Appendix E.6

Updated Methodology for Assessment of Risk and PM2.5 Concentrations at Receptors near Locomotive Tracks in Fairfield, CA

ESA

Memorandum

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Date: 11 June 2014

Subject: Updated Methodology for Assessment of Risk and PM2.5 Concentrations at Receptors near Locomotive Tracks in Fairfield, Ca

The health risk assessment originally submitted as part of the update to the BAAQMD Permit Application in November 2013, and which included CEQA sources (offsite locomotives), was updated to include modeling of locomotives in Fairfield, California, and to include modeling of PM2.5 concentrations in addition to risk. Results of the revised screening-level health risk assessment (HRA) performed by ERM are provided in Table 1 below. This includes risk analysis for toxics listed in BAAQMD Reg. 2-5, including benzene, diesel particulate matter (DPM), ethylbenzene, toluene, xylenes, hexane, and hydrogen sulfide. As shown in Table 1, the cancer risk at the maximum exposed individual residential (MEIR) receptor, maximum exposed individual worker (MEIW) receptor, and maximum sensitive receptor (MSR) are all below 10 in a million. The chronic hazard index and the acute hazard index, at the MEIR, MEIW and MSR, are also below 1.0. In addition, PM2.5 concentrations are below 0.3 ug/m^3.

Table 1. Maximum Cancer and Noncancer Risk

Type of Estimated Health Impact	Cancer Risk per million (Receptor Location)	Chronic Hazard Index (Receptor Location)	Acute Hazard Index (Receptor Location)	PM2.5 Annual Concentration (ug/m^3) (Receptor Location)
Maximum Exposed Individual Residential (MEIR)	7.99 Worst case risk at 160 feet southeast of train tracks in Fairfield (585058E, 4234218N)	0.003 Worst case risk at 160 feet east of train tracks in Fairfield (585058E, 4234218N)	0.0030 Near E. 6th Street, Benicia (575694E, 4212345N)	0.0157 Worst case Conc. at 160 feet southeast of train tracks in Fairfield (585058E, 4234218N)
Maximum Exposed Individual Worker (MEIW)	4.45 (576144E, 4214145N)	0.014 (576144E, 4214145N)	0.0113 (576094E, 4212895N)	N/A
Maximum Sensitive Receptor	0.28 Day Care Center (574594E, 4212895N)	0.0005 Day Care Center (574594E, 4212895N)	0.0004 Elementary School (574900E, 4212500N)	0.00244 Day Care Center (574594E, 4212895N)

The following sources were modeled for the HRA using the ISCST3 air dispersion model:

1. *Locomotive idling – as point source;*
2. *Locomotive transit – as a line of volume sources;*
3. *Locomotive switching – as a line of volume sources;*
4. *Fugitive equipment leak – as rectangular area source*

The ISCST3 model is an EPA model approved by the BAAQMD for using in health risk assessment dispersion modeling. Locomotive emissions during transit mode were modeled over a track length of 4 miles out from the unloading rack. Beyond 4 miles there is no contribution to the total risk from the project sources at the refinery (locomotive idling, switching, and piping fugitives). Locomotive emissions during switching mode were modeled over an approximate two train–lengths (3300 feet) from the unloading rack. As a portion of the track within the facility would be used for both switching and transit, emissions from the two activities were added. Five years of meteorological data from the BAAQMD meteorological site "Valero Admin" (Site Id 8704) was used. These data can be downloaded from the BAAQMD website. The NAD 27 UTM coordinate system was used to identify source, receptor and building/structure locations. Digital Elevation Model (DEM) files were used to obtain the elevations for sources, receptors, and buildings/structures.

Figure 1 shows the receptor grid modeled and Figure 2 shows the location of modeled sources, facility boundary, and locations of maximum exposed receptors.

Risk was directly modeled in ISCST3 using the unit risk factors (URFs) for cancer risk and reference exposure levels (RELs) for non-cancer risk, as the exposure pathway for all the toxic air contaminants (TACs) emitted from the above sources is inhalation only. The risk input to the ISCST3 model, for each source, was calculated as shown below. As a result, the ISCST3 model output is residential cancer risk in terms of risk per million and non-cancer risk in terms of hazard index.

$$Cancer\ Risk\ Modeled_j = \sum_i ER_i\ x\ URF_i\ x\ 10^6$$

$$Non - Cancer\ Risk\ Modeled_j = \sum_i \frac{ER_i}{REL_i}\ x\ 10^6$$

Where:

j	=	*Emissions source modeled*
i	=	*Toxic air contaminant*
ER	=	*Emission rate of toxic air contaminant i in g/s from source j*
URF	=	*Unit risk factor of toxic air contaminant i*
REL	=	*Reference exposure level of toxic air contaminant i*

The detailed emissions spreadsheet for the modeling input, and a figure showing modeled impact locations, are attached to this memorandum.

Cancer risk at the MEIR was estimated as modeled residential risk multiplied by the BAAQMD-recommended age specific factor of 1.7. It must be noted that there are no residences within 1,000 feet of the refinery or along the 4 miles of modeled train route. However, in Fairfield, CA the locomotives would travel along the tracks adjacent to residences and Armijo High School. These residences are as close as 50 feet from the train route in Fairfield, CA which falls within the BAAQMD jurisdiction. Since the modeling domain did not extend all the way to Fairfield, a separate model run was conducted to model the locomotives that travel through Fairfield, CA, as a string of volume sources the length of a 50-car train. Residences in Benicia near the refinery are much farther away from the locomotives passing through Fairfield; thus the MEIR was modeled in Fairfield. For the Fairfield modeling, a five-year meteorological dataset from the Suisun Sewage Treatment Plant, adjacent to Fairfield, was used in the modeling.

Cancer risk at the MEIW was estimated as modeled residential risk multiplied by 0.2199, which is the average OEHHA adjustment factor to convert inhalation based cancer risk estimates for a residential receptor to a worker receptor, based on the difference in the length of time of exposure.

