SAME FOR ALL COMPOUNDS</td><td rowspan="16">SAME FOR ALL COMPOUNDS</td></tr>
<tr><td>Nitrogen Dioxide (ppb)</td><td>750</td><td>250</td></tr>
<tr><td>Total VOCs (non-methane hydrocarbons) (ppb)</td><td>TBD</td><td>TBD</td></tr>
<tr><td>Formaldehyde (ppb)</td><td>135</td><td>45</td></tr>
<tr><td>Acetaldehyde (ppb)</td><td>780</td><td>260</td></tr>
<tr><td>Acrolein (ppb)</td><td>3.3</td><td>1.1</td></tr>
<tr><td>1,3-Butadiene (ppb)</td><td>900</td><td>300</td></tr>
<tr><td>Styrene (ppb)</td><td>14,700</td><td>4,900</td></tr>
<tr><td>Benzene (ppb)</td><td>27</td><td>9</td></tr>
<tr><td>Toluene (ppb)</td><td>29,400</td><td>9,800</td></tr>
<tr><td>Ethylbenzene (ppb)</td><td>1,380</td><td>460</td></tr>
<tr><td>Total Xylenes (ppb)</td><td>15,000</td><td>5,000</td></tr>
<tr><td>H_2S (ppb)</td><td>90</td><td>30</td></tr>
<tr><td>Carbonyl Sulfide (ppb)</td><td></td><td>270</td></tr>
<tr><td>NH_3 (ppb)</td><td>1,380</td><td>460</td></tr>
<tr><td>Black Carbon (μg/m^3)</td><td>30</td><td>10</td></tr>
<tr><td>Visibility (meters)</td><td>If value is <0, flag as suspect</td><td>1,000</td><td>Not applicable</td><td>Not applicable</td><td></td><td></td><td>Not applicable</td></tr>
</table>

4.3 Data Verification

4.3.1 Confirm Daily Operation

Operationally, data are reviewed daily by a data reviewer to assess instrument operation. This initial review, typically of a three- to five-day time-series plot of selected parameters for each instrument, allows the analyst to see common problems and verify instruments are operational. If it appears that an instrument is not operating, or the data are missing, the field operator will be notified and further investigation and corrective action, if needed, will be taken.

In addition to daily checks of the field website, an automated alerting system will let technicians and supervisors know when data have been missing for a specified period of time. Missing data may indicate a power issue, an instrument problem, or a data communication problem. The time period allowed for missing data will likely be adjusted as the project proceeds to reduce false or excessive alerting. The alerting will be set initially for 6 to 12 missing 5-minute values (i.e., 30 to 60 minutes).

4.3.2 Assess Data Reasonableness

Also operationally, the data reviewer quickly assesses whether the R1180 compound concentrations are reasonable with respect to the time of day, season, meteorology, and concentrations expected and observed along other paths. If anomalies are observed, additional analysis will be conducted to determine whether there is an instrument malfunction or the data are truly anomalous but explainable. Data reasonableness is also assessed more thoroughly during the data validation process.

4.4 Data QA Procedures

Raw data management occurs on a daily, monthly, quarterly, and annual basis. The DMS will be used to automatically quality control data, detect outliers and problems, and create alerts. The auto-screening and graphical capabilities will be used for continuous examination of data quality. The DMS will feed auto-screened data to the field operations website and notification system to inform project and facility staff. The operations website will show maps and time-series plots of the R1180 compounds, winds, and visibility data. The auto-QC'd air quality data will be fed to the public website in near-real time. The DMS data will be backed up on a daily basis.

All data produced by the instrument are initially considered **Level 0**. All Level 0 data values that are not associated with bump tests or other instrument maintenance will undergo basic automatic quality control and will be displayed to the public in near-real time (i.e., about 10 minutes or less). At this point, these data are considered **Level 0.5**. Automated screening checks of data feeds are helpful to focus the analyst's efforts on the data that need the most attention and are used to screen out invalid data. All data above notification threshold levels will be flagged as suspect for review and verification. Screening criteria (flags and rates of change) are preliminary and will be refined during the project based on actual observations and instrument performance.

Additional QC checks for the instruments are summarized in **Table 13**. Data that fail checks will be flagged in the DMS and brought to the attention of the reviewer. Data are invalidated only if a known reason can be found for the anomaly or automated screening check failure. If the data are anomalous or fail screening, but no reason can be found to invalidate the data, the data are flagged as suspect. Additional analysis may be needed to deem data valid or invalid. Common reasons for invalidation include instrument malfunction, power failure, and bump test data that were not identified as such. As the measurements progress over time, the screening checks will update and refine the screening checks. Screening checks are typically specific to the site, instrument, time of day, and season, and adjusted over time as more data are collected.

If data are proven to be invalid by subjective data review and/or post processing, they will be removed from the public display, and the rationale for data removal will be provided.

A non-public field operations website will be used for daily graphical review of the data (an example is provided in **Figure 3**). Common data problems include flat signal/constant values, no signal/missing data, extremely noisy signal, rapid changes (spikes or dips), and negative concentrations (see annotated **Figure 4** for examples).

An initial review, typically of a three-to-five-day running time-series plot of selected parameters for each instrument, allows the analyst to see common problems and verify instruments are operational. If it appears that an instrument is not operating, or the data are missing, the field operator will be notified and further investigation and corrective action, if needed, will be taken.

Table 13. Typical instrument QA/QC checks.

QA/QC Checks	Frequency	Acceptance Criteria
UV-DOAS		
Bump test (accuracy)	Quarterly and after major service	±25%
Baseline stability	Continuous	±5%
Measurement quality (R^2)	Continuous	0.8 to 1.0
Integration time	Continuous	80-200 mS *300 mS integration time results in a warning notification*
Signal intensity	Continuous	>80% *Signal intensity below 30 results in a warning notification*
FTIR		
Bump test	Quarterly and after major service	±25%
Baseline stability	Continuous	±5%
IR single beam ratio test (background vs. sample intensity)	Real time	*To be determined*
Measurement quality (R^2)	Continuous	0.7 to 1.0
Signal intensity	Continuous	>5% *Signal intensity below 5 results in a warning notification*
Aethalometer		
Flow rate		±10%
Span check		±10%
Zero check		<550 ng/m^3 for Ch. 6
Picarro G2204		
Multipoint calibration	Quarterly	20%

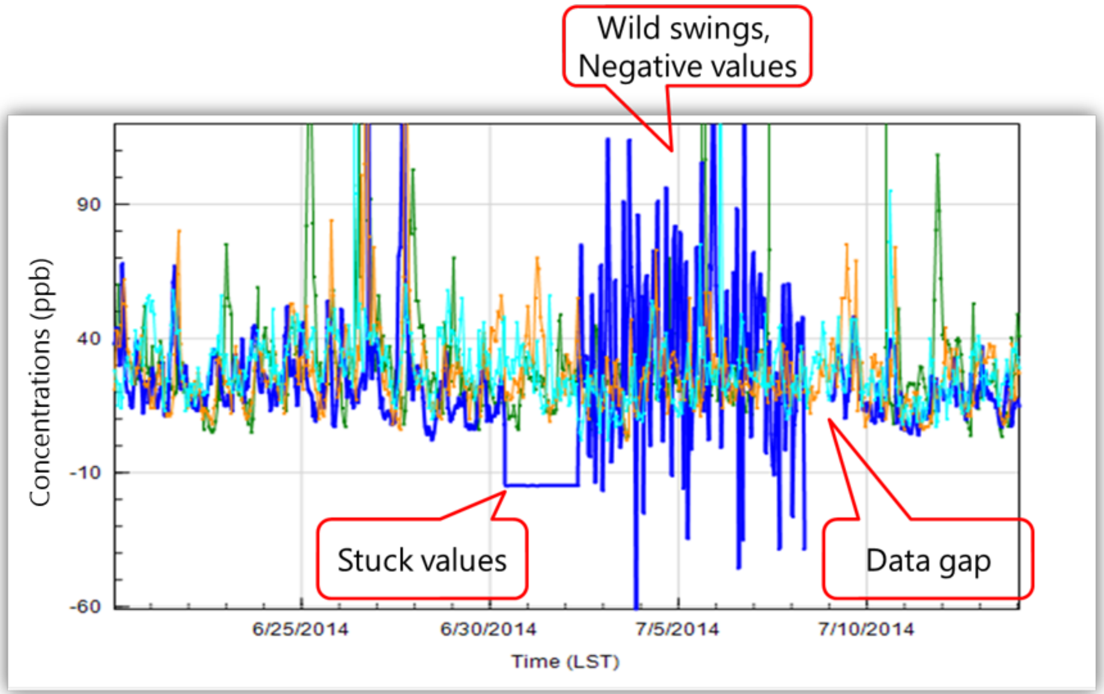

Figure 3. Example of R1180 compound concentration time series showing stuck values, wild swings, large negative values, and a data gap. Such features in the data indicate instrument issues. Data is fictitious.

Once it is clear that instruments are operational, the next step will be to review whether the R1180 compound concentration patterns are reasonable with respect to the time of day, season, meteorology, facility operations, and concentrations are expected and observed at other sites. If anomalies are observed, additional analysis will be conducted to determine whether there is an instrument malfunction or the data are truly anomalous, but explainable and valid. These subjectively reviewed data are considered **Level 1.0**.

In addition to auto-screening and daily visual checks, data will be subjected to more in-depth review on a quarterly basis and when data fail screening. Final data sets will be compiled quarterly, 60 days after each quarter's end and will be provided to the SCAQMD; these data are considered Level 2.0. Tesoro will maintain a data record for five years consistent with Rule 1180.

Any corrections or updates will be copied to the public website. Validation checks will include:

- Looking for statistical anomalies and outliers in the data.
- Inspecting several sampling intervals before and after data issues, bump tests, or repairs.
- Evaluating monthly summaries of minimum, maximum, and average values.
- Ensuring data reasonableness by comparing to remote background concentrations and average urban concentrations.
- Ensuring that data are realistically achievable, i.e., not outside the limits of what can be measured by the instrument.

- Confirming that bump tests were conducted and were within specifications.

These in-depth analyses typically require data that are not available in real time and ensure that the data on the website are updated.

On a quarterly basis, to ensure daily QC tasks are complete, analysts will:

- Review any instrument bump test results.
- Verify that daily instrument checks were acceptable.
- Review manual changes to operations/data, and verify that the changes were logged and appropriately flagged.
- Ensure that bump tests or instrument checks have the appropriate QC codes applied.

On a quarterly basis, analysts will subject the data to final QC including filling in missing records with null values, and adding Null Codes.

- If a record is not created for a particular site/date/time/parameter combination, a null record will be created for data completeness purposes.
- Assign a Code (a reason for being invalidated) to invalid data.
- Inspect data consistency over three months.
- Review ranges of values for consistency—ranges should remain consistent over months of monitoring.
- Check bump test values for consistency.
- Review data completeness.

Actions will be documented, the raw data will be retained, and data chain-of-custody records will be retained.

On an annual basis, Tesoro or its designated contractor will review the performance of the network by reviewing the data completeness by monitoring path, instrument, and R1180 compound; by reviewing results of bump tests; by analyzing the reported values in the context of refinery operations; and by analyzing the data in the context of the meteorology. The results will be summarized in a technical memorandum and provided to the SCAQMD upon request.

Data flagged through auto-screening checks will be graphically reviewed. QC flags will be updated as needed with daily, monthly, and quarterly actions (see **Figure 5**), and the QC flags will be updated on the public website as needed. DMS keeps track of data QC changes.