The sensitive receptor with highest modeled residential risk is a day care center in Benicia. The modeled cancer risk at this location was estimated as shown below:

$$Modeled\ Cancer\ Risk\ = \frac{Modeled\ Residential\ Risk\ x\ ED_C x\ ASF}{ED_R}$$

Where:

ED_C = Exposure duration for children at school = 9 years
ASF = Age sensitivity factor for children at school = 3.0
ED_R = Exposure duration for residential receptor = 70 years

Factors listed above are standard factors used in the calculation.

Locomotive Travel through Other Air Districts

A modeling assessment of risk and PM2.5 concentrations near tracks elsewhere along the route to and from Roseville was also conducted for the Yolo-Solano, Sacramento, and Placer County air districts. The results of the analysis are shown in Table 2 below. The analysis methodology is identical to that described for Fairfield above, except meteorological data from the Sacramento Executive Airport was used for the modeling analysis. This station is more representative of these other areas than that used for Benicia or Fairfield. This is the only meteorological dataset available for use in the ISCST model for that area. Emissions used in the modeling are the same as those used for Fairfield. Figures showing the modeled impact locations are also attached.

Table 2. Maximum Cancer and Non-cancer Risk at Locations Near Rail Tracks in Other Air Districts			
Location of Estimated Health Impact	**Cancer (per million)***	**Chronic Hazard Index**	**PM2.5 Annual Concentration (ug/m3)**
Yolo-Solano Air District (Dixon) 603050 E, 4256574 N	3.91	0.0015	0.0077
Sacramento Air District (Sacramento) 643028 E, 4283130 N	4.25	0.0018	0.0089
Placer Air District (Roseville) 648387 E, 4290123 N	4.59	0.0017	0.0084
Significance Threshold	10	1	N/A

*Includes an Age Sensitivity Factor of 1.7, applicable in the BAAQMD.

Cumulative Analysis

A screening-level cumulative risk was also evaluated in the vicinity of the MEIR noted in Table 1, as recommended in the 2010 BAAQMD CEQA Guidelines, to estimate the combined exposure from the project locomotives, existing locomotives using these tracks, and stationary sources of TACs within 1,000 feet of the MEIR. The BAAQMD provides a Google Earth tool that displays the screening-level health risks and PM2.5 concentrations from TAC sources in each county (BAAQMD 2014). The stationary (top half of table) and existing locomotive sources (bottom half of table) within 1,000 feet of the MEIR are shown in Table 3 below. The cancer risk and PM2.5 concentration values shown in these tables below (outlined in a bold border) were summed for an estimate of cumulative risk at the MEIR.

Table 3. CUMULATIVE ANALYSIS IN FAIRFIELD

Risk and PM2.5 Concentration from Stationary Sources within 1,000 feet of the Maximum Exposed Individual Residence in Fairfield Obtained from BAAQMD Google Earth Data

	Commercial Business	Commercial Business	Commercial Business	Commercial Business	Commercial Business	Commercial Business
Address	744 N Texas Street, Fairfield	1350 N Texas Street, Fairfield	110 Railroad Ave, Ste G, Suisun City	106 Railroad Ave, Suisun City	890 E Travis Boulevard, Fairfield	409 Railroad Ave, Ste B, Suisun City
East UTM Coordinate	584489	584598.388	584768	585018.981	585723	585870
North UTM Coordinate	4234104	4234294.921	4233988	4234204.101	4234917	4234770
Cancer Risk (per million)	0	0	0	16.236956	23.902249	9.18
PM2.5 Annual Concentration (ug/m3)	N/A	0	0	0.029	N/A	0

Risk from Existing Locomotives Traveling on Railroad in Fairfield

	PM2.5	Risk
10 ft N	0.082	47.298
25 ft N	0.065	37.371
50 ft N	0.05	28.81
75 ft N	0.041	23.755
100 ft N	0.035	20.381
200 ft N	0.023	13.456
300 ft N	0.017	10.285
400 ft N	0.014	8.43
500 ft N	0.012	7.157
750 ft N	0.009	5.247
1000 ft N	0.007	4.16
10 ft S	0.139	80.176
25 ft S	0.114	66.021
50 ft S	0.091	52.724
75 ft S	0.077	44.487
100 ft S	0.067	38.83
200 ft S	0.046	26.877
300 ft S	0.036	21.141
400 ft S	0.03	17.675
500 ft S	0.026	15.303
750 ft S	0.02	11.568
1000 ft S	0.016	9.305

Source: http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Tools-and-Methodology.aspx

Total Cancer Risk (chances in a million)	**88.1**
Total PM2.5 Concentration ($\mu g/m^3$)	**0.10**

Near-Refinery Cumulative Analysis

As noted above, the project health risk assessment modeling found the Maximum Exposed Individual Residence (MEIR) to be at a residence in Fairfield adjacent to the rail tracks primarily as a result of the increase in train traffic for the Benicia Refinery project. Even though risks were determined to be below significance thresholds, cumulative risk was evaluated for sources within 1,000 feet of that location.

Similarly, an additional cumulative assessment was also performed to evaluate the combined risks at residences near the refinery from diesel particulate matter sources from the project, I-680, and existing rail traffic on the tracks near the refinery. As part of this cumulative assessment, the health risk assessed for the Valero Improvement Project (VIP) and VIP Amendments was also combined with the above sources to estimate the contribution to risk from existing sources at the refinery.

Screening-level cumulative risk was evaluated in the vicinity of residences near the refinery where the maximum risk and PM2.5 concentration was modeled. This modeled residence is located to the southwest of the refinery. The BAAQMD provides a Google Earth tool that displays the screening-level health risks and PM2.5 concentrations from freeways and rail sources in each county (BAAQMD 2014). The results of the near-refinery residential cumulative risk from the project, the recent VIP/VIP Amendments project, and the freeway and rail sources obtained from the BAAQMD Google Earth tool are presented below in Tables 4 and 5.

Table 4. Combined Risk Values at Maximum Exposed Residence Near the Valero Refinery UTM 575,694 E (meters), 4,212,345 N (meters)

Type of Estimated Health Impact	Source of Contribution to Risk and PM2.5 Concentration				TOTAL	TOTAL with ASF
	Crude by Rail Project	I-680 (at 1,000 feet W)	UP Rail Tracks (at 1,000 feet W)	VIP Project[2]		
Cancer Risk (per million)	0.99	3.47	1.65	2.38[2]	8.49	14.4[1]
PM2.5 Annual Concentration (ug/m^3)	0.003	0.024	0.002	N/A	0.029	0.029

[1]Includes Age Sensitivity Factor (ASF)

[2]Valero Improvement Project Draft Environmental Impact Report, Table 4.7-9, Maximum Nonresidential Location, and the Valero Improvement Project Amendments – Environmental Analysis, Table 3.1.8-2 and Table 3.1.8-3.

[3]Values for I-680 and UP Rail Tracks are obtained from Table 5 below (bold bordered).

Table 5. Freeway and Rail Risk and PM2.5 Values from BAAQMD Google Earth Tool

I-680			Rail		
	PM2.5	Risk		PM2.5	Risk
10 ft W	0.273	37.642	**10 ft W**	0.032	18.608
25 ft W	0.222	30.791	**25 ft W**	0.027	15.612
50 ft W	0.172	23.917	**50 ft W**	0.021	12.417
75 ft W	0.142	19.764	**75 ft W**	0.018	10.372
100 ft W	0.121	16.981	**100 ft W**	0.015	8.919
200 ft W	0.079	11.189	**200 ft W**	0.01	5.802
300 ft W	0.061	8.563	**300 ft W**	0.007	4.276
400 ft W	0.049	7.019	**400 ft W**	0.005	3.389
500 ft W	0.042	5.96	**500 ft W**	0.004	2.822
750 ft W	0.031	4.377	**750 ft W**	0.003	2.061
1000 ft W	0.024	3.467	**1000 ft W**	0.002	1.647
10 ft E	0.456	62.905	**10 ft E**	0.077	44.529
25 ft E	0.37	51.191	**25 ft E**	0.069	39.968
50 ft E	0.285	39.577	**50 ft E**	0.058	33.357
75 ft E	0.235	32.682	**75 ft E**	0.049	28.636
100 ft E	0.202	28.048	**100 ft E**	0.043	25.161
200 ft E	0.131	18.313	**200 ft E**	0.03	17.603
300 ft E	0.099	13.858	**300 ft E**	0.024	13.833
400 ft E	0.08	11.199	**400 ft E**	0.02	11.539
500 ft E	0.067	9.402	**500 ft E**	0.017	9.954
750 ft E	0.047	6.675	**750 ft E**	0.013	7.574
1000 ft E	0.035	5.001	**1000 ft E**	0.01	6.187

Source: http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Tools-and-Methodology.aspx.

The values in the bold border are used in Table 4 above for the contribution to cumulative risk near the refinery.

Crude by Rail Project
Locomotive DPM Emissions for CEQA Modeling
4 June 2014
Annual Emissions

Year 2014 Annual Locomotive DPM Emissions - 100 Railcars per Day

Parameter	Value	Unit	Reference
Additional Annual Tank Cars due to Project	36,500	Cars/year	Based on Project Description
Maximum Freight Weight	106	short tons/car	TRN Spec Sheet-1
Annual Freight Transported due to Project	3,861,700	short tons/year	Based on Project Description
Weight of Empty Tank Car	37	short tons/car	TRN Spec Sheet-1
Total Annual Weight of Empty Tank Cars	1,357,800	short tons/year	
Annual Gross Weight Hauled	5,219,500	short tons/year	Freight Weight + Empty Railcar Weight
Number of Railcars per Train	50	Cars/train	
Length of Line Source	3,000	feet	Google Earth and diagram provided by Valero
Average Fuel Efficiency[1]	400	ton-mi/gal	pg.3 of EPA-420-F-09-025 April 2009 "Emission Factors for Locomotives"
Average Train Size	50	cars/train	Project Description
Length of Railcars	60	ft	
Length of One Train	3,000	ft	
Number of Trains per Day	2	trains/per day	

[1]Based on data collected by the Association of American Railroads for revenue ton-miles and fuel consumption, which show that about one gallon of fuel is consumed by the railroads to haul 400 tons-miles of freight. Thus dividing g/gal emission rates by 400 ton-miles/gal gives approximate g/ton-mile emission rates.