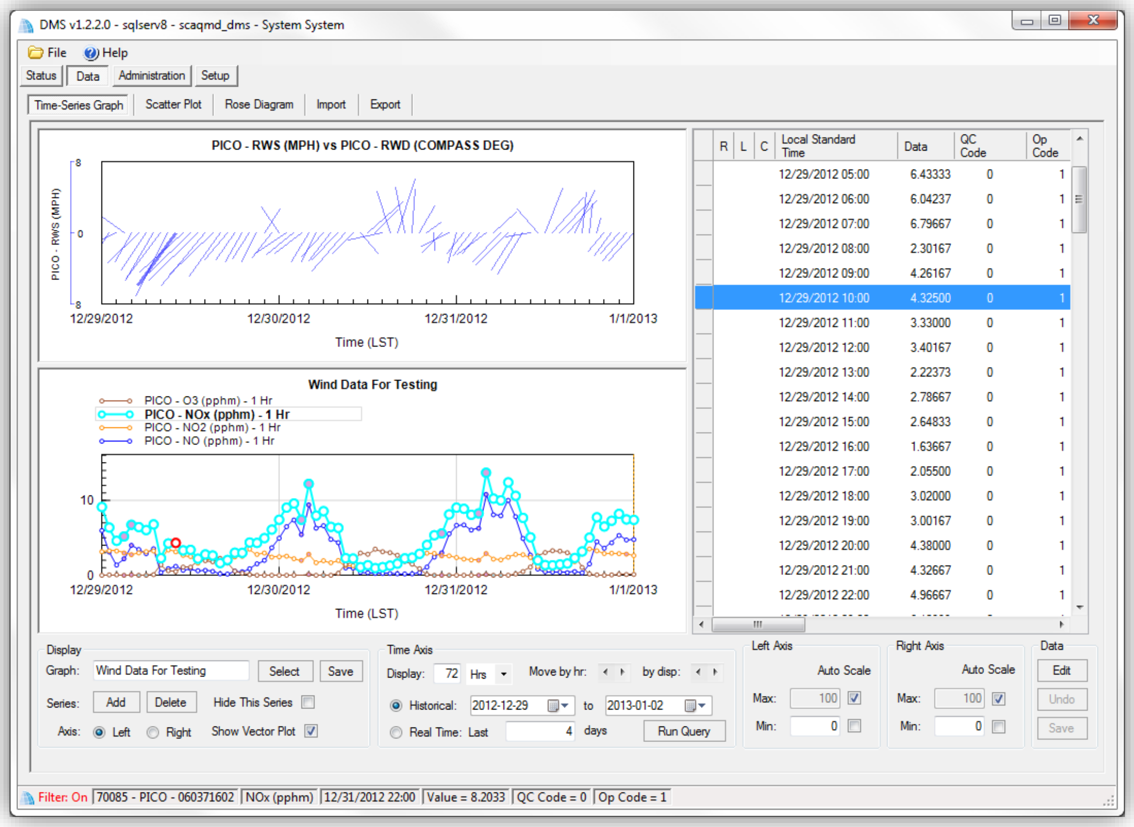

Figure 4. Screenshot of a typical DMS showing winds and R1180 compound concentrations. Actual screen(s) may vary.

4.5 Data Storage and Processing

The DMS data will be backed up on a daily basis. Backup media will be moved weekly to a secure offsite facility. The data will be stored for a period of five years pursuant to Title V permitting requirements.

4.6 Data Delivery

Each quarter, annual summary information will be provided to the website, such as average concentration of each R1180 compound by month, season, and year; maximum and minimum hourly values; and, as appropriate, explanations for any values that are well above background concentrations.

Final data sets will be compiled quarterly, 90 days after each quarter, and made available to the public on the website in graphical format. Validated data will also be provided to the SCAQMD quarterly.

Data graphs will be stored and available on the website for a period of one year. A cloud server will maintain data records for five years consistent with Rule 1180 and facility Title V permit requirements.

4.7 Data Flow to Website

4.7.1 Auto-Screening and Alert Review

All data values that are not associated with bump tests, other instrument maintenance, or instrument problems will be displayed to the public in near-real time. If data are subsequently proven to be invalid, they will be removed from the public display.

A non-public field operations website will be used for daily graphical review of the data. Common problems include flat signal/constant values, no signal/missing data, extremely noisy signal, rapid changes (spikes or dips), and negative values. An initial review, typically of a three- to five-day time-series plot of selected parameters for each instrument, allows the analyst to see common problems and verify instruments are operational. If it appears that an instrument is not operating, or the data are missing, the field operator will be notified and further investigation and corrective action, if needed, will be taken.

Data are screened in real time upon ingest into the DMS, as described in previous sections. Automated procedures will be used to ensure that data are properly ingested, stored, processed, and quality-assured, and that products are delivered to a public-facing website in real time, defined here as 10 minutes or less after the data are collected.

The preliminary QC'd data will be presented in a time series of concentrations of R1180 compounds listed in Table 1; wind speed; and wind direction. Data will be provided as 5-minute and 1-hr running averages, updated every 5 minutes. Data will be annotated for quality (valid, invalid, flagged, missing).

4.7.2 Data Backfill Process and Schedule

Prescreened, raw data in DMS will be augmented with validated data within 90 days after the end of the calendar quarter. Raw data graphs on the public website will be replaced with validated data graphs. All data, raw and validated, are retained in the DMS.

5. Routine Equipment and Data Audits

Rule 1180 specifically calls for "procedures for implementing quality assurance by a qualified independent party, including quality control and audits of the fenceline air monitoring systems."[7] The audit procedures outlined in this QAPP were informed by published EPA methods and recommendations. These methods will be used in the finalization of the QAPP. Quality assurance takes two forms. The internal quality assessment described below will be conducted by a contractor as directed by the QA Manager.

The following is a list of internal assessment tools used by Tesoro:

Internal Audits

- Data quality assessments – as requested by QA Manager
- Performance evaluations – initial, semiannual
- Flow rate audits – initial, quarterly
- Internal technical system audits – initial, 3 to 5 years

The audit function has two components: the system audit (in essence, a challenge to the QAPP) and the performance audit (a challenge to the individual measurement systems).

The system audit provides an overall assessment of the commitment to data validity; as such, all commitments made in the QAPP should be subject to challenge. Typical questions asked in the systems audit include, "Are standard operating procedures being followed?" and "Are there any errors in the data flow from the instrument to the website?" During this audit, the QA Manager reviews the calibration sources and methods used, compares actual test procedures to those specified in this protocol, and reviews data acquisition and handling procedures. The QA Manager also reviews instrument calibration records and gas certificates of analysis. All deficiencies should be recorded in the audit report along with an assessment of the likely effect on data quality. Corrective actions related to a systems audit should be obvious if the appropriate questions are asked.

The performance audit is similar to a calibration in terms of the types of activities performed—all the performance audit adds is an independent assurance that the calibrations are done correctly and that the documentation is complete and accurate. In the ideal case, when both the auditor and site operator are equally knowledgeable, the auditor functions as an observer while the site operator performs the calibration; in this instance, the auditor functions in a "hands-off" mode. In general, these performance audits will be conducted by observing semi-annual bump tests and calibrations. Table 14 describes acceptance testing parameters for the sensors described in this QAPP; the methods described earlier in this QAPP will be used.

[7] Refinery Fenceline and Community Air Monitoring (Rule 1180; approved by the SCAQMD on December 1, 2017). Available at http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/r1180.pdf?sfvrsn=9.

NIST-traceable gas standards will be used for the UV-DOAS, FTIR, and H_2S instruments. All open-path instruments will be challenged with the appropriate gas with a short path ancillary cell.

The Aethalometer should be subjected to both a leak check and flow rate check. The simplest acceptance test for temperature is a two-point test using room temperature and a stirred ice slurry. A mercury-in-glass thermometer with an up-to-date calibration can be used to verify agreement to within 1°C. For anemometers, the instrument is challenged with various rotation rates to test the performance from the transducer in the sensor to the output. For the wind sensor, the starting torque of the bearing assembly is measured and compared to the range of values provided by the manufacturer.[10] The visibility measurement will be challenged using a blocking device (for zero) and a special optic having a known extinction value.

The QA Manager, during the course of any assessment or audit, shall identify to the technical staff performing experimental activities any immediate corrective action that should be taken. If serious quality problems exist, the QA Manager is authorized to stop work. Once the assessment report has been prepared, the Field Staff Manager ensures that a response is provided for each adverse finding or potential problem and implements any necessary follow-up corrective action. The QA Manager shall ensure that follow-up corrective action has been taken.

Table 14. Description of performance audits for the systems described herein.

Sensor	Test	Acceptance Criteria
UV-DOAS	100 ppm p-Xylene; internal flow-through QA cell	±25%
FTIR	100 ppm isobutylene; internal flow-through QA cell	±25%
Picarro G2204 H_2S Monitor	0, 250, 150, 50 ppb	±20%
Aethalometer	Flow meter, internal leak check	±10%
Temperature	Two point test	±0.5°C
Relative Humidity	Hygrometer	±7%
Wind Speed	Starting threshold test; transfer function test	±0.25 m/s below 5 m/s and ±5% above 5 m/s
Wind Direction	Angle verification	±5 degrees
Visibility	Extinction	±10%

6. Standard Operating Procedures

Instrument-specific SOPs for the systems listed below are provided as Appendices to this document.

- Appendix A. UV Sentry Detection System Site Acceptance Test Procedure and Maintenance Summary
- Appendix B. Air Sentry FTIR Detection System Site Acceptance Test Procedure and Maintenance Summary
- Appendix C. Standard Operating Procedure for Picarro G2204 Methane/Hydrogen Sulfide Analyzer
- Appendix D. Standard Operating Procedure for Magee Scientific Aethalometer Model AE33
- Appendix E. Standard Operating Procedures for Campbell Scientific CS120A Visibility Sensor

Appendix A. UV Sentry Detection System Site Acceptance Test Procedure and Maintenance Summary

TERRA APPLIED SYSTEMS

STi Sonoma Technology

Site Acceptance Test Procedure and Maintenance Summary

UV Sentry Detection System

CEREX MONITORING SOLUTIONS, LLC.

Marathon Los Angles Refinery FenceLine Monitors

Carson, CA

Revised July 29, 2019

Adapted by

Terra Applied Systems

and

Sonoma Technology, Inc.

This document addresses the commissioning and analyzer response check procedure for Cerex Monitoring Solutions UV Sentry units. The procedure is intended to verify that the equipment is performing to expectations and that the detection and communication links are functioning correctly.

This procedure should only be used by personnel with experience in the safe use of the analyzer and test equipment.

Analyzer Response Check Procedure Summary

The purpose of the Analyzer Response Check procedure is field verification of the factory calibration and field performance of the UV Sentry. The QA Audit process challenges the instrument using known concentrations of Benzene reference gas to verify proper detection and quantification under field conditions.

Safe Work and Hazard Identification

The following information should be noted when preparing work plans and permits for safe work practices.

Operator Qualifications

Installing, operating and servicing Cerex UV Sentry analyzers should only be performed by personnel trained in the operation of the system components and familiar with handling of gas delivery and testing equipment.

Safe Work and Hazardous Environment Operation

Work should conform with manufacturer guidance and site health and safety practices.

The Cerex Monitoring Solutions UV Sentry Series Analyzers are not rated for safe operation in hazardous or explosive environments. Any uses in an area that may contain flammable mixtures or highly corrosive vapors require special preparations to address safety and safe operation of the equipment.

WARNING – Eye hazard. Risk of eye injury. CEREX UVDOAS Analyzers contain an ultra-violet light source that may cause eye injury after prolonged exposure. Always wear UVA/B/C eye protection when working on or near the operating equipment.

Procedure Warnings

This QA Audit procedure requires the handling of Benzene and operation of equipment designed for toxic gas containment and dispensation. Improper handling of materials or hardware may result in serious injury, destruction of property, or damage to the UV Sentry. Only qualified individuals should attempt or perform analyzer quality assurance audit activities. Cerex assumes no liability for the use or misuse of this guidance document, or for operator performed QA Audits, Calibration or Gas Handling activities. No claims are made by Cerex as to the compliance of this procedure to any regulations or engineering best practices. The operator is solely responsible for safety of personnel and property.

Preliminary Preparation

Safe Operating Precautions

1. Locate the closest safety showers and eyewash stations.
2. Field at least 2 people to carry out procedure.
3. Ensure that a clear escape path is identified.
4. Standard site PPE is appropriate. If gloves are required, nitrile or latex should be used.

Test Apparatus Setup

Materials Required

1. Operator supplied Standard Operating Procedure approved by the End-User and in compliance with End-User's Health and Safety Plan (this document).
2. This procedure is for the Internal UV Sentry QA Cell
3. Cell bump test purge apparatus including:
    a. Tubing as required: 1/8" or 1/4" PTFE tubing for gas supply from the bottle to the QA cell
    b. Tubing as required: 1/4" or 3/8" PTFE tubing for QA cell to the vent
    c. Vent vapor scrubber column of granular activated carbon.
4. Gas delivery system capable of supplying purge and reference gas at 0.1-5 L/min through the QA cell at a total system pressure of 3 psig or less.
5. Reference standard traceable gas blend in nitrogen for detection at 5x instrument theoretical detection limit or higher. **100 ppmv Benzene** is typical.
6. Clean air purge gas source
7. All relevant PPE, hardware and procedural guidance per SOP, Safety Plan, and Safe Work Permit.
8. Local or remote network link device (as required).
9. External laptop computer with network interface device to the Sentry unit (as required).

Gas Purge System Setup

1. Connect the reference cell vent to the reference cell and route it through an appropriate vapor scrubber (as required) and outside the structure.
2. Connect the purge gas cylinder to the internal test cell.
3. Ensure the cell vent is open and unobstructed to atmosphere
4. Flow purge gas to purge the system.

Verify Proper Sentry Alignment

1. Open the CMS window.
2. Click on the **UV** tab.
3. If Run is active press **STOP**.
4. Click the **ALIGN** button at the bottom left of the plot display.

5. Adjust the alignment until the signal is optimized.
    a. **Set Integration time to 20 ms**
    b. **Target intensity at 300 nm is 80-120%**
    c. **Target intensity at 254 nm is > 5%**
6. **Record** the intensity and integration time
7. Press **OK** and **SAVE or ACCEPT** (if prompted) settings to exit the CMS Alignment window.
8. Press **RUN** to resume operation.

PREPARE CMS FOR GAS TESTING

CONFIGURE CMS FOR AUDIT - (THIS MAY BE CONCURRENT WITH GAS PURGE ASSEMBLY SETUP)

1. The analyzer should be powered and running for **at least 30 minutes**.
2. Stop CMS data collection by pressing the **STOP** button.

CONFIGURE INSTRUMENT

1. Create a unique data file destination folder.
2. On the CMS **OPERATION** tab, select this destination folder as the primary data record location.
3. Exit the configuration menu. Click the **RUN** button and allow the analyzer to complete 3 or more acquisitions.
4. Once leak check is complete and purge gas has flowed to spectral baseline, click the **RUN** button and allow the analyzer to complete five or more sequential acquisitions.
5. On the DATA screen, select p-Xylene.
6. Go to the UV screen and monitor the spectrum between 240-260 nm.
7. The baseline absorbance should be <0.001.

GAS FLOW AND ANALYZER RESPONSE CHECK

CHECK GAS TEST

1. Start Check Gas flow
    a. Set Check Gas flow rate to 1-3 L/min
    b. Monitor the acquisition cycle
    c. When the acquisition cycle is at 100%, open the Test gas flow control
    d. After 1 min the flow may be reduced to approximately 0.3-1 L/min
2. Collect Check Gas data
    a. Monitor the concentration reported on the **DATA** tab.
    b. **Monitor concentrations** until the cell volume is exchanged with reference gas and at least 3 consecutive results read a value approximately +/- 20 % of the reading.
    c. **Monitor the UV spectrum** between 240-260 nm and the R2 value for baseline drift.

   d. **If the R2 goes <75%** or if the operator observes that the measurement is compromised, purge the system and allow a new background to be acquired, and then resume gas flow and measurement.
   e. **Verify that the average value is near the expected concentration**. If the measurements do not meet specification, repeat the procedure. If repeated measurements appear nonconforming, initiate corrective action investigation.
   f. Continue monitoring until at least **10 stable measurements** are observed.
   g. **Verify client system** is receiving and displaying instrument information correctly.
3. Purge the Reference gas
   a. **Open the purge** gas valve to flow air through the system.
   b. Monitor the concentration to **verify that the cell is purged** to non-detect within 4 measurement cycles
   c. **Continue to Purge the QA cell** for at least 5 minutes.
   d. **Repeat** the process if indicated

RESTORE NORMAL OPERATION

1. Restore the operations file location to the standard configuration
2. **Remove** tubing and cap the connectors.
3. **Save and Exit the configuration.**
4. Press **RUN** to begin monitoring.

TEST SUSPENSION

In the event of a leak or plant alarm requiring suspension of work, the process should be safely suspended.

1. If a plant or site alarm sounds during the validation, stop the test immediately as follows.
2. Close the reference gas bottle valve completely.
3. Allow the system to flow purge gas to the scrubber/vent.

DATA EVALUATION AND REPORTING (TEMPLATE IN APPENDIX A)

1. Concentration
   a. Average the concentration of 10 consecutive stable measurements.
   b. Report the percent difference between the average and the certified value.
2. Calculate the Limits of Detection and Quantitation
   a. Calculate the sample standard deviation of the 10 selected results.
   b. Report the Detection Limit as three times the standard deviation.
   c. Report the Quantitation Limit as five times the standard deviation

APPENDIX A: ANALYZER RESPONSE CHECK RECORD TEMPLATE

UV Sentry Fenceline Detection System

DATE: __________________ Location: __________________________________

Test Technician 1 :_______________________________ 2 :_______________________________

Sentry Alignment

Integration time ____________________________ Target 20-24mS

300 nm Intensity ____________________________ Target 80-120%

254 nm Intensity ____________________________ Target >5%

Gas Purge System

Flow purge gas Start Time ______________________

Prepare CMS

Path length in the CMS Configuration ______________________ m

Configure Test Files

Site File (i.e. QA Audit UV# YearMoDy) ____

Baseline Check ______________________ init

Reference Gas

Concentration ______________________ ppm

Source ____

Date ______________________

NOTES:

QA Audit Record - UV Sentry Vapor Detection System - Page 2

Purge Flow Conditions

Start Time ______________________

NOTES:

Check Gas Test

Initial Gas flow ______________________ L/min

Start Time ______________________

Reduced Gas flow ______________________ L/min

Start Time ______________________

Collect Check Gas Data Start Time ______________________

Data Record:

TIME	PPM	R2
____________________	__________	_________
____________________	__________	_________
____________________	__________	_________
____________________	__________	_________
____________________	__________	_________
____________________	__________	_________
____________________	__________	_________
____________________	__________	_________
____________________	__________	_________
____________________	__________	_________
____________________	__________	_________
____________________	__________	_________
____________________	__________	_________
____________________	__________	_________
____________________	__________	_________

Verify Client ______________________ Init

Stop Time ______________________ Init

Open the **PURGE** gas Time ______________________

Reference Concentration __________ ppm

Average Concentration __________ ppm

% difference __________ %

Std Deviation __________ ppm

Estimated MDL (3X Std Dev) __________ ppm

Restore Normal Operation

Restore running data file ______________________ Init

Press **RUN** to begin monitoring. ______________________ Init

Appendix B: Routine Service and Maintenance Summary

The Cerex UV-DOAS system is designed to require only modest service and maintenance. Table C-1 summarizes typical UV-DOAS maintenance activities as recommended by the manufacturer. These actions help ensure data integrity and maximize up time. Preventative maintenance frequency depends on the operating environment and may need to be adjusted. On an as-needed basis, system status alarms may alert operators to specific issues that need to be addressed.

Table C-1. Typical schedule of maintenance activities for the Cerex UV-DOAS.

Activity	Monthly	Quarterly	Annually
Visually inspect the system.	✓		
Inspect optics on detector and retro-reflector; clean if necessary.	✓		
Inspect system filters.	✓		
Confirm the alignment to verify there has not been significant physical movement. Note: this is automatically monitored as well.	✓		
Download data from detector hard drive and delete old files to free space, if needed.	✓		
Ensure there are no obstructions between the detector and the retro-reflector (such as equipment, vegetation, vehicles).	✓		
Change out the UV source.		✓	
Replace ventilation exit and intake filters.		✓	
Clean optics on detector and retro-reflector.		✓	
Realign system after service.		✓	
Check system performance indicators.		✓	
Perform bump test (simulates system-observed gas content at the required path average concentration) to verify the system can detect at or below a lower alarm limit.		✓	
Review and test light and signal levels. Check average light intensity to establish baseline for bulb change frequency.		✓	
Verify system settings.			✓

Appendix B. Air Sentry FTIR Detection System Site Acceptance Test Procedure and Maintenance Summary

TERRA APPLIED SYSTEMS

STi Sonoma Technology

Site Acceptance Test Procedure and Maintenance Summary

Air Sentry FTIR Detection System

CEREX

MONITORING SOLUTIONS, LLC.

Marathon Los Angeles Refinery FenceLine Monitor

Carson, CA

Revised July 29, 2019

Adapted by

Terra Applied Systems

and

Sonoma Technology, Inc.

This document addresses the commissioning and analyzer response check procedure for Cerex Monitoring Solutions Air Sentry FTIR units. The procedure is intended to verify that the equipment is performing to expectations and that the detection and communication links are functioning correctly.

This procedure should only be used by personnel with experience in the safe use of the analyzer and test equipment.

ANALYZER RESPONSE CHECK PROCEDURE SUMMARY

The purpose of the Analyzer Response Check procedure is field verification of the factory calibration and field performance of the Air Sentry FTIR. The QA Audit process challenges the instrument using known concentrations of Isobutylene reference gas to verify proper detection and quantification under field conditions.

SAFE WORK AND HAZARD IDENTIFICATION

The following information should be noted when preparing work plans and permits for safe work practices.

Operator Qualifications

Installing, operating and servicing Cerex Air Sentry FTIR analyzers should only be performed by personnel trained in the operation of the system components and familiar with handling of gas delivery and testing equipment.

Safe Work and Hazardous Environment Operation

Work should conform with manufacturer guidance and site health and safety practices.

CAUTION – Laser Radiation. Risk of eye injury with prolonged direct exposure. CEREX FTIR Analyzers contain a Class 3B invisible laser radiation when the interferometer cover is removed. Do not remove the interferometer cover. Eye protection is recommended when working near the IR source.

The Cerex Monitoring Solutions Air Sentry FTIR Analyzers are not rated for safe operation in hazardous or explosive environments. Any uses in an area that may contain flammable mixtures or highly corrosive vapors require special preparations to address safety and safe operation of the equipment.

Procedure Warnings

This QA Audit procedure requires the handling of Isobutylene and operation of equipment designed for toxic gas containment and dispensation. Improper handling of materials or hardware may result in serious injury, destruction of property, or damage to the Air Sentry FTIR. Only qualified individuals should attempt or perform analyzer quality assurance audit activities. Cerex assumes no liability for the use or misuse of this guidance document, or for operator performed QA Audits, Calibration or Gas Handling activities. No claims are made by Cerex as to the compliance of this procedure to any regulations or engineering best practices. The operator is solely responsible for safety of personnel and property.

Preliminary Preparation

Safe Operating Precautions

1. Locate the closest safety showers and eyewash stations.
2. Field at least 2 people to carry out procedure.
3. Ensure that a clear escape path is identified.
4. Standard site PPE is appropriate. If gloves are required, nitrile or latex should be used.

Test Apparatus Setup

Materials Required

1. Operator supplied Standard Operating Procedure approved by the End-User and in compliance with End-User's Health and Safety Plan.
2. This procedure is for the Internal Air Sentry FTIR QA Cell.
3. Cell bump test purge apparatus including:
   a. Tubing as required: 1/8" or 1/4" PTFE tubing for gas supply from the bottle to the QA cell
   b. Tubing as required: 1/4" or 3/8" PTFE tubing for QA cell to the vent
   c. Vent vapor scrubber column of granular activated carbon.
4. Gas delivery system capable of supplying purge and reference gas at 0.1-5 L/min through the QA cell at a total system pressure of 3 psig or less.
5. Reference standard traceable gas blend in nitrogen for detection at 5X instrument theoretical detection limit or higher. **100 ppmv Isobutylene** is typical.
6. Clean air purge gas source.
7. All relevant PPE, hardware and procedural guidance per SOP, Safety Plan, and Safe Work Permit.
8. Local or remote network link device (as required).
9. External laptop computer with network interface device to the Sentry unit (as required).