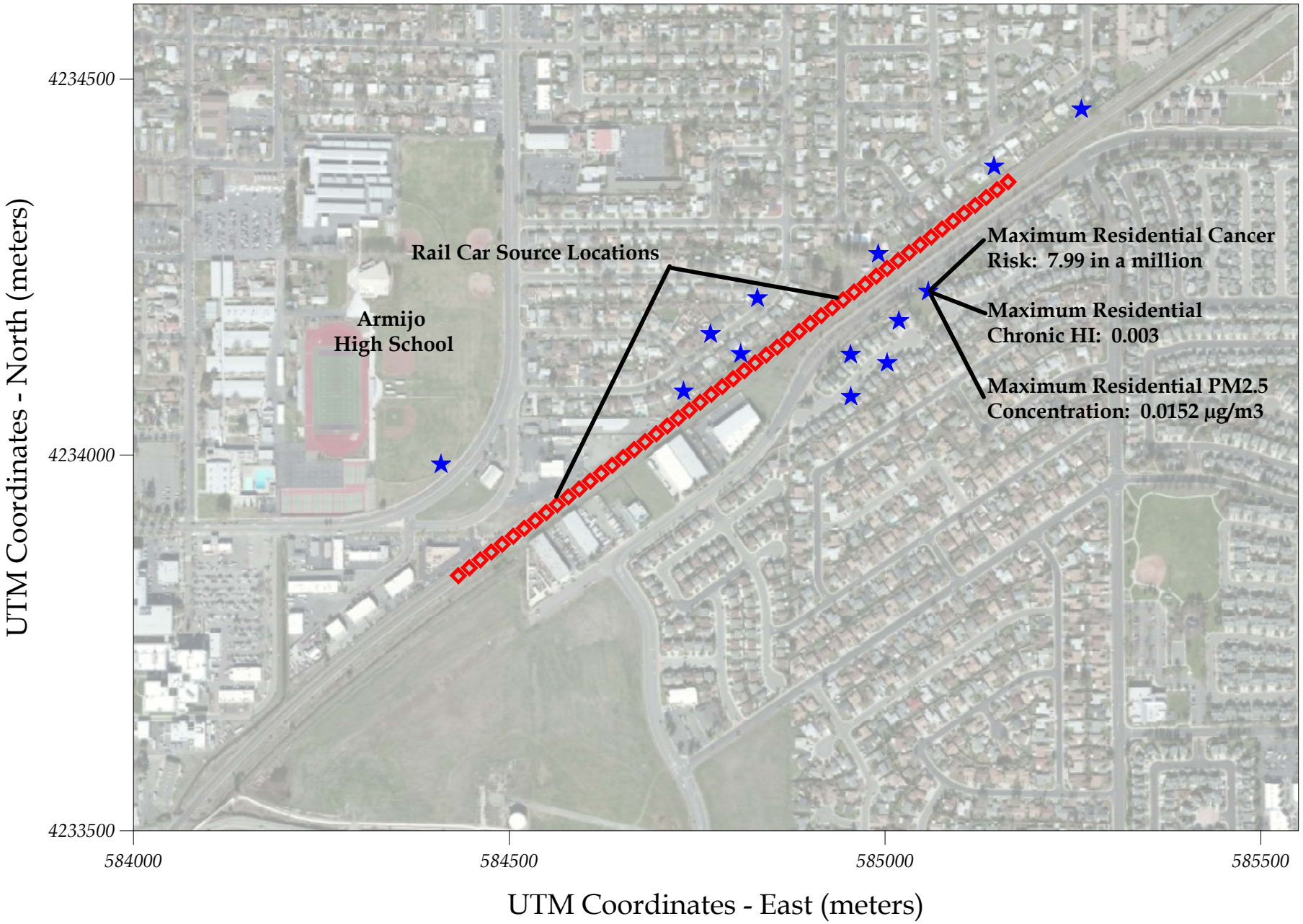
Source Type - Mode	2014 PM10 Locomotive Emissions Factor		DPM Emissions
	Value	Unit	g/s
Line Source - Running Full[1]	3.4	g/gal fuel	0.001183
Line Source - Running Empty[1]	3.4	g/gal fuel	0.000416
Total			0.001183
1. Emission Factors for large line haul Locomotives in calendar year 2015. Source: EPA-420-F-09-025, April 2009			

Cancer Risk	DPM		Risk to Model	Total Number of Sources	Risk to Model per Source	DPM (PM2.5) to Model per source
Source	**g/s**	**URF**	**per million**		**per million**	
Locomotive Travel	0.00118	3.00E-04	0.35484	51	0.006958	2.32E-05

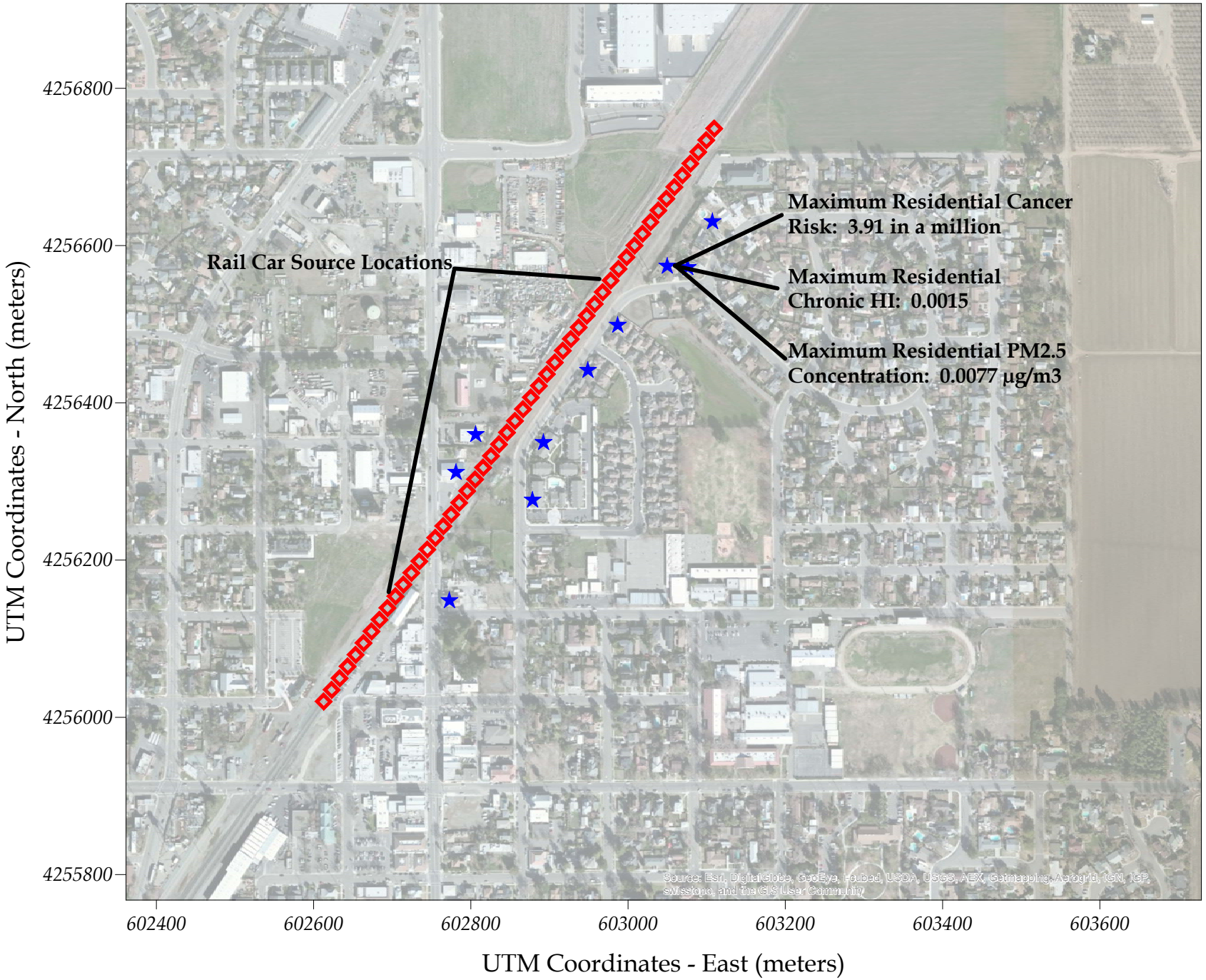
Chronic Risk	DPM		Risk to Model	Total Number of Sources	Risk to Model
Source	**g/s**	**REL**	**Chronic Hazard Index**		**Chronic Hazard Index**
Locomotive Travel	0.00118	5.00E+00	0.0002	51	4.64E-06