Gas Purge System Setup

1. Connect the reference cell vent to the reference cell and route it through an appropriate vapor scrubber (as required) and outside the structure.
2. Connect the purge gas cylinder to the internal test cell.
3. Ensure the cell vent is open and unobstructed to atmosphere.
4. Flow purge gas to purge the system.

Verify Proper Sentry Alignment

1. Open the CMS window.
2. Click on the **FTIR** tab.

3. If Run is active, press **STOP**.
4. Click the **ALIGN** button at the bottom left of the plot display.
5. Adjust the alignment until the signal is optimized.
    a. **Set FTIR Resolution to 64 cm -1**
    b. **Maximize intensity**
6. **Record** the intensity
7. **Change** resolution back to **1 cm-1**
8. Press **OK** and **SAVE or ACCEPT** (if prompted) settings to exit the CMS Alignment window.
9. Press **RUN** to resume operation.

PREPARE CMS FOR GAS TESTING

CONFIGURE CMS FOR AUDIT - (THIS MAY BE CONCURRENT WITH GAS PURGE ASSEMBLY SETUP)

1. The analyzer should be powered and running for **at least 30 minutes**.
2. Stop CMS data collection by pressing the **STOP** button.

CONFIGURE INSTRUMENT

1. Create a unique data file destination folder.
2. On the CMS **OPERATION**, select this destination folder as the primary data record location.
3. Exit the configuration menu. Click the **RUN** button and allow the analyzer to complete three or more acquisitions.
4. Once leak check is complete and purge gas has flowed to spectral baseline, click the **RUN** button and allow the analyzer to complete five or more sequential acquisitions.
5. On the DATA screen, select Isobutylene.
6. Go to the FTIR screen and monitor the spectrum between 957.4 to 975.9 cm^{-1}.
7. The baseline absorbance should be <0.001.

GAS FLOW AND ANALYZER RESPONSE CHECK

CHECK GAS TEST

1. Start Check Gas flow
    a. Set Check Gas flow rate to 1-3 L/min
    b. Monitor the acquisition cycle
    c. When the acquisition cycle is at 100%, open the Test gas flow control
    d. After 1 min the flow may be reduced to approximately 0.3-1 L/min
2. Collect Check Gas data
    a. Monitor the concentration reported on the **DATA** tab.
    b. **Monitor concentrations** until the cell volume is exchanged with reference gas and at least 3 consecutive results read a value approximately +/- 20 % of the reading.

   c. Go to the **FTIR** tab and monitor the spectrum between 957.4 to 975.9 cm^{-1} and the R2 value for baseline drift.
   d. **If the R2 goes <75%** or if the operator observes that the measurement is compromised, purge the system and allow a new background to be acquired, and then resume gas flow and measurement.
   e. **Verify that the average value is near the expected concentration**. If the measurements do not meet specification, repeat the procedure. If repeated measurements appear nonconforming, initiate corrective action investigation.
   f. Continue monitoring until at least **10 stable measurements** are observed.
   g. **Verify client system** is receiving and displaying instrument information correctly.
3. Purge the Reference gas
   a. **Open the purge** gas valve to flow air through the system.
   b. Monitor the concentration to **verify that the cell is purged** to non-detect within 4 measurement cycles.
   c. **Continue to Purge the QA cell** for at least 5 minutes.
   d. **Repeat** the process if indicated.

RESTORE NORMAL OPERATION

1. Restore the operations file location to the standard configuration.
2. **Remove** tubing and cap the connectors.
3. **Save and Exit the configuration.**
4. Press **RUN** to begin monitoring.

TEST SUSPENSION

In the event of a leak or plant alarm requiring suspension of work. the process should be safely suspended.

1. If a plant or site alarm sounds during the validation. stop the test immediately as follows.
2. Close the reference gas bottle valve completely.
3. Allow the system to flow purge gas to the scrubber/vent.

DATA EVALUATION AND REPORTING (TEMPLATE IN APPENDIX A)

1. Concentration
   a. Average the concentration of 10 consecutive stable measurements.
   b. Report the percent difference between the average and the certified value.
2. Calculate the Limits of Detection and Quantitation
   a. Calculate the sample standard deviation of the 10 selected results.
   b. Report the Detection Limit as three times the standard deviation.
   c. Report the Quantitation Limit as five times the standard deviation.

APPENDIX A: ANALYZER RESPONSE CHECK TEMPLATE

Air Sentry FTIR Fenceline Detection System

DATE: ___________________ Location: ___________________________________

Test Technician 1 :________________________________ 2 :________________________________

Sentry Alignment

Signal Intensity ____________________________

Gas Purge System

Flow purge gas Start Time _______________________

Prepare CMS

Path length in the CMS Configuration _______________________ m

Configure Test Files

Site File (i.e. QA Audit UV# YearMoDy) ____

Baseline Check _______________________ init

Reference Gas

Concentration _______________________ ppm

Source ____

Date _______________________

NOTES:

QA Audit Record Air Sentry FTIR Vapor Detection System - Page 2

Purge Flow Conditions

Start Time ______________________

NOTES:

Check Gas Test

Initial Gas flow ______________________ L/min

Start Time ______________________

Reduced Gas flow ______________________ L/min

Start Time ______________________

Collect Check Gas Data Start Time ______________________

Data Record:

TIME	PPM	R2
____________________	__________	_________
____________________	__________	_________
____________________	__________	_________
____________________	__________	_________
____________________	__________	_________
____________________	__________	_________
____________________	__________	_________
____________________	__________	_________
____________________	__________	_________
____________________	__________	_________
____________________	__________	_________
____________________	__________	_________
____________________	__________	_________
____________________	__________	_________
____________________	__________	_________

Verify Client ______________________ Init

Stop Time ______________________ Init

Open the **PURGE** gas Time ______________________

Reference Concentration __________ ppm

Average Concentration __________ ppm

% difference __________ %

Std Deviation __________ ppm

Estimated MDL (3X Std Dev) __________ ppm

Restore Normal Operation

Restore running data file ______________________ Init

Press **RUN** to begin monitoring. ______________________ Init

APPENDIX B: CEREX FTIR SERVICE AND MAINTENANCE SUMMARY

The Cerex FTIR system is designed to require only modest service and maintenance. Table C-1 summarizes FTIR maintenance activities, as recommended by the manufacturer. Preventative maintenance frequency depends on the operating environment and may need to be adjusted. On an as-needed basis, system status alarms may alert operators to specific issues that need to be addressed.

Table C-1. Typical schedule of maintenance activities for the Cerex FTIR.

Activity	Monthly	Quarterly	Semi-Annually	Annually	~18 months	Five Years
Visually inspect the system.	✓	✓		✓		
Inspect and clean AC system exterior heat sink.			✓			
Inspect and clean AC system interior heat sink.				✓		
Confirm the alignment to verify there has been no significant physical movement. [a]	✓					
Download data from detector hard drive and delete old files to free space, if needed.	✓					
Ensure there are no obstructions between the detector and the retro-reflector (such as equipment, vegetation, vehicles).	✓					
Change out the IR source.						✓
Realign system after service.		✓				
Check system performance indicators.		✓				
Perform bump test.		✓				
Review and test light and signal levels. Check average light intensity to establish baseline for IR Source change frequency and retro-reflector wear.				✓		
Verify system settings.		✓				
Replace cryocooler or swap detector module assembly.					✓	

[a] This is monitored both manually and automatically.

Appendix C. Standard Operating Procedure for Picarro G2204 Methane/Hydrogen Sulfide Analyzer

Sonoma Technology

Standard Operating Procedure for Picarro G2204 Methane/Hydrogen Sulfide Analyzer

August 8, 2019

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Contents

Summary

This Standard Operating Procedure (SOP) describes the general operation and maintenance of the Picarro G2204 CH_4 and H_2S analyzer, and is adapted from the Picarro G2204 Analyzer User's Guide (Part Number 40041, Rev. A 8/24/11).

The Picarro G2204 is used to quantify methane (CH_4) and hydrogen sulfide (H_2S) using cavity ring-down spectroscopy

Safety

Installing, operating, and servicing Picarro analyzers should only be performed by personnel trained in the operation of the system components and familiar with handling gas delivery and testing equipment. This procedure should not be performed by someone who does not understand the system, the technology, or the hazards of the materials used. The following information should be noted when preparing work plans and permits for safe work practices.

LASER SAFETY: The Picarro Analyzer is classified as a Class 1 Embedded Laser Product

WARNING: CLASS 3B INVISIBLE LASER RADIATION WHEN OPEN. AVOID EXPOSURE TO THE BEAM.

WARNING – Toxic Gas Hazard. Hydrogen sulfide is a colorless gas, that can be harmful even at low concentrations. The described procedures should be carried out in a well ventilated area. Work should conform to manufacturer guidance and site health and safety practices.

Analyzer Components

The G2204 Analyzer consists of the following main components:

- Analyzer module – includes the data acquisition, control, and communications hardware and firmware to perform spectral collection and analysis.
- Pump module – provides the vacuum required for sample gas flow into and out of the analyzer
- Accessories – includes 2 A/C power cables (one for the analyzer and one for the pump); one USB flash drive preloaded with back-up software; user manual; certificate of compliance.

Basic Analyzer Setup

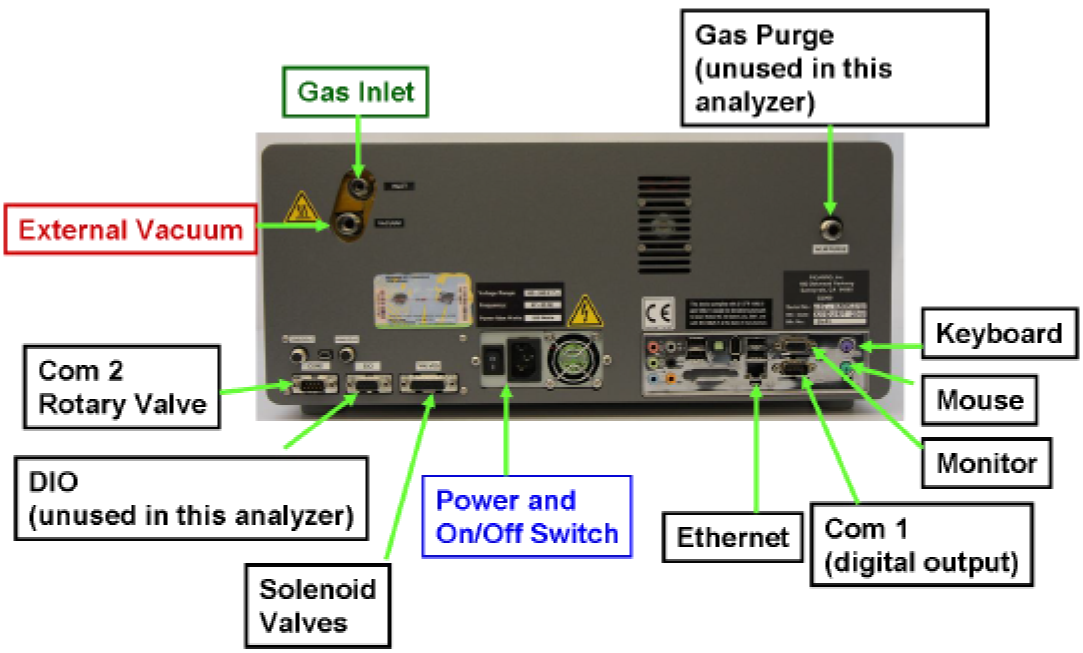
1. The analyzer should be installed on a bench top or flat surface, with the external vacuum pump nearby or on the floor.

2. Remove the caps from the analyzer gas connection inlet and vacuum connection ports.

3. Remove the caps from the external vacuum pump.

   Caps can be saved for later use and should be reinstalled if the analyzer or pump are stored, moved, or shipped.

4. Connect a Teflon gas line between the "external vacuum" port on the analyzer, as highlighted in red in the figure below, and the external vacuum pump. Nuts should be tightened with an 11/16" wrench.



5. AC power to the external vacuum pump can now be connected.

6. Attach a tube to the external vacuum pump exhaust port and direct to a safe place for venting the mixture of sample gases.

   Half-inch Teflon tubing or a cartridge containing Sulfursorb activated carbon scrubber should be attached to the exhaust port. ***Caution: ensure that the scrubber system does not create back pressure into the analyzer.***

7. Attach a PS2 mouse, PS2 keyboard, Ethernet cable, and VGA monitor display cable to the computer connections on the back of the analyzer.

Basic Analyzer Operation

When the main power is turned on, the analyzer will start operation automatically, including the Graphical User Interface (GUI).

Icons on the desktop of the analyzer include:

- Controller – provides instrument diagnostics and service information
- Picarro Mode Switcher – restarts analyzer in different measurement modes.

The analyzer will not begin producing data until all the measurement parameters have reached their operational set points (temperature, pressure, etc.), as indicated in the **Status** log window. Data are automatically saved once the analyzer begins producing data. The GUI provides a continuous, real-time data readout. Data are stored on the local drive (C:\Userdata\DataLog_User \YYYY\MM\DD, where Y=year, M=month, D=day).

Shutdown Procedure

A flow of clean, relatively dry gas should always be directed though the instrument for several minutes prior to shutdown. Check the moisture trap at the analyzer inlet connection to ensure the excess water is not getting into the sample cavity.

Selecting "**Shutdown in current state**" stops the gas flow and shuts down the software. It does not shut off the main computer. You will be prompted to confirm the shutdown. Select the "**OK**" check box to initiate the shutdown procedure, then flip the analyzer main power switch to complete shutdown. This is the most common shutdown procedure and works for short off periods (hours to days).

If "**Prepare for shipping**" is selected, the cavity pressure will increase until it reaches near atmospheric pressure. The status log will indicate the pressure as the cavity is filled. The proportional valves will be closed, software will terminate, and the instrument will power off completely. This should be selected if the analyzer will be unused for longer periods of time (weeks or more).

Note: If power to the analyzer is cut off, the analyzer will stop operation. However, when power is reapplied, the analyzer will restart automatically. The software will close out previous files and open new files for data collection.

Maintenance and Service

Field Maintenance

Table 1 describes maintenance actions, including cleaning and verifications, and their required frequencies.

Table 1. Regular maintenance schedule

Maintenance Action	Frequency
Inspect sample line tubing	Monthly, or during a site visit
Inspect and clean sample inlet	Monthly, or during a site visit
Inspect and clean insect/moisture trap	Monthly, or during a site visit
Backup data to external storage	Monthly
Gas verification test	Monthly to Quarterly
Replace particulate filter	Annually*

* In cleaner environments, the filter can last more than a year.

Equipment and Supplies for Servicing Analyzer

Before beginning the particulate filter replacement, make sure to have all of these materials:

- 1.5mm hex driver
- 9/16" open-end wrench
- 5/8" open-end wrench
- 11/16" open-end wrench

Particulate Filter

There are two in-line, sub-micron particulate filters in front of the measurement cavity. The first is user-replaceable; replacement filters can be purchased from Picarro and installed by the user. **It is important to NEVER remove the second filter that is directly attached to the cavity.** Only change the first filter at the back of the analyzer.

Removing Old Particulate Filter

1. Power down the instrument following the "shutdown in current state" procedure outlined above.
2. Using the 1.5mm hex driver, remove the analyzer top lid by removing six hex screws.

3. Remove the piece of foam from around the input bulkhead by sliding it toward the back of the analyzer.
4. Using the 5/8″ wrench, loosen the retaining nut on the input bulkhead.
5. Using the 9/16″ and 11/16″ wrenches, disconnect the filter from the tube section near the front of the analyzer.
6. Slide the filter and bulkhead slightly toward the back of the analyzer and lift out.
7. Using the 9/16″ and 11/16″ wrenches, disconnect the filter from bulkhead fitting.

Installing the New Particulate Filter

Note: When re-attaching 1/4″ Swagelok fittings, the nut should be hand-tightened and then turned an additional 1/8 of a turn using a wrench.

1. Using the 9/16″ and 11/16″ wrenches, remove the filter from its packaging and attach it to the bulkhead fitting. The arrow on the filter needs to point away from the bulkhead fitting.
2. Using the 9/16″ and 11/16″ wrenches, reposition the filter and bulkhead fitting, and reattach to the tube section.
3. Using the 5/8″ wrench, reposition the filter cover and tighten the retaining nut on the bulkhead fitting. The metal edge of the filter cover should be under the foam at the top of the enclosure.
4. Reposition the piece of foam around the input bulkhead fitting.
5. With the 1.5mm hex driver, replace the analyzer top and secure with 6 hex screws.

Analyzer Calibration

Precautions

CAUTION: Pressure and flow – When the analyzer is connected directly to a pressurized gas tank or a sample container, the user needs to be mindful of sample flow and pressure (1-3 psi range). If the pressure and flow are too high or too low, damage to valves and the cavity may occur.

There is no general rule to determine how frequently Picarro analyzers need to be calibrated. Calibration gas verifications can begin at a monthly rate, then decrease quarterly if the analyzer is in good operational condition and drift appears to be minimal.

1. The range of your standards generally should encompass or exceed the expected range of your dataset.

2. If a new slope calibration is to be applied, the user must be mindful of their experimental uncertainty. For example, a change in the slope calibration from 1 to 0.95 may not represent a change in the system's linearity, but may simply reflect the experimental uncertainty.
3. If during your slope calibration, a new value of 0.9 or 0.85 is suggested by the Data Recal tool (software designed to aid in calibrations), please repeat the measurements of your standards.
4. If you are uncertain about the state of your current slope and offset values, they can be reset back to their user default values of 1 and 0, respectively. In your Picarro GUI, navigate to "Tools -> User Calibration -> (password: picarro) ->" Then change the slope and offset values of your parameter of interest to 1 and 0, respectively.
5. If the user is not comfortable with changing the calibration of the analyzer, an offline correction of the dataset is recommended. Measuring standards along with samples is good practice regardless, and it enables users to correct their data for slope and/or offset offline. Be mindful that in order to correct for slope, at least 2-3 standards must be included between your samples, whereas for offset corrections, 1-2 are sufficient.

Calibration Procedure If Using Permeation Tube

This calibration involves using a permeation tube device running through a DynaCal system. The system works by activating the permeation device through heating. Different concentrations can be achieved by adjusting the flow of the DynaCal. **WARNING: The permeation tube device contains dangerous amounts of H_2S. Do not damage or open the tube! Be careful when handling it.**

1. Turn on the DynaCal with the main power switch. Turn on the pump and heater.
2. Turn the control valve on the DynaCal to the "Standby" position.
3. Set the temperature on the DynaCal to 30°C and set the flow to the lowest setting.
4. Open the Dynacal's permeation tube chamber. Put the ¼" x 3.5 cm spacer on the non-permeating end (away from the wafer) of the device body.
5. With the spacer facing down, GENTLY place the permeation device into the chamber either by using forceps or by tilting the DynaCal forward and sliding the permeation device to the bottom.
6. Close the permeation chamber and allow 30 minutes for it to equilibrate. It is recommended to start this process ahead of time.
7. Connect ¼" tubing to the Teflon outlet of the DynaCal. Connect the tube to a tee that is open on one end and is connected to the Picarro on the other. This provides a bypass to keep the system at atmospheric pressure. The tee should be as close to the Picarro as possible to minimize the residence time.

8. Route the open end of the bypass and the exhaust of the Picarro outside of the shelter.

9. Set the DynaCal's control valve to the "Span with Overflow" position.

10. Adjust the flow of the DynaCal to set it to the desired concentration.
    a. More than three calibration concentrations should be used, including a zero.
    b. A zero calibration can be done by running the DynaCal with no permeation device in its chamber. Make sure to let the chamber purge completely before attempting a zero calibration if the permeation device was previously in use.
    c. The possible DynaCal concentrations can be calculated with the following equation:

$$Concentration\ (ppm) = \frac{K \times R_{perm}}{F}$$

Where K=24.45/M.W.(calibrant), R_{perm} is the permeation rate in ng/min (included with the permeation tube documentation), and F is the chamber carrier flow (mL/min). Flow must be corrected to standard temperature and pressure using:

$$F = (0.6262)F_c\sqrt{\frac{P}{T}}$$

Where F is indicated flow corrected to standard temperature and pressure, P is ambient pressure in mmHg, T is the temperature in Kelvin, and Fc is the calibrated flow when the flowmeter is at standard conditions.

See the table below for the flow rates corresponding to each setting on the DynaCal's rotameter:

Float Setting	Total Flow (cc/min)
1	241
2	420
3	622
4	840
5	1041

It is recommended that all possible concentrations be calculated ahead of time and be recorded somewhere until the permeation device expires and is replaced with a new one.

Sample calculation:

Given: R_{perm} = 20.17 ng/min

Flow = 420 cc/min (from flow rate table above); this corresponds to a float setting of 2)

Ambient temperature = 17.5°C

Ambient pressure: 1013 hPa

H_2S gas M.W. = 34.081 g/mol

First, calculate the pressure: $1013\ hPa\left(\frac{100\ Pa}{1\ hPa}\right)\left(\frac{760\ mmHg}{101325\ Pa}\right) = 759.8\ mmHg$

Then, calculate the flow: $F = (0.6262) \times 420 \times \sqrt{\frac{759.8}{(273.15+17.5)}} = 425.23\ mL/min$

Now calculate the concentration:

$$Concentration\ (ppm) = \frac{K * R_{perm}}{F} = \frac{24.45 * 20.17}{34.081 * 425.24} = 0.03403\ ppm\ (34.03\ ppb)$$

11. Collect Check Gas data.
    a. Observe the concentration reported on the analyzer readout (GUI).
    b. After the concentration becomes stable, allow the analyzer **to run until 10 minutes of stable measurements are made.**
    c. Verify that the value is near the expected concentration. If the measurements do not meet specifications, repeat the procedure. If repeated measurements appear nonconforming, initiate corrective action investigation.
    d. Verify system is receiving and displaying instrument information correctly.
    e. After 10 minutes of stable measurements are observed, close calibration gas cylinder. Allow the pressure to fall to zero and the flow to stop.
12. Select the next calibration gas concentration
13. Repeat Step 8 for all concentrations of calibration gas.
14. Once calibration is complete, purge the sample inlet line.
    a. Remove the permeation tube device from the DynaCal's chamber, either with forceps or by tilting the DynaCal forward and catching the tube as it slides out. **Caution**: the permeation tube might be hot to the touch! Put the permeation tube device back into its container and store in cool place at around 20°C.

b. Run the DynaCal without the permeation tube to purge the system.

c. Purge the sample inlet for at least 2 minutes.

d. **Verify that the target gas concentration has returned to 0 ppm**.

e. Remove the DynaCal's hoses.

Calibration Procedure If Using Gas Calibrator

This procedure pertains to using a dynamic gas calibrator capable of flowing varying concentrations of calibration gas to an instrument.

1. Connect calibration gas cylinder and zero gas cylinder to the appropriate ports on the dynamic gas calibrator.
2. Connect the outlet of the dynamic gas calibrator to the analyzer sample inlet.
3. Route the instrument exhaust outside of the analyzer shelter, with the Sulfursorb scrubber attached.
4. Open all calibration gas bottles and ensure you are not over-pressurizing the dynamic gas calibrator.
5. Configure the gas calibrator with the appropriate calibration concentrations and desired flow.
   a. Multiple calibration concentrations should be used, including a zero.
   b. The following describes a typical range of concentrations that can be used:

Calibration Concs.
0 ppb
250 ppb
150 ppb
50 ppb
0 ppb

6. Ensure the sample vent is open and unobstructed to the atmosphere by monitoring vent flow and sample pressure.
7. Start flowing calibration gas by selecting the desired concentration or zero gas on the dynamic gas calibrator.
8. Collect check gas data.
   a. Observe the concentration reported on the analyzer readout (GUI).
   b. After the concentration becomes stable, allow the analyzer **to run until 10 minutes of stable measurements are made.**

   c. Verify that the value is near the expected concentration. If the measurements do not meet specifications, repeat the procedure. If repeated measurements appear nonconforming, initiate corrective action investigation. Use the Picarro User's Guide for reference.

   d. Verify system is receiving and displaying instrument information correctly.

   e. After 10 minutes of stable measurements are observed, close calibration gas cylinder. Allow the pressure to fall to zero and flow to stop.