Locomotive Small Line Haul - Line Source (As Separated Volume Source)					
Track Length Considered for Modeling	3,000	feet		0.6	miles
Length of the Line Source, L_{RS}	3,000	ft		0.6	miles
Width of the Line Source, W (Width of one track + 3 m on each side)*	30	ft		9.1	m
Source Type	Line source represented by separated volume sources, Elevated source not on or adjacent to a building				
Length of the Side of the Line/Volume Source = W	30	ft		9.1	m
Spacing of Separated Volume Source Along Line (c/c)	59	ft		18.1	m
Starting Location	Offset Half Volume Width				
Release Height (stack height of 15 ft + avg. vertical plume rise)*	45.8	ft		13.95	m
Initial Lateral Dimension (SYINIT) = 2W/2.15	27.62			8.42	m
Initial Vertical Dimension (SZINIT) = Release Height/4.3	10.64			3.24	m
Number of Volume Sources Generated by BEEST Model	51	volume sources/line		51	volume sources/line

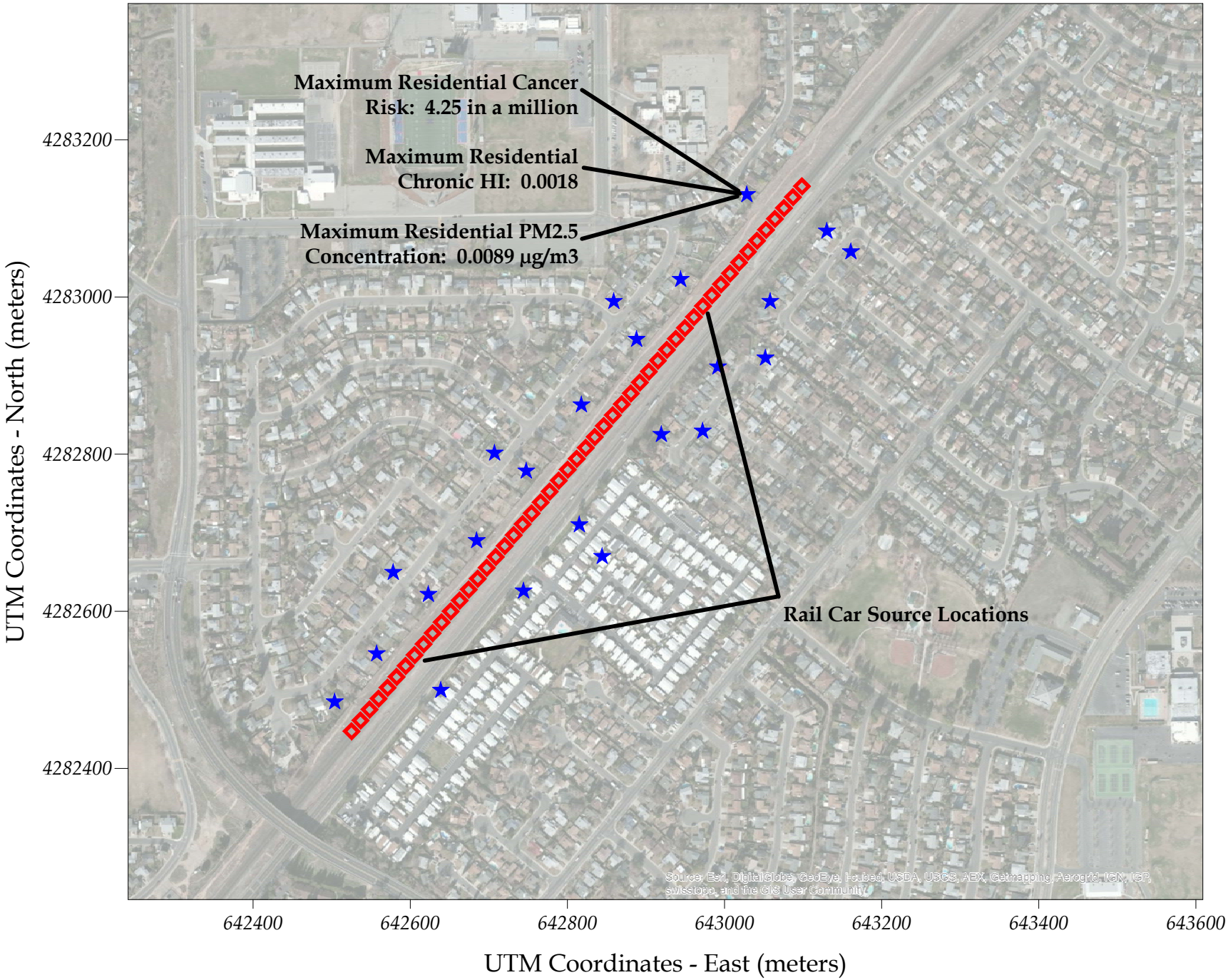
*Appendix C3, Health Risk Assessment for the Southern, California Intermodal Gateway (SCIG), Pg 23/89, http://www.portoflosangeles.org/EIR/SCIG/DEIR/APPENDIX_C3.p
Release parameters obtained from Railyard studies such as
http://www.arb.ca.gov/railyard/hra/env_sheila_admrpt.pdf
http://www.arb.ca.gov/railyard/hra/sr_oak_rpt.pdf
* Average of day time and night time release height for arriving and departing line haul in Table 4-1. http://www.arb.ca.gov/railyard/hra/env_richmond_admrpt.pdf