9. Select the next calibration gas concentration
10. Repeat Step 8 for all concentrations of calibration gas.
11. Once calibration is complete, purge the sample inlet line.
    a. Flow zero air through the system.
    b. Purge the sample inlet with zero air for at least 2 minutes.
    c. **Verify that the target gas concentration has returned to 0 ppm**.
    d. Remove the hoses and cap the connectors.

Calibration Procedure If Using Calibration Gas Cylinders

*****Note***** This procedure has been specifically written for use with the calibration/validation gas panel to minimize over-pressurization and leaks.

The following procedure pertains to using a zero air calibration gas cylinder, a mid-span gas cylinder roughly 40-60% of the desired span concentration, and a span bottle approximately 95-100% of desired span concentration, based on the expected range of measurements or site-specific safety requirements. **For refineries, H_2S concentrations should be less than 500 ppb.** The mid-span gas should be between 200 and 300 ppb.

1. Connect the **To cell** line from the calibration panel to the sample inlet on the instrument.
2. Route the instrument exhaust outside of the analyzer shelter, with the Sulfursorb scrubber attached.
3. Connect the calibration gas cylinder line to the **Cal gas inlet** connection on the calibration panel.
4. Connect the zero gas cylinder line to the **Zero gas inlet** connection on the calibration panel.
5. Ensure the sample vent is open and unobstructed to the atmosphere by monitoring vent flow and sample pressure.
6. Set the zero air flow and pressure.
   a. Open the valve on the zero air channel on the purging panel and ensure there is <25 psi of pressure on the zero air channel.
   b. Close the secondary pressure regulator and open the **bypass** valve.

   c. Open the secondary pressure regulator slowly and set flow to 1 L/min or a flow with line pressure between 1-3 psi. **Do not over-pressurize**.
   d. Once desired flow is set, open the **To cell** valve and close the **bypass** valve to send zero air to the instrument.

7. Set the calibration gas flow and pressure.
   a. Close the **To cell** valve to prevent sending too much flow or pressure to the sample inlet.
   b. Close the secondary pressure regulator and open the **bypass** valve.
   c. Open the secondary pressure regulator slowly and set flow to 1 L/min or a flow with line pressure between 1-3 psi. **Do not over-pressurize**.
   d. Once desired flow is set, open the **To cell** valve and close the **bypass** valve to send calibration gas to the instrument.
8. Collect calibration gas data.
   a. Observe the concentration reported on the analyzer readout (GUI).
   b. After the concentration becomes stable, allow the analyzer **to run until 10 minutes of stable measurements are made.**
   c. Verify that the value is near the expected concentration. If the measurements do not meet specifications, repeat the procedure. If repeated measurements appear nonconforming, initiate corrective action investigation. Use the Picarro User's Guide for reference.
   d. Verify the system is receiving and displaying instrument information correctly.
   e. After 10 minutes of stable measurements are observed, close the calibration gas cylinder. Allow the pressure to fall to zero and flow to stop.
9. Repeat procedure for all concentrations of calibration gas.
10. Purge the reference gas.
    a. Open the purge gas valve to flow zero air through the system.
    b. Set the flow rate to 1 L/min or a flow with line pressure less than 1-3 psi.
    c. Purge the sample inlet with zero air for at least 2 minutes.
    d. **Verify that the target gas concentration has returned to 0 ppm**.
    e. Remove the hoses and cap the connectors.

Appendix D. Standard Operating Procedure for Magee Scientific Aethalometer Model AE33

STi Sonoma Technology

Standard Operating Procedure for Magee Scientific Aethalometer Model AE33

September 12, 2019 STI-916067

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Contents

1. Purpose and Method

This Standard Operating Procedure (SOP) describes the general maintenance of the Magee Scientific Aethalometer Model AE33 black carbon analyzer.

This manual is adapted from Magee Scientific's User Manual, version 1.54, which is available at http://www.mageesci.com/EACworkshop2016/MANUALS/AE33/AE33_UsersManual_Rev154.pdf.

The Magee Scientific Aethalometer Model AE33 is used to quantify black carbon (BC) in the air. The Aethalometer draws air through a spot on filter tape and then analyzes the aerosol present in the sampled air by measuring the transmission of light through the tape. The sample spot transmission is compared to an unloaded portion of the filter tape, which acts as a reference. This analysis is performed at seven optical wavelengths, from the near-infrared to the near-ultraviolet. The Aethalometer calculates the instantaneous concentration of optically-absorbing aerosols from the rate of change of the attenuation of light transmitted through the particle-laden filter. Two measurements are obtained simultaneously from two sample spots with different rates of accumulation of the sample. Both spots derive their samples from the same input air stream. The two results are combined mathematically to eliminate nonlinearities common in previous instrument measurements to provide the compensated particle light absorption and BC mass concentration.

The instrument will be operated with 1-minute time resolution.

2. Equipment and Supplies

Maintenance for the Magee AE33 is performed with the following equipment:

- Instruments for flow checks
- New roll of filter tape
- Adhesive tape
- Screwdriver
- Flow calibration pad (black rubber)
- Flow meter

3. Personnel Qualifications

Installation, operation, maintenance, repair, or calibration of the instrument and all support equipment should be performed by properly trained personnel. Personnel should meet all minimum STI requirements and qualifications for an Air Quality Field Technician.

4. User Interface and Operation

4.1. User Interface

The four top level tabs in the touch screen user interface are: **HOME**, **OPERATION**, **DATA**, and **ABOUT**.

HOME has the following parameters:

- BC - the measured values for Black Carbon (measured at 880 nm)
- UVPM - UV particulate matter (calculated at 370 nm)
- REPORTED FLOW - measured flow (in LPM)
- TIMEBASE - timebase setting (in seconds)
- TAPE ADV. LEFT - the amount of remaining tape (inches)
- STATUS - instrument status: green (all OK), yellow (check status), and red (stopped) with a Status Condition (see Section 4.2)
- Bottom of HOME screen shows the date and time

Note: The BC and UVPM values will typically be similar, but not exactly the same. If aromatic compounds are present in the sampled air (such as when sampling fresh woodsmoke, for example), the UVPM concentration will exceed the BC mass concentration value significantly, depending upon the amount and type of organic material present.

OPERATION has four sub-tabs: GENERAL, ADVANCED, LOG, and MANUAL.

- GENERAL – with the following settings:
  - Flow (LPM) (see Note below on flow-reporting standard).
  - TimeBase (seconds).
  - Three radio buttons (one must be selected):
    - TA ATNmax - maximum attenuation at which the Aethalometer advances tape.
    - TA INT - the time interval at which the Aethalometer advances tape (hours).
    - TA Time - the time at which the Aethalometer advances tape.
  - Start, Stop, Stability, Clean air, and Change Tape buttons.
- ADVANCED – includes all parameters that can be set in the Aethalometer.
- LOG – with the last operational reports of status, parameter changes, and data download.
- MANUAL – with basic commands to operate hardware (solenoids, pump, chamber, TA).

DATA has two sub-tabs: TABLE and EXPORT.

- TABLE reports (1) the raw measurement values, (2) the BC concentration calculated from each individual spot (BC1, BC2), and (3) the compensated BC concentration. All three concentrations use the unit ng/m^3.

- EXPORT, which allows the selection data to be copied to a USB.

ABOUT – lists features and contact information.

4.2. Instrument Status

The instrument's current status condition is displayed in decimal format on the front panel **HOME** screen and in the Status column of the data download. The status condition relates to various subcomponents of the instrument (Detector, Flow, LED, etc.). The decimal number represents a sum of all of the status conditions occurring at any given time. Multiple status conditions are interpreted using subtraction of the largest possible Status Condition value using the table below.

Table 1. Status conditions and descriptions.

Parameter	Status Condition	Description
Detector	0	Measuring
	1	Not measuring (due to either tape advance, fast calibration in progress)
	2	Calibrating (LED, Flow, Tape Sensors)
	3	Stopped
Flow		Flow OK
	4	Flow low/high by more than 0.25 LPM
	8	Flow check status history
	12	Flow low/high and check status history
LED		LEDs OK
	16	Calibrating
	32	Calibration error in one or more channels (at least one channel OK)
	48	LED error (all channels calibration error, COM error)
Tape Advance		Tape advance OK
	128	Tape warning (less than 10 spots left)
	256	Tape last warning (card box visible, less than 5 spots left)
	384	Tape error (tape not advancing, end of tape)
Tests		No test
	1024	Stability test
	2048	Clean air test

	3072	Change tape

When Status Condition 3 is encountered, the Aethalometer stops. In all other statuses, it continues to operate with a warning, and the data is flagged accordingly. The status is represented by one value, which can point to one parameter or a combination of parameters.

4.2.1. Single Status Condition

If the value displayed matches a value in the Status Condition column, it indicates only one parameter and its description. Examples:

- Status = 0, all OK; front panel LED is GREEN
- Status = 1, all OK, tape advancing; blinking GREEN LED
- Status = 128, machine is running, tape advance warning flag is set; YELLOW

4.2.2. Multiple Status Conditions

If the Status displayed does not match a value in the table, it means that there are multiple parameters whose Status Conditions are added together, forming a sum that must be broken down by subtraction. First, find the largest value in the Status Condition column that does not exceed the Status value, and subtract it from the sum. Next, find the next largest value in the Status Condition column that does not exceed the remainder, and subtract again. Continue finding the next largest number and subtracting it until the remainder matches a value in the Status Condition column. Examples:

- Status = 289, which breaks down as follows: 289 − 256 = 33; 33 − 32 = 1; therefore, the Status Conditions are 256, 32, and 1. This means the machine is not measuring (1), the LED calibration had errors in one or more (but not all) channels (32), and less than 5 tape advances are left (256).

- Status = 145, which breaks down as follows: 145 − 128 = 17; 17 − 16 = 1; therefore, the Status Conditions are 128, 17, and 1. This means the machine is not measuring (1), the LED calibration is in process (16), and less than 10 tape advances are left (128).

4.3. Downloading or Viewing Data

To download data, insert the USB stick in either of the front USB ports. Do not use the rear ports as they are intended for the mouse and keyboard only and not for data transfer (surge protection).

Go to the "**DATA**/EXPORT" menu and press "Export to USB". The data will be stored in a text file with a header. The file name is shown as:

AE33_Sss- nnnnn_yyyymmdd.dat

In the sample file name above, *ss* is the production series number, *nnnnn* is the serial number, and *yyyymmdd* is the date; for example, 20120901 means September 1, 2012. Please make sure that the transfer is finished before removing the USB stick from the Aethalometer. The data file can then be transferred to a personal computer as any other file, and processed with any preferred data processing application.

5. Field Maintenance

Table 2 describes maintenance actions for routine system management, including cleaning and inspections and their required frequencies.

Table 2. Regular maintenance schedule.

Maintenance Action	Frequency
Inspect sample line tubing	Monthly, or during a site visit
Visually inspect the tape	Monthly, or during a site visit
Inspect and clean the size selective inlet	Monthly, or during a site visit
Inspect and clean the insect screen assembly	Monthly, or during a site visit
Perform leak test	Monthly, or after maintenance or repair
Flow verification test	Monthly, or after maintenance or repair
Flow calibration	Monthly, or if any flow from the flow verification summary is >10%
Check/set the instrument date and time	Monthly
Install new filter tape roll	As needed upon instrument warning
Biannual to Annual Actions	
Inspect optical chamber, clean if necessary	Every six months (or as needed)
Clean air test	Every six months
Stability test	Every six months
Inlet leakage test	Annually
Neutral Density (ND) filter test	Every six months
Lubricate optical chamber sliders	Annually
Change bypass cartridge filter	Annually

5.1. Inspect Sample Line Tubing

Visually inspect the sample line tubing for condensation, cracks, kinks, or other structural damage. Replace if needed.

5.2. Inspect and Clean the Insect Screen Assembly

The insect and water trap is installed in the sample inlet line, at a point close to the instrument, and clearly visible. This trap prevents the entry of contaminates (which will compromise the data) or water (either rain or condensation), which can lead to serious damage of the flow sensors. Visually inspect the trap, and remove and clean as necessary.

5.3. Install New Filter Tape Roll

Supplies needed for this procedure: new roll of filter tape, and adhesive tape. See Section 9.2 of the Magee Scientific User's Manual for reference (a link is provided in Section 1).

When you observe an instrument warning of tape change needed, follow these instructions to change the tape. This should occur roughly every 6 weeks or so.

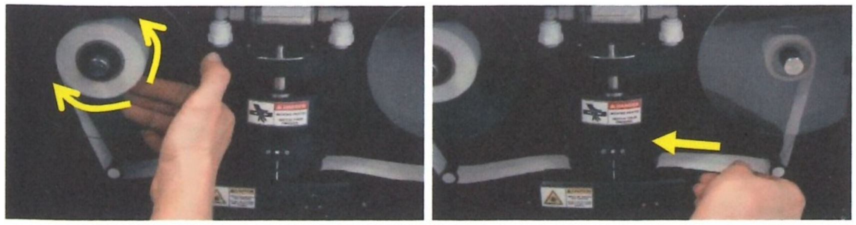
1. If the instrument is running, press **Stop** on the front panel.
2. Open the front door of the instrument.
3. Loosen the thumb screws and remove the transparent plastic covers from both the "supply" spool (on the left hand side), and the "collection" spool (on the right-hand side).
4. Using thumb and fingers on both sides of the optical chamber, lift the chamber upwards against its springs.
5. When the chamber is fully raised, lock it in place by pushing the metal latch.
6. Remove the used tape from both spools. Place the used tape in a Ziploc bag.
7. Take the new filter tape and place it on the supply spool. Take note of the metal spring leaf, which stabilizes the top surface of the roll.



8. Make sure the roll is correctly oriented—the tape must unroll from the left-hand side.
9. Take the other cardboard spool center and attach the end of the filter to it using adhesive tape.
10. Place the empty center on the "take-up" spool axis (the right-hand side of the collection spool).
11. Make sure that the tape is fed beneath both the left and the right guide posts, and passes under the optical chamber.



12. Release the optical chamber by lifting up with thumbs and fingers on both sides. The spring-loaded latch will automatically release.
13. Replace both of the transparent plastic covers. Tighten the thumb screws by hand only.
14. Check that the left-hand supply spool can turn freely.
15. Make sure that the right-hand collection spool is firmly clamped to its axis: test by gently pulling the tape, and make sure the spool center does not move.



16. The filter tape replacement procedure is now completed. Press **Start** to resume operation.

5.4. Perform Leak Test

Supplies for this procedure: a flow calibration pad, and a flow meter.

1. If the instrument is running, press **Stop** on the **Operation/General** screen.
2. On the **Operation/General** screen, press **Leakage test** to start the test.
3. A new screen appears. Choose **Manual**.
4. The instrument will measure the flow through the filter tape. Confirm by pressing **OK**.
5. Connect your external mass flow meter to the inlet port.
6. Connect the flow meter using well-sealed tubing and fittings. Make sure the connections are tight.
7. Press **OK**.
8. Choose the flow at which you want to perform the test. Normally this test is conducted at 5 LPM. Press **OK**.
9. Observe the flow measured by your flow meter.
   IMPORTANT! Make sure that your flow readings are reported at the same "Standard" reporting conditions of Temperature (25°C) and Pressure (101325 Pa) that you are using in the Aethalometer. Many flow meters display flow at "actual" conditions (i.e. local T and P) and also display the same result corrected to "standard" conditions.
10. Press the input box field and enter the flow from the external flow meter.
    IMPORTANT! Units are in milliliters per minute (mLPM), not liters per minute (LPM).
11. Confirm by pressing **OK**.
12. Measure the flow again, but through the rubber flow calibration pad rather than the filter tape.
13. When prompted, remove the filter tape and install the rubber flow calibration pad with the notch facing toward you.
14. When ready, press **OK**.
15. Repeat the procedure as before when measuring the flow through the filter tape (steps 4–11).

16. When finished, remove the flow calibration pad and replace the filter tape. Press **OK**.
17. The test is now complete. The report shows:
    - Instrument serial number
    - Date and time of the test
    - Results of the test: selected flow and flows through the filter tape and calibration pad

    This report is also saved on the CF card and is available for download with data files.
18. The leakage should be less than 10%. If the reported leakage is larger than 10%, contact Magee Scientific or your authorized distributor.

5.5. Perform Flow Verification Test

Supplies for this procedure: a flow calibration pad and a flow meter. See Section 9.3 in the Magee Scientific User's Manual for reference.

1. If the instrument is running, press **Stop** on the **Operation/General** screen.
1. Press the **Verify flow** button to start the test.
2. A new screen will appear. Choose **Manual**.
3. Measure the flow through the flow calibration pad.
4. Wait for the chamber to lift. When prompted, remove the filter tape and install the rubber flow calibration pad with the notch facing toward you.
5. When the pad is installed, press **OK**.
6. Connect the external flow meter to the inlet port using well-sealed tubing and fittings. Make sure that the connections are tight.
7. Press **OK**. The Flow Verification routine will measure the flow at three different values (approximately 1 LPM, 3 LPM, and 5 LPM), and compare the "internal" value (from the instrument's flow sensors) with the "external" value measured by the external flow meter.
8. Note the flow on your external mass flow meter.
   IMPORTANT! Make sure that your flow readings are reported at the same reporting conditions of T and P as the instrument's setting.
9. Press the empty box marked **Flow** and enter the flow from the external flow meter.
   IMPORTANT! Units are milliliters per minute (mLPM).
10. Confirm by pressing **OK**. The process will repeat at the three flow values.
11. After entering the last value (at 5 LPM) and pressing **OK**, the instrument will show the flow verification report. This report is also saved on the CF card and is available for download with data files.
12. The test is satisfactory if the difference of flow readings is less than ±10%. If the difference is larger, re-calibration of the flow sensors is needed (see section 9.3 of the Magee Scientific User's Manual).
13. Confirm by pressing **OK**.
14. When prompted, remove the rubber flow calibration pad and re-install the filter tape. Press **OK** when done.

5.6. Perform Flow Calibration

Supplies for this procedure: a flow calibration pad (black rubber) and a flow meter.

1. If the instrument is running, press **Stop** on the **Operation/General** screen.
2. Press the **FlowCal** button to start the test.
3. A new screen will appear. Choose **Manual**.
4. The instrument will run through several procedures. The first is to measure the flow through the flow calibration pad.
   - If the rubber pad is already in place, you can press Skip.
   - If not, please wait for the chamber to lift. When prompted, remove the filter tape and install the rubber flow calibration pad with the notch facing toward you.
   - When the pad is installed, press OK.
5. Connect the external flow meter to the inlet port.
6. Connect the flow meter using well-sealed tubing and fittings. Make sure that the connections are tight. Press **OK**.
7. The instrument will measure the flow at three different points: close to 1 LPM, 3 LPM, and 5 LPM.
8. Observe the flow measured by your flow meter.
   IMPORTANT! Make sure that your flow readings are reported at the same "Standard" reporting conditions of temperature and pressure that you are using in the Aethalometer.
9. Press the input box field and enter the flow from the external flow meter.
   IMPORTANT! Units are milliliters per minute (mLPM), not LPM.
10. Confirm by pressing **Enter**.
11. After entering the last value (at 5LPM) and pressing **OK**, the procedure is completed.
12. Remove the flow calibration pad and replace the filter tape. Press **OK** when done.
13. Press **Start** to resume sampling.
14. Repeat flow verification test

6. Biannual Maintenance

Table 3. Biannual maintenance schedule.

Maintenance Action	Frequency
Inspect optical chamber; clean if necessary	Every six months (or more frequently if needed)
Clean air test	Every six months
Stability test	Every six months
Inlet leakage test	Annually
Neutral Density (ND) filter test	Annually
Lubricate optical chamber sliders	Annually
Change bypass cartridge filter	Annually

6.1. Clean Optical Chamber

The optical chamber should be inspected if the data are uncharacteristically noisy. This procedure will ensure that there is no dust or contamination in the optical path. See Section 9.1 in the Magee Scientific User's Manual for reference.

Supplies for this procedure: a can of dust-off spray, a technical-grade ethanol, and cotton swabs.

1. If the measurements are running, press **Stop**. This procedure can also be done when the instrument is powered off.
2. Open the front door to access the optical chamber.
3. Using thumb and fingers on both sides of the optical chamber, lift the chamber upward against its springs. When the chamber is fully raised, lock it in place by pushing the metal latch. The chamber is now locked.
4. Find the release button on the front of the chamber.
5. While pressing the release button upward, grasp the lower portion of the optical head and turn it clockwise so the front of the chamber moves to the left. The lower portion will loosen from its bayonet fitting and can be removed.
6. The lower portion of the optical head consists of a translucent block. Clean all surfaces with ethanol. Put a few drops of ethanol in the openings and remove any dust or debris by using soft cotton swabs.
7. Repeat this procedure from both sides.
8. Use compressed air to remove any debris from the openings.
9. To re-install the optical head, align the notched marker to the left of center; push the optical head upwards to engage the three bayonet fittings; and turn counter-clockwise (so the front of the chamber moves to the right).
10. When the chamber is fully installed, the marker line will be at the front, and the locking pin will click back into place.
11. Using thumb and fingers on both sides of the optical chamber, lift the chamber upward. The locking latch will automatically release. Allow the chamber to return down to the tape.
12. Restart the instrument and resume measurements.

6.2. Perform Clean Air Test

The Clean Air test is conducted using the built-in filter to determine the stability and performance of the Aethalometer under the air flow conditions. The Clean Air test lasts for 20 minutes, during which time a Status Code of 2048 is shown. At the end of the test, a report is generated and saved to the CF card.

1. If the measurements are running, press **Stop**. If the Aethalometer is off, turn it on and wait a minimum of one hour for average BC values to stabilize.
2. Go to the **Operation/General** screen, and press the **Clean Air** button to start the test. **IMPORTANT: if you want the instrument to automatically proceed with BC measurements**

after the Clean Air test, please be sure to check the box "continue after test" before starting.

3. A new screen will list all relevant information about the test settings (test duration, flow, and timebase). When ready, press **OK**.
4. The instrument will begin the test. The Clean Air test uses a built-in filter to determine the stability and performance of the Aethalometer under dynamic conditions of air flow. Air is drawn through a cartridge filter (mounted on the top of the optical chamber), and this particle-free air then flows through the analytical system.
5. After 20 minutes, the test will stop automatically.
6. The Clean Air test procedure report will be generated and appear on the screen. A separate report will be generated and saved on the CF card for later download.
7. The test result is acceptable if the value of PPBC on Spot1 is lower than 550 ng/m^3 for Channel 6. If the reported value of PPBC on Spot 1 is larger than this value, please contact Magee Scientific or your authorized distributor.
8. Confirm completion of the test by pressing **OK**. The **Average BC** values should be close to zero (less than ±100) if the Aethalometer is warmed up and stabilized for at least one hour. Occasionally, a short transient may be seen at first due to a filter compression artifact.

6.3. Perform Stability Test

The stability test determines the performance of the light source and detector without air flowing through the system. The Stability Test lasts for 20 minutes; during this time, a Status Code of 1024 will be shown. At the end of the test, a report will be generated and saved to the CF card.

1. If the measurements are running, press **Stop**. If the Aethalometer is off, turn it on and wait a minimum of one hour for average BC values to stabilize.
2. Go to the **Operation/General** screen, and press the **Stability Test** button to start the test. **IMPORTANT: if you want the instrument to automatically proceed with BC measurements after the Stability Test, please be sure to check the box "continue after test" before starting.**
3. A new screen will list all relevant information about the test settings (test duration, flow, and timebase). When ready, press **OK**.
4. The instrument will begin the test, and will stop automatically after 20 minutes.
5. The Stability Test procedure report will be generated and appear on the screen. A separate report will be generated and saved on the CF card for later download.
6. The test result is acceptable if the value of PPBC on Spot1 is lower than 450 ng/m^3 for Channel 6. If the reported value of PPBC on Spot 1 is larger than this value, please contact Magee Scientific or your authorized distributor.
7. Confirm completion of the test by pressing **OK.** The **Average BC** values should be close to zero (less than ±100) if the Aethalometer is warmed up and stabilized for at least one hour.

6.4. Perform Inlet Leakage Test

Supplies: an external flow meter.

The Inlet Leakage test is used to test the integrity of the inlet system, from the point of sample entry to the instrument's analytical area. In many cases, the sample entry point is outdoors, while the instrument is indoors. This test detects any leakage throughout the system.

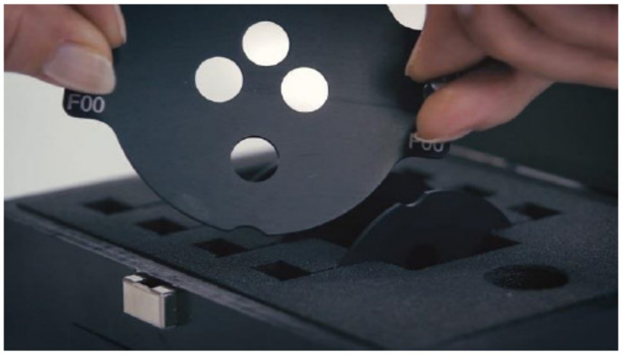
The test routine compares two measurement values from an external flow meter: one taken at the rear port of the instrument, and the other taken at the sample point of entry (which may be outdoors). The routine requires the use of the black rubber Flow Calibration Pad. During this test, data will be flagged by status code 6144.

1. From the **Operation/General** screen, press **Inlet Leakage Test**.
2. Follow the instructions on the screen to insert the Flow Calibration Pad.
3. Measure the flows with an external flow meter at the two points.
4. When the test is finished, a report will be generated. The leakage should be less than 10%. If the reported leakage is larger than 10%, please contact Magee Scientific or your authorized distributor.

6.5. Perform Neutral Density (ND) Filter Test

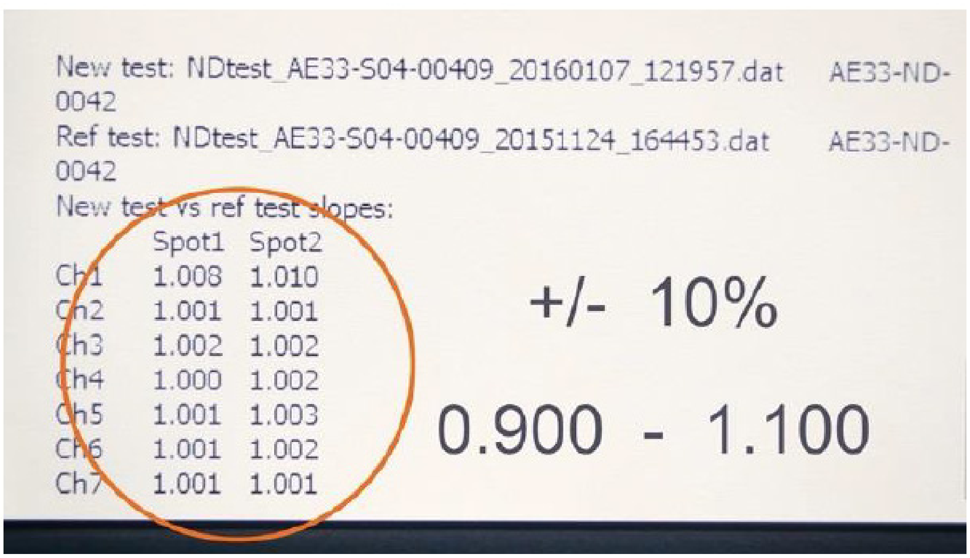
Supplies: an ND filter test kit.

1. Go to the **Operation/General** screen on the Aethalometer. If the measurements are running, press **Stop**.
2. Press the **ND test** button to start the test.
3. A new screen will prompt you to enter the ND Kit Serial Number, which is marked on the test kit box.
4. After entering the Serial Number of the ND Kit, confirm by pressing **Enter** and **OK**.
5. If this is the first time the ND Test has been performed on this instrument, you will be prompted for calibration parameters. These must be uploaded from the USB memory stick that is included in the ND kit box. Insert the USB stick into the USB port on the front panel, then press **Yes**.
6. The instrument will copy the calibration parameters file and then begin the test procedure.
7. Always keep the filter tape in position across the analytical area. When prompted, insert ND element No. 0 (zero) on top of the filter tape, with the "V" notch facing forward (see below).. Do not touch the glass—hold the element by the metal studs.



Press **OK** when inserted. Watch the screen, and remove the filter disk when prompted.

8. Repeat the same procedure when prompted for ND elements Nos. 1, 2, and 3.
9. The test is complete after ND element No. 3 is removed.
10. The instrument will generate a report that shows the instrument serial number, the date and time of the test, and the results of the test. This report will also be saved internally and will be available for future download.
11. Report values on both Spot1 and Spot2 should be within ±10% of 1.000: i.e., between 0.9 and 1.1, for all seven wavelengths (Ch1 to Ch7). See below.
12. If the results fall outside this range, repeat the test. If the results still fall outside the range, contact Magee Scientific.



6.6. Lubricate Optical Chamber Sliders

Supplies: silicon grease, and a cotton swab.

1. If the measurements are running, press **Stop**. This procedure can also be done when the instrument power is switched off.

2. Open the front door of the Aethalometer.
3. Put a small amount of grease on the cotton swab.
4. Apply the grease on all three sliders (vertical shafts) of the optical chamber (see below). Try to apply the grease uniformly over the whole length of the sliders.

5. Grasp the optical chamber with thumb and fingers on both sides, and move it up and down against its springs several times. This will distribute the grease over the full range of the sliders.

7. Troubleshooting

If there is an error code on the startup screen, refer to Section 13 of the manual for an extensive list of codes. Identify the code and problem from the list, and then call STI.

Appendix E. Standard Operating Procedures for Campbell Scientific CS120A Visibility Sensor

Standard Operating Procedures for Campbell Scientific CS120A Visibility Sensor

Prepared by
Sonoma Technology, Inc.
September 2019

1.1 Safety

Installation, operation, maintenance, repair, or calibration of the instrument and all support equipment should be performed by properly trained personnel. Personnel should meet all minimum requirements and qualifications for an Air Quality Field Technician. Maintenance on this sensor often involves working while elevated. Make sure to follow all safety procedures for elevated work when doing so.

1.2 Materials Needed

- Microfiber cloth
- Calibration bungs
- Calibration disk
- Micro-USB to USB-A cable

1.3 Startup Checklist

Verify that the following actions are completed when starting up the Campbell Visibility Sensor:

_____ Verify serial connections to the datalogger are correct (sensor TX to logger RX, sensor RX to logger TX, and sensor ground to any ground terminal on the logger)

_____ Check datalogger to see if data is coming from the sensor

_____ Check the data to make sure it makes sense (visibility value is a reasonable number and the correct values are being recorded to the right parameters)

_____ Make sure the lenses are clean and clear of obstructions (spider webs, etc.)

_____ Use a microfiber cloth (you can use a blower first). Do not use abrasive cleaners; use isopropyl alcohol only if needed.

1.4 System Verification Checks

The following tests will be performed as a verification of analyzer operation.

Calibration Prep

The sensor can be checked and adjusted using the optional sensor high grade calibration kit part number 28678 from Campbell Scientific. The calibration must be run using the onboard menu system. You can access this menu via LoggerNet's terminal emulation program using the port the sensor is connect to. For more info on how to use this program, see LoggerNet's documentation which can be accesses on Campbell Scientific's website.

The test should ideally be performed in the following conditions:

- Ambient temperature should be between 0ºC and 50ºC
- The local visibility should be approximately 10,000 metres or higher.

The system is self-regulating. However, it is recommended that the sensor is calibrated at least every two years.

The calibration is performed from menu item 3 on the main terminal screen.

Once you have selected menu item 3 you should be presented with the following screen.

```
CS125 CALIBRATION - MENU 3
ID 0
S/N 1006
(1) Perform calibration
(2) Restore the factory calibration
(3) Perform dirty windows zero offset calibration
(4) Restore dirty windows factory calibration

(9) Refresh
(0) Return to main menu
```

Select option 1 to start the calibration. You will then be asked to confirm that you would like to perform a calibration. Please note, once you have entered yes at this point you will not be able to exit until the test is complete. However, power cycling the unit at this point will have no adverse effect on the sensor.

Once you have started the tests you will be asked for the sensor calibrator serial number and coefficient with a confirmation at each step giving you the chance to correct typing mistakes.

```
Starting calibration.
Input the sensor calibrator serial number ->E2002
Is E2002 correct? (Y/N)?
Input the sensor calibrator constant ->28.8
Is 28.8 correct? (Y/N)?

Place one calibration bung into each hood, then press any key.
```

Dark Level Calibration

When you have entered the calibrator information the sensor will wait for you to place the foam bungs into the sensor hoods. The bungs are designed to block all light from the outside reaching inside the head. Place one bung into each hood. If either of the bungs are damaged or appear to have any gaps around the edge please contact Campbell Scientific.

```
Starting dark level calibration.
This test will take approximately two minutes
```

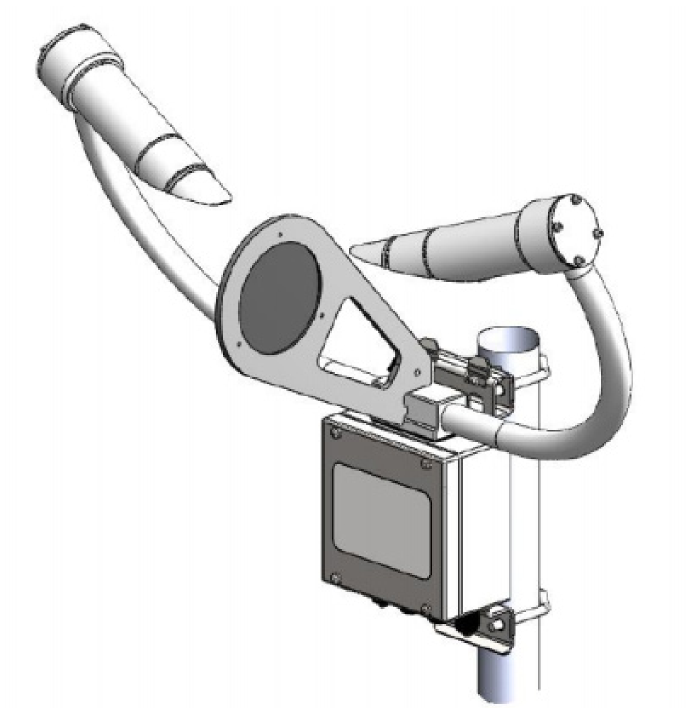
This part of the test will take approximately two minutes. Every ten seconds a dot should appear indicating that the test is progressing as normal.

```
Dark level test complete. Please remove the bungs.
Now place the sensor calibrator into the sampling
volume.
Press any key once this is done.
```

Remove the bungs once the sensor instructs you to.

Light Level Calibration

Place the sensor calibrator into the volume by fastening it to the central mounting point.



```
Starting light level calibration.
This test will take approximately two minutes.
```

This part of the test will take approximately two minutes. Every ten seconds a dot should appear indicating that the test is progressing as normal.

```
Calibration is now complete.
Saving user settings
Press any key to exit.
```

Once the second stage of the test has been completed the new calibration constants will be saved automatically. All calibration constants including both the user and the factory setting can be viewed from menu item 4 from the main menu once the test is completed. Document the new user calibration constant and the factory setting each time a calibration is done.

DO NOT forget to remove the calibration disk once finished.

END OF DOCUMENT