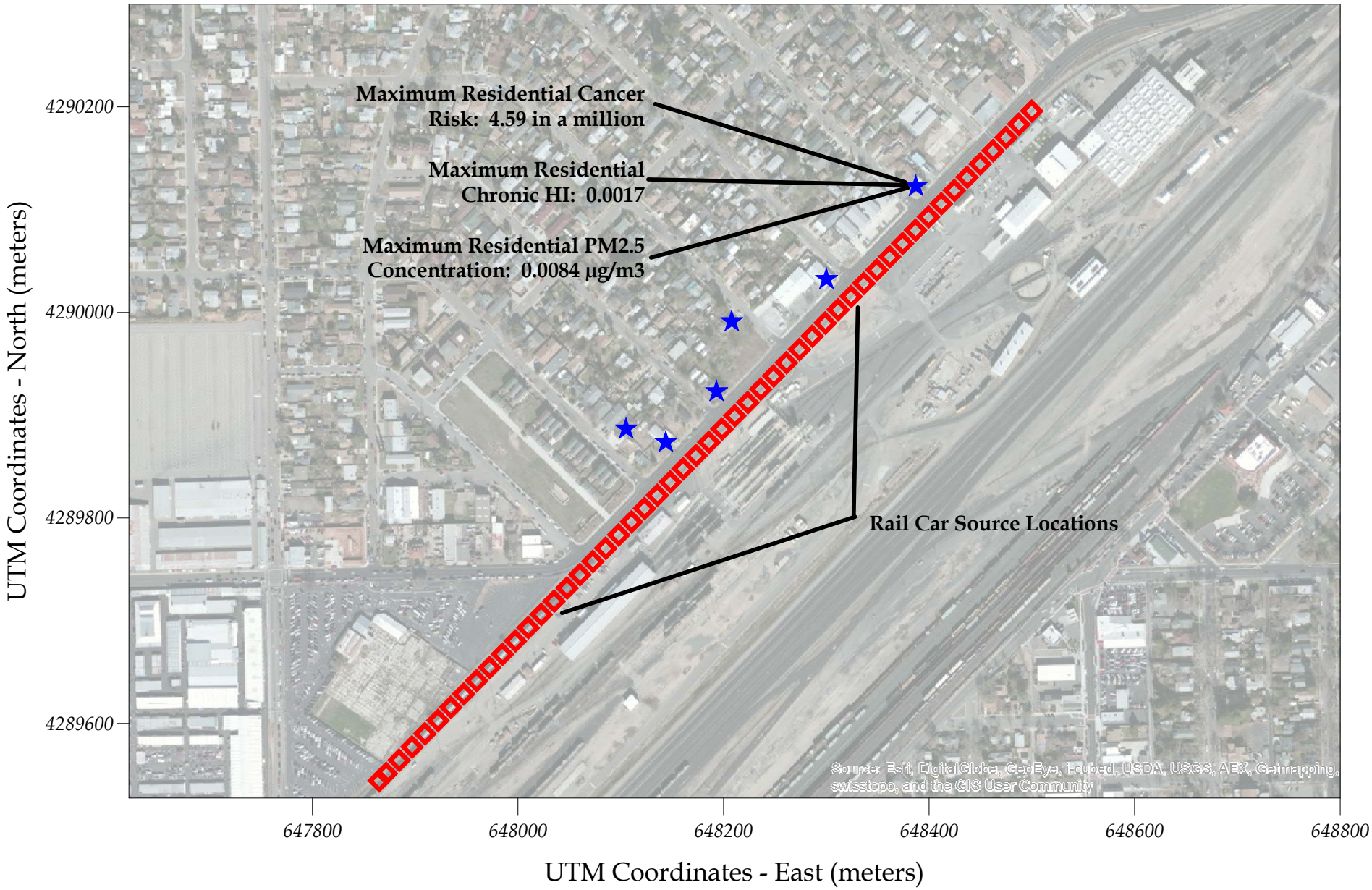
Fairfield Rail Source Locations and Modeling Health Risk Results
Valero Crude by Rail Project
Benicia, California



Yolo Solono County Rail Source Locations and Modeling Health Risk Results
Valero Crude by Rail Project
Benicia, California



Sacramento County Rail Source Locations and Modeling Health Risk Results
Valero Crude by Rail Project
Benicia, California



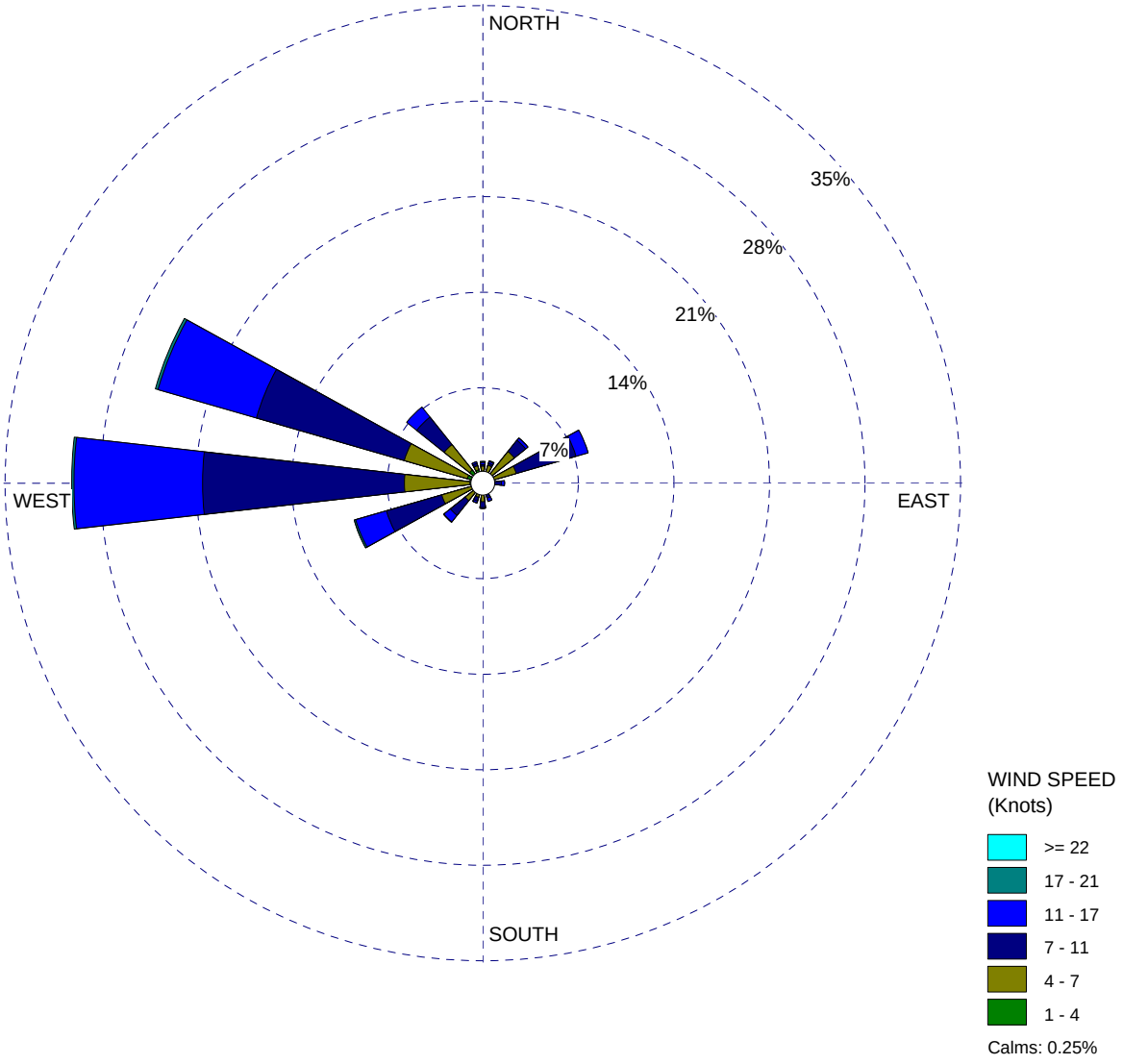
Placer County Rail Source Locations and Modeling Health Risk Results
Valero Crude by Rail Project
Benicia, California

WIND ROSE PLOT:

Valero Refinery, Benicia, California

DISPLAY:

Wind Speed
Direction (blowing from)



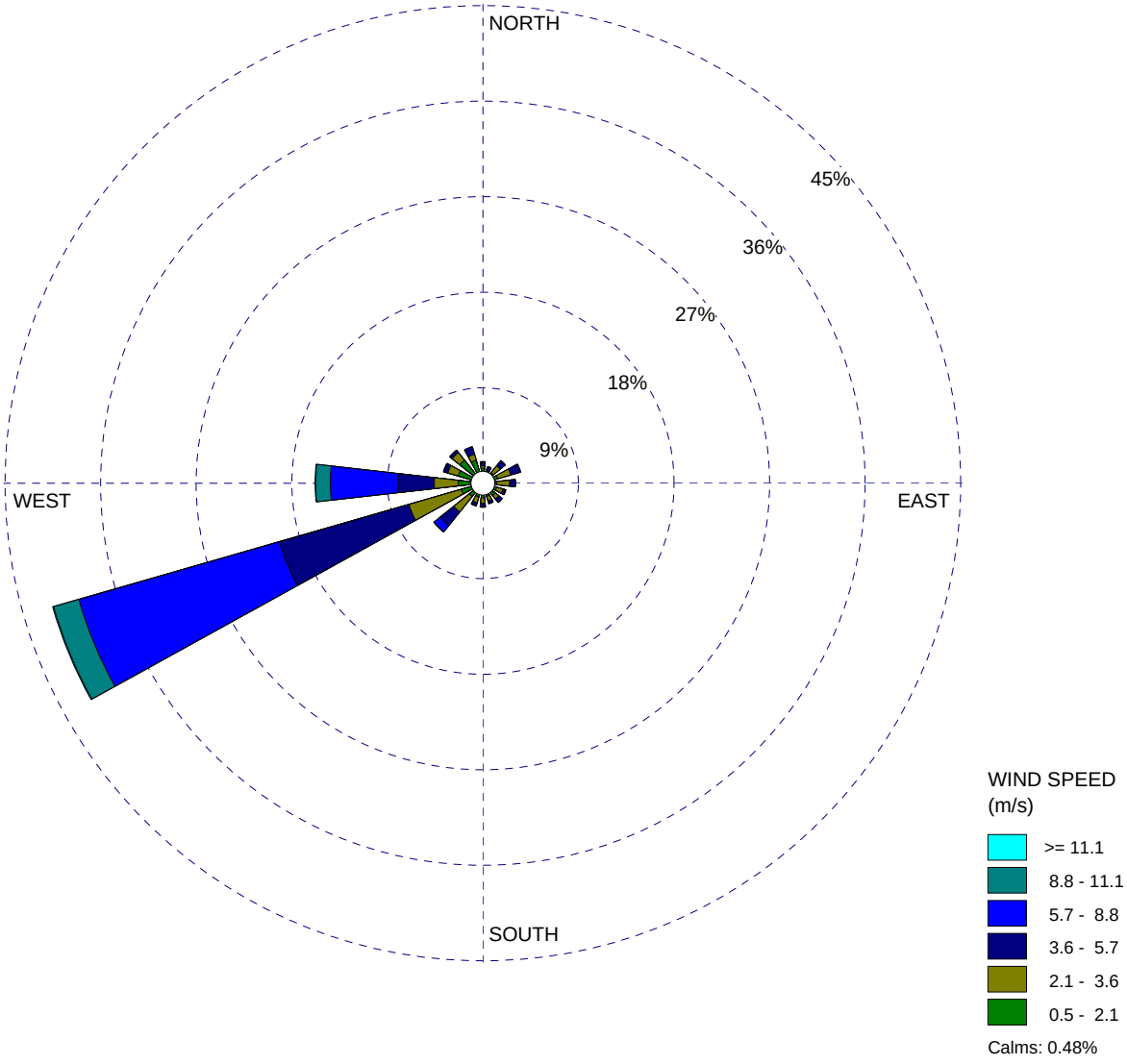
COMMENTS:	DATA PERIOD:	COMPANY NAME:	
2000, 2001, 2003, 2004	**Start Date: 1/1/2000 - 00:00** **End Date: 12/31/2005 - 23:00**	MODELER:	
	CALM WINDS: **0.25%**	TOTAL COUNT: **43824 hrs.**	
	AVG. WIND SPEED: **8.59 Knots**	DATE: **6/10/2014**	PROJECT NO.:

WIND ROSE PLOT:

Suisun City, California

DISPLAY:

Wind Speed
Direction (blowing from)



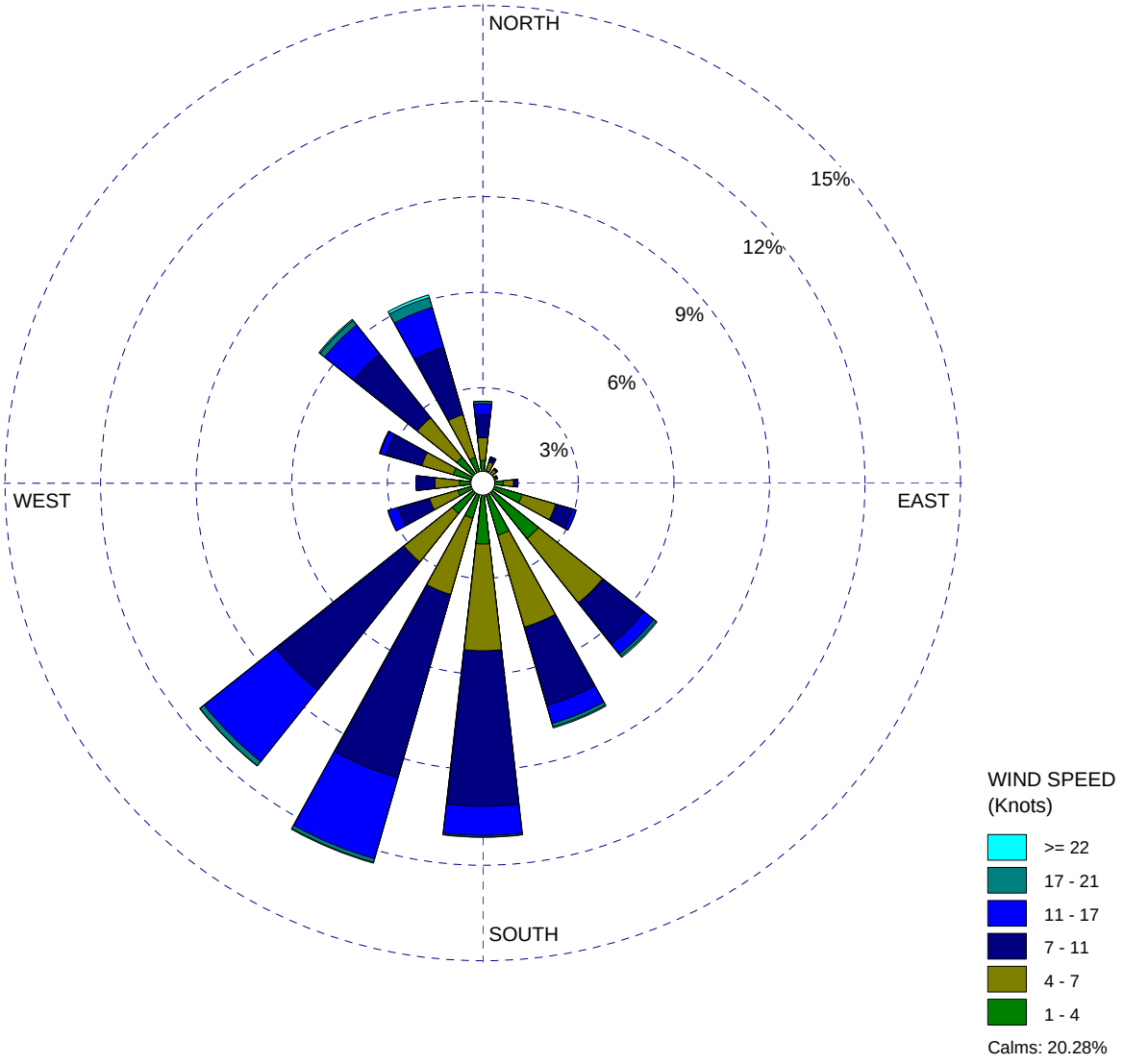
COMMENTS: 2001 through 2005	DATA PERIOD: **Start Date: 1/1/2001 - 00:00** **End Date: 12/31/2005 - 23:00**	COMPANY NAME:	
		MODELER:	
	CALM WINDS: **0.48%**	TOTAL COUNT: **43824 hrs.**	
	AVG. WIND SPEED: **4.30 m/s**	DATE: **6/12/2014**	PROJECT NO.:

WIND ROSE PLOT:

Sacramento Executive Airport

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS: 2001 through 2005	DATA PERIOD: **Start Date: 1/1/1985 - 00:00** **End Date: 12/31/1989 - 23:00**	COMPANY NAME:	
		MODELER:	
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	AVG. WIND SPEED: **6.06 Knots**	DATE: **6/12/2014**	PROJECT NO.: