AECOM Environment

Prepared for:
Tesoro Refining and Marketing Company
Los Angeles Refinery
Wilmington, CA

Prepared by:
AECOM
Camarillo, CA
60308776
January 2014

AB 2588 Health Risk Assessment for the Tesoro Refining and Marketing Company Los Angeles Refinery (SCAQMD ID No.: 800436)

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List of Acronyms

AER	Annual Emissions Reporting
AT	alimentary tract
bhp	brake horsepower
BO	bone
CARB	California Air Resources Board
CAS	Chemical Abstract System
CN	central nervous system
CV	cardiovascular system
DEM	Digital Elevation Model
DPM	diesel particulate matter
DV	developmental
EN	endocrine
EPA	Environmental Protection Agency
EY	eye
F	Fahrenheit
ft	feet
g/s	grams per second
HARP	Hot Spots Analysis and Reporting Program
HE	hematologic
HI	hazard index
HRA	Health Risk Assessment
IC	internal combustion
IM	immunological system
ISCST3	Industrial Source Complex Short Term, Version 3
KI	kidney
km	kilometer
LAR	Tesoro Refining and Marketing Company's Los Angeles Refinery
lbs/hr	pounds per hour
lbs/yr	pounds per year
m	meter
MEIR	maximum exposed individual resident
MEIW	maximum exposed individual worker
NAD	North American Datum
OEHHA	Office of Environmental Health Hazard Assessment
PMI	point of maximum impact
RE	respiratory system

REL	reference exposure level
RP	reproductive system
SCAQMD	South Coast Air Quality Management District
SK	skin
TAC	toxic air contaminant
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
ug/m^3	micrograms per cubic meter
ZOI	zone of impact

Glossary of Definitions

Acute Health Impacts: Health effects that occur over a relatively short period of time (e.g., minutes or hours). The term is used to describe brief exposures and effects that appear promptly after exposure.

Cancer Health Impacts: Estimates of health risks associated with long-term exposures resulting from emissions of carcinogenic agents. The maximum individual excess cancer risk is an estimate of the highest increased cancer risk any off-site individual can expect from a lifetime (70 years) of exposure to emissions of toxic air contaminants.

Chronic Health Impacts: Adverse non-cancer health effects that develop and persist (e.g., months or years) over time after long-term exposure to a substance.

Hazard Index: The sum of individual acute or chronic hazard quotients for each substance affecting a particular toxicological endpoint.

Health Risk Assessment (HRA): A study of the potential health risks to the public from a facility's toxic air contaminant emissions.

Maximum Exposed Individual Resident (MEIR): MEIR is the off-site location of an actual residence that has the highest estimated impact for each health effect.

Maximum Exposed Individual Worker (MEIW): MEIW is the off-site location of an actual business that has the highest estimated impact for each health effect.

Point of Maximum Impact (PMI): The PMI is the off-site location with the highest estimated impact level for each health effect, and does not necessarily coincide with the presence of an individual. The PMI typically occurs on or near the property fenceline, where air toxic concentrations are highest.

Population Cancer Burden: Population cancer burden is the population-weighted number of excess cancer cases resulting from lifetime exposure to pollutants and based on a defined population.

Sensitive Receptor (SEN): A location where individuals are considered to be more sensitive to pollutants than average. Sensitive receptor locations include schools, day care facilities, convalescent homes, and hospitals.

Toxic Air Contaminant (TAC): An air pollutant that may cause or contribute to an increase in mortality or in serious illness, or that may pose a present or potential hazard to human health.

Zone of Impact (ZOI): The ZOI is defined as the geographic area within which the total excess lifetime cancer risk to all emitted carcinogens is 1 in 1 million or greater, or a chronic or acute hazard index of 0.5 or greater.

1.0 Executive Summary

The Air Toxics “Hot Spots” Information and Assessment Act of 1987 (AB 2588) requires facilities that may cause a significant increase in public health risks from their operations due to the emissions of toxic air contaminants (TAC) to assess those impacts in a health risk assessment (HRA). The Tesoro Refining and Marketing Company’s Los Angeles Refinery (LAR) was required by the South Coast Air Quality Management District (SCAQMD) to prepare an updated HRA using 2006–2007 emissions (per the notice dated May 25, 2009) to reflect current operations and emissions from the facility. The previous HRA was approved by the SCAQMD in 2000 and was based on 1996 emissions inventory data. The SCAQMD requires that the updated HRA include all updated health risk factors and evaluate emissions of TACs recently determined by the California Office of Environmental Health Hazard Assessment (OEHHA) to cause cancer or adverse non-cancer health impacts that may not have been evaluated in the previous HRA. Examples of such pollutants are diesel exhaust particulate matter (DPM) and naphthalene. The SCAQMD requested that the updated HRA include DPM emissions from all stationary and portable internal combustion (IC) engines, and that the HRA consider SCAQMD Rule 1470 diesel combustion activity and emissions rates for all stationary diesel engines greater than 50 brake horsepower (bhp) (Appendix A).

The HRA was submitted to the SCAQMD in November 2009. The HRA was revised in October 2011 in response to comments from the SCAQMD received in July 2011. The revisions included corrections to locations of some sources and updated estimates of DPM emissions from IC engines. The HRA has subsequently been revised to correct some source locations and stack parameters (Appendix B).

The LAR HRA is a multi-pathway risk analysis performed using the Hot Spots Analysis and Reporting Program (HARP) software package (Version 1.4d, January 2011)[1] developed by the California Air Resources Board (CARB) for conducting health risk assessments in California under the Air Toxics Hot Spots Program (CARB 2011). The HARP modeling system is a comprehensive health risk assessment tool that contains air emissions, dispersion, and risk analysis modules. The methods used to assess potential human health risks are consistent with those prepared by The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments (OEHHA 2003), which describes algorithms, exposure methods, and cancer and non-cancer health values needed to perform an HRA under AB 2588. This guidance manual is generally considered the best available reference for conducting human health risk assessments in California.

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[1] HARP Version 1.4d, January 2011, is the latest version of the HARP model that was available when the HRA was revised in October 2011. It was used for the current HRA revision to be consistent with the previous revision.

This HRA contains three quantitative determinations: emissions estimation, air dispersion analysis, and health risk characterization. Source emissions of TACs from the facility as reported in the 2006–2007 Annual Emissions Reporting (AER) were estimated using various approved emissions factors from the SCAQMD, U.S. Environmental Protection Agency (EPA), and prior source testing. Exposure calculations were performed using air dispersion modeling analysis to predict ground-level air concentrations by source. Results of the air modeling exposure predictions were applied to emissions estimates and, along with the respective cancer health risk factors and chronic and acute non-cancer reference exposure levels for each toxic substance, used to perform a health risk characterization that quantified individual health risks associated with predicted levels of exposure.

1.1 Facility Information

Tesoro Refining and Marketing Company operates the Los Angeles Refinery (SCAQMD ID: 800436), located at 2101 East Pacific Coast Highway, Wilmington, California. The facility is bounded by East Sepulveda Avenue to the north, the Dominguez Channel to the east, South Alameda Street to the west, and Southern Pacific Railroad to the south. Figure 1-1 shows the general location of the refinery; a facility plot plan is provided in Appendix C.

The predominant land use in the immediate vicinity of the facility is port-related storage and manufacturing, and light and heavy industry. These areas are considered actual worker locations per SCAQMD guidance, and were evaluated as potential worker receptor locations. The predominant residential areas immediately around the facility are to the east and southwest. The nearest residential receptor is approximately 0.5 mile to the southwest. Sensitive receptors are defined as groups of individuals that may be more susceptible to health risks from TAC exposure. These include infants and children, older adults, the chronically ill, and any other members of the general population who are more susceptible to the effects of TAC exposure than the population at large. Sensitive receptor locations include schools, day care facilities, convalescent homes, and hospitals. Forty-eight sensitive receptors were identified for inclusion in the HRA. This HRA included emissions from various sources at the facility, as reported in the 2006–2007 AER.

1.2 Air Toxic Contaminant Emissions

This HRA is based on TAC emissions as reported in the 2006–2007 AER to the SCAQMD, per the agency's guidance. A total of 51 TACs were identified in the AER as being emitted from the facility, including 20 TACs that contribute to cancer risk, 23 TACs that contribute to non-cancer chronic impacts, and 18 TACs that contribute to acute non-cancer impacts. Of the 51 reported TACs, 15 TACs do not have health values (see Table 2-2). All annual estimated TAC emissions were evaluated in the HRA based on the mass emissions reported in the AER, with the following exceptions:

- Emissions factors from the CARB Off-Road Engine Emissions Factor Model and SCAQMD off-road equipment factors were used to estimate DPM emissions from off-road engines, including stationary emergency internal combustion (IC) engines and portable equipment (six air compressors and six firewater engines).

- DPM emissions from stationary emergency IC engines were determined based on permitted limits using the non-emergency operating limits of 20 or 50 hours per year, and a maximum allowable emergency usage of 199 hours per year.

- Because contractor portable equipment usage can vary substantially from year to year, portable equipment emissions from contractor activities were based on fuel usage information for contractor activities over the past several years (through 2010), which provides more accurate annualized usages for routine activities than were included in the 2006–2007 AER.

Table 1-1 presents the maximum 1-hour and annual facility emissions by substance in pounds per hour (lbs/hr) and pounds per year (lbs/yr), respectively.

1.3 Dispersion Modeling and Exposure Assessment

Air dispersion modeling and health risk analysis were used to assess exposure to TAC emissions from the LAR. The HRA was performed using the HARP software package (Version 1.4d, January 2011), which is a comprehensive health risk assessment tool that contains air emissions inventory, dispersion, and risk analysis modules. The dispersion analysis was performed in HARP using the Industrial Source Complex (ISCST3 version 99155) dispersion model developed by the U.S. EPA, which estimates both short-term and long-term average ambient concentrations at receptor locations to produce exposure estimates. The HRA was completed in accordance with the OEHHA Air Toxics Hot Spots Program Guidance Manual for the Preparation of Health Risk Assessments (OEHHA 2003) and the SCAQMD Supplemental Guidelines for Preparing Health Risk Assessments for AB 2588 (SCAQMD 2011).

Two receptor types were modeled to evaluate health risks: Grid receptors were used to define the zone of impact (ZOI), and discrete (individual) receptors were used to assess points of maximum impact within areas of anticipated off-site worker and residential exposures, as appropriate, along with actual sensitive receptor locations. The ZOI modeling was performed using regularly spaced grid receptors. The maximum exposed individual resident (MEIR), maximum exposed individual worker (MEIW), sensitive receptors, and population-wide cancer burden evaluations were performed using discrete receptors, indicating that these are locations associated with individuals or populations, and they correspond to their actual locations.

1.4 Health Risk Characterization

This HRA was conducted in accordance with AB 2588 requirements for completion of a refined health risk analysis that determines cancer risk (multi-pathway analysis) and non-cancer health hazards (chronic and acute). This HRA evaluates cancer risk, non-cancer acute risk, and chronic health hazard for residential, off-site worker, and sensitive receptor locations, and identifies points of maximum impact and population cancer burden. Cancer risk, non-cancer acute risk, and chronic health risk evaluation requirements for each substance are identified in Table 1-2. The exposure pathways evaluated in this HRA are inhalation, dermal, soil ingestion, home-grown produce, and mother’s milk. Table 1-3 presents the target organ systems for non-cancer impacts.

1.5 Summary of Results

Cancer risk estimates are expressed in units of increased cancer occurrences per 1 million individuals. Non-cancer health hazard impacts are expressed as a hazard index (HI) value for a specific target organ (toxicological endpoint).

A brief discussion of the HRA results is summarized herein. Per the OEHHA and SCAQMD guidance, all cancer risk values reported in this HRA are in units of risk per 1 million and are rounded to the nearest tenth. All non-cancer risk values are reported to the nearest hundredth. The rounding convention is that all rounding digits 5 and higher are rounded up.

Location of Maximum Health Risk Impacts

Maximum impact locations include the point of maximum impact (PMI), MEIR, and MEIW. The PMI is predicted at the facility fenceline and does not necessarily coincide with the presence of an individual. The MEIR and MEIW are the off-site locations of an actual residence and business that have the highest estimated impact for each health effect. Table 1-4 summarizes impact levels at the maximum impact points for each health effect. Figure 1-2 shows the location of the PMI, MEIR, and MEIW for cancer risks with respect to the facility. The locations presented in this report are expressed in Universal Transverse Mercator (UTM) coordinates in Zone 11 of North American Datum 83 (NAD 83).

Cancer risks by source and chemical at the MEIR and MEIW are listed in Tables 1-5 through 1-8. Based on the 2006–2007 AER emissions, the facility's potential multi-pathway cancer risk is as follows:

- 8.1-in-1-million at the MEIR; emissions of DPM are the largest contributor to cancer risk at the MEIR (approximately 34%), followed by 1,3-butadiene (19%); hexavalent chromium (9%), arsenic (8%), and benzene (8%). Tables 1-5 and 1-6 present risk at the MEIR by source and pollutant, respectively.

- 7.6-in-1-million at the MEIW; emissions of DPM are the largest contributor to cancer risk at the MEIW (48%), followed by 1,3-butadiene (16%), hexavalent chromium (8%), and benzene (7%). Tables 1-7 and 1-8 present risk at the MEIW by source and pollutant, respectively.

- 10.8-in-1-million at the maximum exposed sensitive receptor (see Table 1-4).

The maximum non-cancer chronic HI is 0.23 at the MEIR and 0.43 at the MEIW (Table 1-4). The maximum non-cancer acute HI at the MEIR is 0.06 and at the MEIW is 0.23 for the respiratory toxicological endpoint (Table 1-4).

Zone of Impact

The ZOI for cancer risk is the area subject to an added cancer risk of more than 1-in-1-million, and is used to identify sensitive receptors and population-wide cancer burden. The cancer risk ZOI extends approximately 6.2 miles (10 kilometers) to the east from the property boundary. Figure 1-2 shows the 70-

year lifetime cancer risk ZOI (i.e., 1-in-1-million risk contour). The 10-in-1-million cancer risk isopleth is shown in Figure 1-3.

The ZOI for non-cancer acute or chronic health hazard impacts is the area subject to an HI of 0.5 or greater. Both acute and chronic HI values do not exceed the ZOI isopleth threshold of 0.5, and, therefore, isopleths are not shown for these impacts.

Population Cancer Burden

Population cancer burden is the population-weighted number of cancer cases based on the population within the ZOI. The population cancer burden was calculated for residential receptors within the ZOI, and was estimated at approximately 0.4, which is below the cancer burden threshold of 0.5. The population cancer burden was computed using population data included in the HARP modeling system.

Results

The HRA results show that population cancer burden and cancer and non-cancer impacts from the LAR are below mandatory risk reduction thresholds. However, the maximum 70-year sensitive receptor cancer risk of 10.8-in-1-million exceeds the public notification threshold.

Table 1-1: Facility TAC Emissions Rates by Substance

CAS	Pollutant	1-Hour Maximum (lb/hr)	1-Hour Maximum (g/s)	Annual Average (lb/yr)	Annual Average (g/s)
71432	Benzene	2.24E-01	2.83E-02	1.96E+03	2.83E-02
50328	Benzo[a]pyrene	2.29E-04	2.88E-05	2.00E+00	2.88E-05
56553	Benz[a]anthracene	1.74E-04	2.19E-05	1.53E+00	2.19E-05
91203	Naphthalene	5.47E-02	6.89E-03	4.79E+02	6.89E-03
191242	Benzo[g,h,i]perylene	2.08E-06	2.62E-07	1.82E-02	2.62E-07
193395	Indeno[1,2,3-cd]pyrene	3.33E-06	4.20E-07	2.92E-02	4.20E-07
205992	Benzo[b]fluoranthene	6.72E-05	8.46E-06	5.88E-01	8.46E-06
218019	Chrysene	2.34E-03	2.95E-04	2.05E+01	2.95E-04
95636	1,2,4-Trimethylbenzene	8.71E-02	1.10E-02	7.63E+02	1.10E-02
100414	Ethyl benzene	8.44E-02	1.06E-02	7.40E+02	1.06E-02
110543	Hexane	6.26E-01	7.89E-02	5.49E+03	7.89E-02
108883	Toluene	5.80E-01	7.31E-02	5.08E+03	7.31E-02
95476	o-Xylene	1.15E-01	1.45E-02	1.01E+03	1.45E-02
106423	p-Xylene	1.34E-01	1.69E-02	1.18E+03	1.69E-02
108383	m-Xylene	1.34E-01	1.69E-02	1.18E+03	1.69E-02

Table 1-1: Facility TAC Emissions Rates by Substance

CAS	Pollutant	1-Hour Maximum (lb/hr)	1-Hour Maximum (g/s)	Annual Average (lb/yr)	Annual Average (g/s)
1330207	Xylenes (mixed)	3.49E-01	4.39E-02	3.06E+03	4.39E-02
7440439	Cadmium	4.49E-04	5.66E-05	3.93E+00	5.66E-05
50000	Formaldehyde	1.00E+00	1.26E-01	8.76E+03	1.26E-01
7440382	Arsenic	8.01E-04	1.01E-04	7.02E+00	1.01E-04
7439921	Lead	3.51E-02	4.42E-03	3.07E+02	4.42E-03
7440020	Nickel	1.42E-02	1.79E-03	1.25E+02	1.79E-03
85018	Phenanthrene	3.62E-04	4.57E-05	3.17E+00	4.57E-05
86737	Fluorene	1.78E-04	2.25E-05	1.56E+00	2.25E-05
129000	Pyrene	1.11E-04	1.40E-05	9.73E-01	1.40E-05
75070	Acetaldehyde	1.83E-01	2.30E-02	1.60E+03	2.30E-02
7664417	Ammonia	2.86E+01	3.60E+00	2.50E+05	3.60E+00
7440508	Copper	2.39E-03	3.01E-04	2.09E+01	3.01E-04
7647010	Hydrochloric acid	1.30E+00	1.63E-01	1.14E+04	1.63E-01
7439965	Manganese	4.18E-02	5.27E-03	3.67E+02	5.27E-03
7439976	Mercury	3.30E-04	4.16E-05	2.89E+00	4.16E-05
7782492	Selenium	8.66E-02	1.09E-02	7.58E+02	1.09E-02
18540299	Chromium, hexavalent (& compounds)	1.18E-04	1.49E-05	1.04E+00	1.49E-05
83329	Acenaphthene	2.21E-05	2.79E-06	1.94E-01	2.79E-06
91576	2-Methyl naphthalene	3.26E-05	4.11E-06	2.86E-01	4.11E-06
120127	Anthracene	3.93E-05	4.95E-06	3.44E-01	4.95E-06
192972	Benzo[e]pyrene	1.87E-05	2.36E-06	1.64E-01	2.36E-06
207089	Benzo[k]fluoranthene	1.53E-04	1.93E-05	1.34E+00	1.93E-05
208968	Acenaphthylene	1.25E-04	1.58E-05	1.10E+00	1.58E-05
463581	Carbonyl sulfide	4.36E-01	5.49E-02	3.82E+03	5.49E-02
7783064	Hydrogen sulfide	2.62E-01	3.31E-02	2.30E+03	3.31E-02
198550	Perylene	1.09E-06	1.38E-07	9.59E-03	1.38E-07
7440417	Beryllium	2.20E-05	2.77E-06	1.92E-01	2.77E-06
106990	1,3-Butadiene	4.86E-02	6.13E-03	4.26E+02	6.13E-03
67561	Methanol	7.19E-02	9.05E-03	6.29E+02	9.05E-03
106934	Ethylene dibromide {EDB}	8.07E-05	1.02E-05	7.07E-01	1.02E-05
107062	Ethylene dichloride {EDC}	8.53E-05	1.07E-05	7.47E-01	1.07E-05

Table 1-1: Facility TAC Emissions Rates by Substance

CAS	Pollutant	1-Hour Maximum (lb/hr)	1-Hour Maximum (g/s)	Annual Average (lb/yr)	Annual Average (g/s)
71556	Methyl chloroform {1,1,1-Trichloroethane}	5.67E-02	7.15E-03	4.97E+02	7.15E-03
100425	Styrene	5.43E-04	6.84E-05	4.76E+00	6.84E-05
78933	Methyl ethyl ketone {2-Butanone}	3.61E-03	4.55E-04	3.16E+01	4.55E-04
108101	Methyl isobutyl ketone {Hexone}	1.05E-03	1.32E-04	9.16E+00	1.32E-04
9901	Diesel engine exhaust, particulate matter (Diesel PM)	6.64E-02	8.36E-03	5.81E+02	8.36E-03

lb/hr = pounds per hour; g/s = grams per second; lb/yr = pounds per year

Table 1-2: List of AB 2588 Substances and Impacts

Listed Substance	CAS Number	Multi-Pathway	Carcinogenic	Chronic Non-Cancer	Acute Non-Cancer
Benzene	71432		X	X	X
Benzo[a]pyrene	50328		X		
Benz[a]anthracene	56553		X		
Naphthalene	91203		X	X	X
Benzo[g,h,i]perylene	191242				
Indeno[1,2,3-cd]pyrene	193395				
Benzo[b]fluoranthene	205992		X		
Chrysene	218019		X		
1,2,4-Trimethylbenzene	95636				
Ethyl benzene	100414		X	X	
Hexane	110543			X	
Toluene	108883			X	X
o-Xylene	95476			X	X
p-Xylene	106423			X	X
m-Xylene	108383			X	X
Xylenes (mixed)	1330207			X	X
Cadmium	7440439	X	X	X	
Formaldehyde	50000		X	X	X
Arsenic	7440382	X	X	X	X

Table 1-2: List of AB 2588 Substances and Impacts

Listed Substance	CAS Number	Multi-Pathway	Carcinogenic	Chronic Non-Cancer	Acute Non-Cancer
Lead	7439921	X	X		
Nickel	7440020	X	X	X	X
Phenanthrene	85018				
Fluorene	86737				
Pyrene	129000				
Acetaldehyde	75070		X	X	X
Ammonia	7664417			X	X
Copper	7440508				X
Hydrochloric acid	7647010			X	X
Manganese	7439965			X	
Mercury	7439976			X	X
Selenium	7782492			X	
Chromium, hexavalent (& compounds)	18540299	X	X	X	
Acenaphthene	83329				
2-Methyl naphthalene	91576				
Anthracene	120127				
Benzo[e]pyrene	192972				
Benzo[k]fluoranthene	207089				
Acenaphthylene	208968				
Carbonyl sulfide	463581				
Hydrogen sulfide	7783064			X	X
Perylene	198550				
Beryllium	7440417	X	X	X	
1,3-Butadiene	106990		X	X	
Methanol	67561			X	X
Ethylene dibromide {EDB}	106934				
Ethylene dichloride {EDC}	107062				
Methyl chloroform {1,1,1-Trichloroethane}	71556				

Table 1-2: List of AB 2588 Substances and Impacts

Listed Substance	CAS Number	Multi-Pathway	Carcinogenic	Chronic Non-Cancer	Acute Non-Cancer
Styrene	100425				
Methyl ethyl ketone {2-Butanone}	78933				X
Methyl isobutyl ketone {Hexone}	108101				
Diesel engine exhaustparticulate matter	9901		X	X	

Table 1-3: Toxicological Endpoints for Chronic and Acute Hazard Index Analysis

Listed Substance	Target Organ												
	AT	BO	CV	DV	EN	EY	HE	IM	KI	CN	RE	RP	SK
Benzene				A,C			A,C	A		C		A	
B[a]P													
B[a]anthracene													
Naphthalene											C		
B[g,h,i]perylene													
In[1,2,3-cd]pyr													
B[b]fluoranthene													
Chrysene													
1,2,4TriMeBenze						A					A,C		
Ethyl Benzene	C			C	C				C				
Hexane										C			
Toluene				A,C		A				A,C	A,C	A	
o-Xylene						A				C	A,C		
p-Xylene						A				C	A,C		
m-Xylene						A				C	A,C		
Xylenes						A				C	A,C		

Table 1-3: Toxicological Endpoints for Chronic and Acute Hazard Index Analysis

Listed Substance	Target Organ												
	AT	BO	CV	DV	EN	EY	HE	IM	KI	CN	RE	RP	SK
Cadmium									C		C		
Formaldehyde						A					C		
Arsenic			A,C	A,C						A,C	C		C
Lead													
Nickel	C						C	A			A,C		
Phenanthrene													
Fluorene													
Pyrene													
Acetaldehyde						A					A,C		
NH3						A							
Copper											A		
HCl													
Manganese										C			
Mercury				A,C					C	A,C			
Selenium	C		C							C			
Cr(VI)							C						
Acenaphthene													
2MeNaphthalene													
Anthracene													
B[e]pyrene													
B[k]fluoranthene													
Acenaphthylene													
Carbonyl Sulfide													
H2S										A	C		
Perylene													
Beryllium	C							C			C	C	
1,3-Butadiene											C		

Table 1-3: Toxicological Endpoints for Chronic and Acute Hazard Index Analysis

Listed Substance	Target Organ												
	AT	BO	CV	DV	EN	EY	HE	IM	KI	CN	RE	RP	SK
Methanol				C						A,C	C		
EDB													
EDC													
1,1,1-TCA													
Styrene													
MEK						A					A		
MIBK													
Diesel Exhaust Particulate Matter											C		

Notes:	
C = chronic toxicity	EY = eye
A = acute toxicity	HE = hematologic
AT = alimentary tract	IM = immunological system
BO = bone	KI = kidneys
CN = central nervous system	RE = respiratory system
CV = cardiovascular system	RP = reproductive system
DV = developmental	SK = skin
EN = endocrine	

Table 1-4: Summary of Health Risks for PMI, MEIR, MEIW, and Sensitive

Receptor	UTM Easting (m)[a]	UTM Northing (m)[a]	Risk (per million for cancer, hazard index for non-cancer)[b]
Cancer Risk			
PMI (70-year)	385452.3	3739191.6	72.2
MEIR (70-year)	384900	3739300	8.1
MEIW (40-year)	385900	3739300	7.6
Sensitive (70-year)	386714	3739912	10.8
Sensitive (9-year)	386714	3739912	2.8
Non-Cancer Chronic Hazard Index			
PMI	386197.0	3740155.6	0.84
MEIR	387300	3739500	0.23
MEIW	386000	3739500	0.43
Sensitive	387041	3739640	0.24
Non-Cancer Acute Hazard Index[c]			
PMI	385983	3740687	0.30
MEIR	387000	3740500	0.06
MEIW	386300	3740200	0.23
Sensitive	386714	3739912	0.05

[a] UTM Zone 11, NAD83, CLARKE1866

[b] Cancer risk per 1 million computed from total cancer risk by multiplication by 1,000,000.

[c] The maximum Acute Non-Cancer Hazard Index is for the respiratory toxicological endpoint.

Table 1-5: Source Contributions to Cancer Risk at the MEIR

Source	Inhalation Pathway	Non-Inhalation Pathway				Total Cancer Risk	Percent
		Dermal	Soil	Mother's Milk	Home Grown Vegetables		
Engines-North (Portable and R219)	1.36E-06	--	--	--	--	1.36E-06	17%
Engines-South (Portable and R219)	1.19E-06	--	--	--	--	1.19E-06	15%
No.7 & 8 Boilers	2.38E-07	1.69E-07	7.72E-08	--	3.56E-08	5.20E-07	6%
Fluid Catalytic Cracking Unit-H-4 Heater	3.13E-07	5.37E-08	8.13E-09	--	6.82E-08	4.43E-07	5%
Fluid Catalytic Cracking Unit-H-3 Heater	1.76E-07	3.02E-08	4.57E-09	--	3.83E-08	2.49E-07	3%
No.9 & 10 Boilers	1.07E-07	7.60E-08	3.46E-08	--	1.60E-08	2.33E-07	3%
Alkyl Unit	1.90E-07	1.64E-08	2.45E-09	--	2.07E-08	2.30E-07	3%
Fluid Catalytic Cracking Unit	1.72E-07	1.48E-08	2.22E-09	--	1.88E-08	2.08E-07	3%
Spray Paint-South	4.19E-08	2.66E-09	8.75E-08	--	6.24E-08	1.95E-07	2%
Boiler House	1.60E-07	1.38E-08	2.06E-09	--	1.75E-08	1.93E-07	2%
Other	2.54E-06	2.69E-07	1.63E-07	--	2.67E-07	3.25E-06	40%
Sum	**6.49E-06**	**6.46E-07**	**3.82E-07**	**--**	**5.44E-07**	**8.07E-06**	**100%**
Facility Emergency IC Engine Total	1.82E-07	--	--	--	--	1.82E-07	2%

Table 1-6: Chemical Contributions to Cancer Risk at the MEIR

Chemical	Inhalation Pathway	Non-Inhalation Pathway				Total Cancer Risk	Percent
		Dermal	Soil	Mother's Milk	Home Grown Vegetables		
Diesel engine exhaust, particulate matter (Diesel PM)	2.73E-06	--	--	--	--	2.73E-06	34%
1,3-Butadiene	1.56E-06	--	--	--	--	1.56E-06	19%
Chromium, hexavalent (& compounds)	7.11E-07	--	--	--	--	7.11E-07	9%
Arsenic	1.39E-07	3.33E-07	1.62E-07	--	2.97E-08	6.63E-07	8%
Benzene	6.26E-07	--	--	--	--	6.26E-07	8%
Benzo[a]pyrene	1.41E-08	1.87E-07	2.80E-08	--	2.37E-07	4.66E-07	6%
Lead	8.28E-08	5.28E-09	1.74E-07	--	1.24E-07	3.86E-07	5%
Formaldehyde	3.28E-07	--	--	--	--	3.28E-07	4%
Other	2.99E-07	1.21E-07	1.80E-08	--	1.53E-07	6.00E-07	7%
Sum	**6.49E-06**	**6.46E-07**	**3.82E-07**	**--**	**5.44E-07**	**8.07E-06**	**100%**

Table 1-7: Source Contributions to Cancer Risk at the MEIW

Source	Inhalation Pathway	Non-Inhalation Pathway				Total Cancer Risk	Percent
		Dermal	Soil	Mother's Milk	Home Grown Vegetables		
Engines-South (Portable and R219)	3.18E-06	--	--	--	--	3.18E-06	42%
Fluid Catalytic Cracking Unit-H-4 Heater	4.61E-07	1.52E-07	2.00E-08	--	--	6.33E-07	8%
Spray Paint-South	7.37E-08	1.37E-07	2.31E-07	--	--	4.41E-07	6%
Fluid Catalytic Cracking Unit	3.67E-07	6.07E-08	7.89E-09	--	--	4.36E-07	6%
Fluid Catalytic Cracking Unit-H-3 Heater	2.92E-07	9.66E-08	1.27E-08	--	--	4.02E-07	5%
Engines-North (Portable and R219)	3.59E-07	--	--	--	--	3.59E-07	5%
Boiler House	2.65E-07	4.37E-08	5.68E-09	--	--	3.14E-07	4%
Cogen Fugitives	2.44E-07	4.04E-08	5.25E-09	--	--	2.90E-07	4%
HCOD fugitives, Tank 2513	9.09E-08	1.50E-08	1.95E-09	--	--	1.08E-07	1%
Fixed Roof Tanks-2	1.06E-07	7.18E-12	9.33E-13	--	--	1.06E-07	1%
Other	1.00E-06	2.31E-07	8.65E-08	--	--	1.32E-06	17%
Sum	**6.44E-06**	**7.76E-07**	**3.71E-07**	**--**	**--**	**7.59E-06**	**100%**
Facility Emergency IC Engine Total	7.93E-08	--	--	--	--	7.93E-08	1%

Table 1-8: Chemical Contributions to Cancer Risk at the MEIW

Chemical	Inhalation Pathway	Non-Inhalation Pathway				Total Cancer Risk	Percent
		Dermal	Soil	Mother's Milk	Home Grown Vegetables		
Diesel engine exhaust, particulate matter (Diesel PM)	3.62E-06	--	--	--	--	3.62E-06	48%
1,3-Butadiene	1.22E-06	--	--	--	--	1.22E-06	16%
Chromium, hexavalent (& compounds)	6.05E-07	--	--	--	--	6.05E-07	8%
Benzene	5.57E-07	--	--	--	--	5.57E-07	7%
Lead	8.35E-08	1.56E-07	2.63E-07	--	--	5.02E-07	7%
Benzo[a]pyrene	1.48E-08	3.39E-07	4.40E-08	--	--	3.98E-07	5%
Formaldehyde	1.65E-07	--	--	--	--	1.65E-07	2%
Arsenic	2.06E-08	9.49E-08	4.01E-08	--	--	1.56E-07	2%
Other	1.54E-07	1.86E-07	2.39E-08	--	--	3.67E-07	5%
Sum	**6.44E-06**	**7.76E-07**	**3.71E-07**	**0.00E+00**	**0.00E+00**	**7.59E-06**	**100%**

Figure 1-1: General Location of Tesoro Refinery

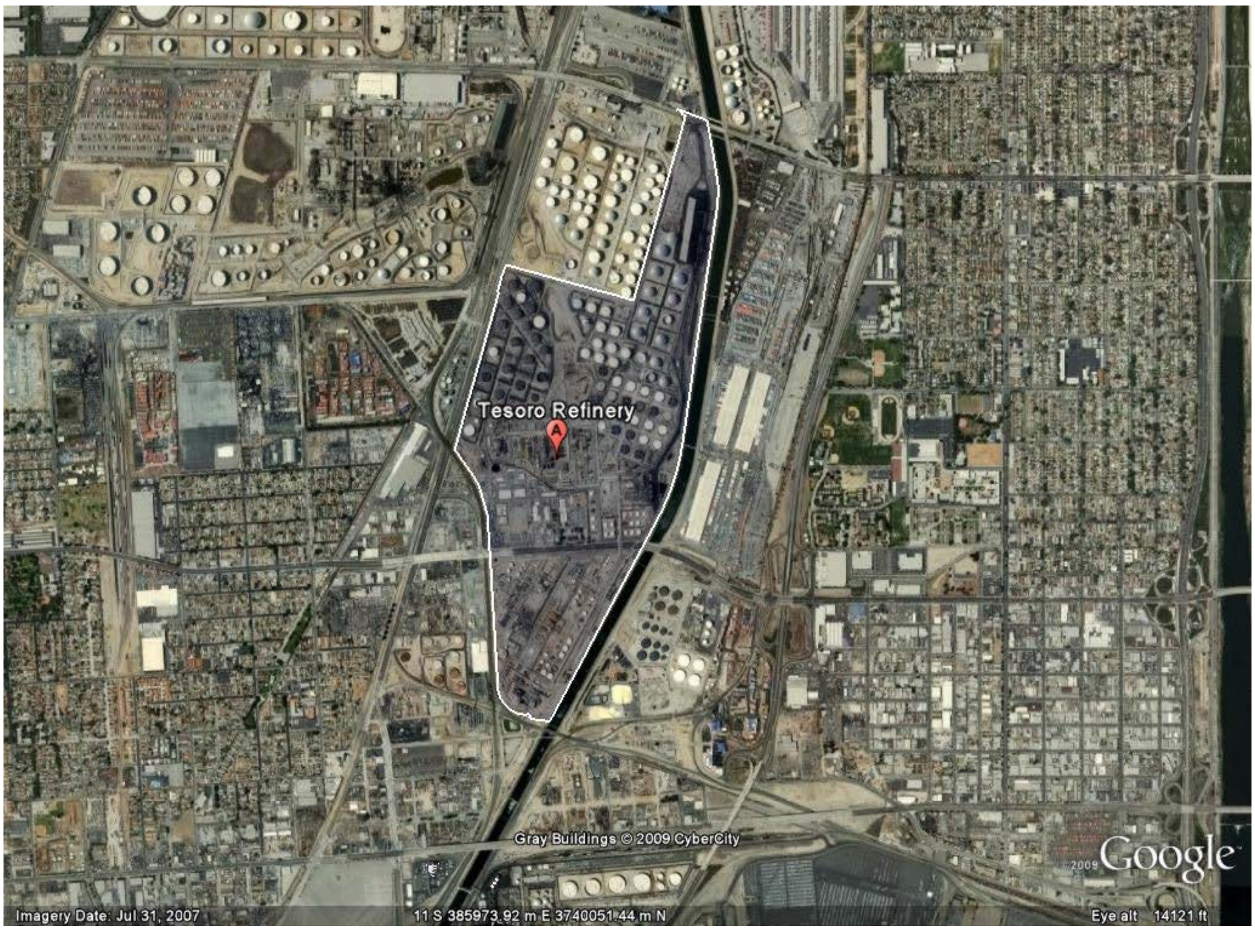


Figure 1-2: Cancer Risk Zone of Impact and Location of Cancer PMI, MEIR, and MEIW

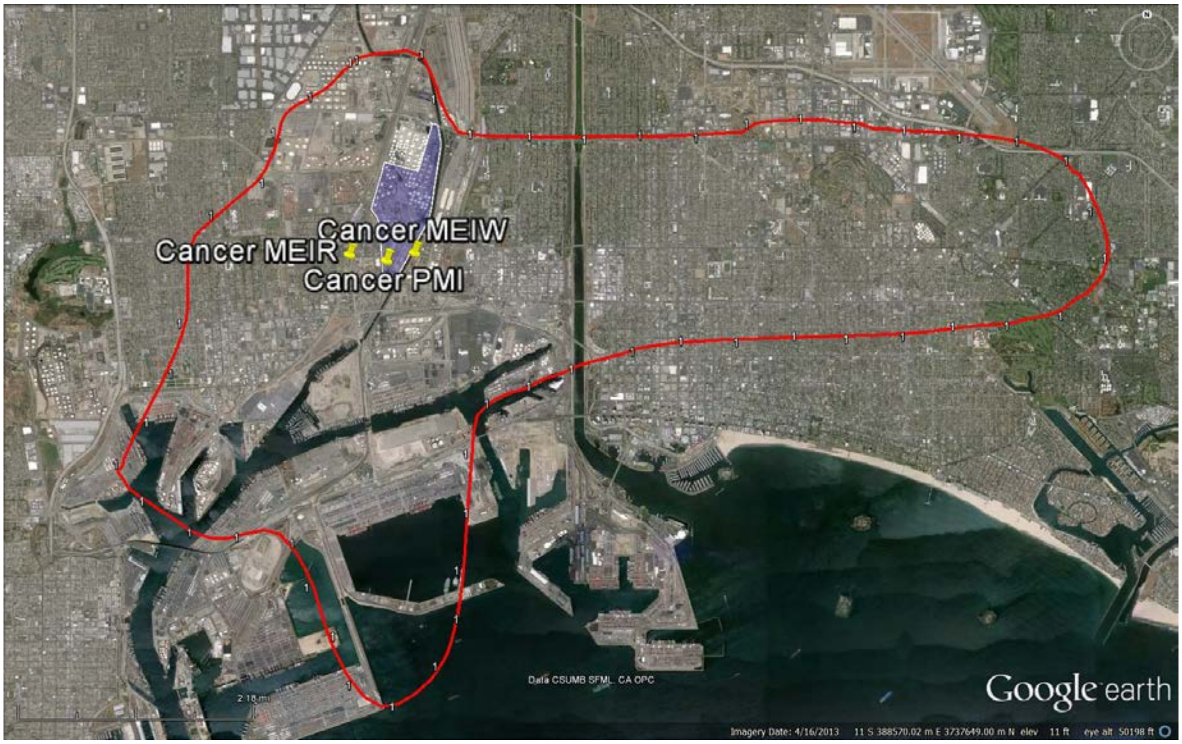


Figure 1-3: Cancer Risk 10-in-1-million Isopleth

2.0 Hazard Identification

Fifty-one TACs were reported in the 2006–2007 AER for the LAR, including 20 TACs that contribute to cancer risk, 23 TACs that contribute to non-cancer chronic impacts, and 18 TACs that contribute to acute non-cancer impacts. A list of the TACs reported in the LAR AER is provided in Table 2-1, along with the health factors (updated August 2010) used to evaluate potential health risk impacts.

The human health risks potentially associated with these substances were evaluated in this HRA. Cancer risk was assessed using inhalation and oral slope factors, expressed in units of increased occurrences per milligram dosage per kilogram body weight per day. Non-cancer chronic impacts were assessed using inhalation and oral reference exposure level (REL), expressed as an HI for specific target organs. Non-cancer acute impacts were assessed using an inhalation REL to estimate health hazard impacts for each specific target organ. The exposure pathways evaluated in this HRA were inhalation, dermal, soil ingestion, home-grown produce, and mother's milk. Table 2-2 presents a list of reported AER TACs that do not have health values.

Table 2-1: Dose/Response Values for AB 2588 Compounds

CAS	Pollutant	Cancer Risk Factors		Non-Cancer Health Factors		
		Inhalation Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$	Oral Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$	Inhalation Chronic Reference Exposure Level ($\mu g/m^3$)	Oral Chronic Reference Exposure Level (mg/kg/d)	Acute Reference Exposure Level ($\mu g/m^3$)
71432	Benzene	1.00E-01	*	6.00E+01	*	1.30E+03
50328	Benzo[a]pyrene	3.90E+00	1.20E+01	*	*	*
56553	Benz[a]anthracene	3.90E-01	1.20E+00	*	*	*
91203	Naphthalene	1.20E-01	*	9.00E+00	*	*
191242	Benzo[g,h,i]perylene	*	*	*	*	*
193395	Indeno[1,2,3-cd]pyrene	3.90E-01	1.20E+00	*	*	*
205992	Benzo[b]fluoranthene	3.90E-01	1.20E+00	*	*	*
218019	Chrysene	3.90E-02	1.20E-01	*	*	*
95636	1,2,4-Trimethylbenzene	*	*	*	*	*
100414	Ethyl benzene	8.70E-03	*	2.00E+03	*	*
110543	Hexane	*	*	7.00E+03	*	*

Table 2-1: Dose/Response Values for AB 2588 Compounds

CAS	Pollutant	Cancer Risk Factors		Non-Cancer Health Factors		
		Inhalation Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$	Oral Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$	Inhalation Chronic Reference Exposure Level $(\mu g/m^3)$	Oral Chronic Reference Exposure Level (mg/kg/d)	Acute Reference Exposure Level $(\mu g/m^3)$
108883	Toluene	*	*	3.00E+02	*	3.70E+04
95476	o-Xylene	*	*	7.00E+02	*	2.20E+04
106423	p-Xylene	*	*	7.00E+02	*	2.20E+04
108383	m-Xylene	*	*	7.00E+02	*	2.20E+04
1330207	Xylenes (mixed)	*	*	7.00E+02	*	2.20E+04
7440439	Cadmium	1.50E+01	*	2.00E-02	5.00E-04	*
50000	Formaldehyde	2.10E-02	*	9.00E+00	*	5.50E+01
7440382	Arsenic	1.20E+01	1.50E+00	1.50E-02	3.50E-06	2.00E-01
7439921	Lead	4.20E-02	8.50E-03	*	*	*
7440020	Nickel	9.10E-01	*	5.00E-02	5.00E-02	6.00E+00
85018	Phenanthrene	*	*	*	*	*
86737	Fluorene	*	*	*	*	*
129000	Pyrene	*	*	*	*	*
75070	Acetaldehyde	1.00E-02	*	1.40E+02	*	4.70E+02
7664417	Ammonia	*	*	2.00E+02	*	3.20E+03
7440508	Copper	*	*	*	*	1.00E+02
7647010	Hydrochloric acid	*	*	9.00E+00	*	2.10E+03
7439965	Manganese	*	*	9.00E-02	*	*
7439976	Mercury	*	*	3.00E-02	1.60E-04	6.00E-01
7782492	Selenium	*	*	2.00E+01	*	*
18540299	Chromium, hexavalent (& compounds)	5.10E+02	*	2.00E-01	2.00E-02	*
83329	Acenaphthene	*	*	*	*	*
91576	2-Methyl naphthalene	*	*	*	*	*
120127	Anthracene	*	*	*	*	*
192972	Benzo[e]pyrene	*	*	*	*	*
207089	Benzo[k]fluoranthene	3.90E-01	1.20E+00	*	*	*

Table 2-1: Dose/Response Values for AB 2588 Compounds

CAS	Pollutant	Cancer Risk Factors		Non-Cancer Health Factors		
		Inhalation Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$	Oral Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$	Inhalation Chronic Reference Exposure Level ($\mu g/m^3$)	Oral Chronic Reference Exposure Level (mg/kg/d)	Acute Reference Exposure Level ($\mu g/m^3$)
208968	Acenaphthylene	*	*	*	*	*
463581	Carbonyl sulfide	*	*	*	*	*
7783064	Hydrogen sulfide	*	*	1.00E+01	*	4.20E+01
198550	Perylene	*	*	*	*	*
7440417	Beryllium	8.40E+00	*	7.00E-03	2.00E-03	*
106990	1,3-Butadiene	6.00E-01	*	2.00E+01	*	*
67561	Methanol	*	*	4.00E+03	*	2.80E+04
106934	Ethylene dibromide {EDB}	2.50E-01	*	8.00E-01	*	*
107062	Ethylene dichloride {EDC}	7.20E-02	*	4.00E+02	*	*
71556	Methyl chloroform {1,1,1-Trichloroethane}	*	*	1.00E+03	*	6.80E+04
100425	Styrene	*	*	9.00E+02	*	2.10E+04
78933	Methyl ethyl ketone {2-Butanone}	*	*	*	*	1.30E+04
108101	Methyl isobutyl ketone {Hexone}	*	*	*	*	*
9901	Diesel engine exhaust, particulate matter (Diesel PM)	1.10E+00	*	5.00E+00	*	*

Table 2-2: TACs without Health Values

CAS	Pollutant
191242	Benzo[g,h,i]perylene
193395	Indeno[1,2,3-cd]pyrene
95636	1,2,4-Trimethylbenzene
85018	Phenanthrene
86737	Fluorene
129000	Pyrene
83329	Acenaphthene
91576	2-Methyl naphthalene
120127	Anthracene
192972	Benzo[e]pyrene
208968	Acenaphthylene
463581	Carbonyl Sulfide
198550	Perylene
71556	Methyl chloroform {1,1,1-Trichloroethane}
108101	Methyl isobutyl ketone {Hexone}

3.0 Exposure Assessment

The exposure assessment estimates the potential exposure to the public and determines the ground level concentration of the pollutants using air quality modeling.

3.1 Facility Description

The Tesoro LAR (SCAQMD ID: 800436) is a petroleum refinery. The facility is located in an industrial area of Wilmington, California, and is on relatively flat terrain. Figure 1-1 shows the location of the facility. The facility plot-plan is presented in Appendix C.

Most emissions from the LAR are volatile organic compounds that remain in a gaseous state when emitted, and predominantly cause exposure through the inhalation pathway. A small percentage of the emissions is semi-volatile organic and toxic metals, emitted as particles that can cause exposures through other pathways, such as soil ingestion and dermal exposure. Therefore, TAC emissions were evaluated for all three pathways: inhalation, soil ingestion, and dermal exposure. In addition, other potentially viable pathways, such as through mother's milk and home-grown produce ingestion, were also evaluated for the facility TAC emissions. Pathways such as drinking water and fish or meat ingestion were not considered viable pathways for facility emissions, as the facility's emissions are not expected to impact any domestic water systems, fish cultivation (for consumption), or livestock grazing areas.

3.2 Emissions Inventory

The emissions considered in this HRA are the TAC emissions reported in the 2006–2007 AER for LAR. Fifty-one toxic chemicals were reported in the AER, of which only 36 TACs have health values per the OEHHA's updated health table (August 2010). The TACs that do not have any health values are listed in Table 2-2.

The emissions inventories for the 2009 and revised 2011 HRAs incorporated updates to refine estimates of DPM emissions from diesel engine use at the LAR. Specifically, adjustments were made to the diesel emissions estimation for IC engines. The sources responsible for the DPM emissions at the facility are six permitted stationary emergency air compressors, six permitted stationary emergency firewater engines, exempt welding operations, and operation of routine and predictable contractor equipment.

For the 2009 and revised 2011 HRAs, the DPM emissions reported in the AER were revised for all the permitted stationary engines by using measured actual hours of non-emergency operation of the engines during the reporting period. The stationary engines are limited to a maximum non-emergency operation of 20 or 50 hours per year, reflecting required testing of the engines. DPM emissions were also updated based on better long-term information regarding contractor use of portable equipment on-site. Most routine and predictable activities performed by contractors are for process unit turnarounds, which do not occur annually. Accordingly, these emissions were estimated based on available contractor fuel usage data, then annualized to represent long-term exposure to pollutants that do not occur annually. Modeling for the HRA incorporates fuel usage information for contractor activities over the past several years (through 2010), which provides more accurate annualized usages for routine activities. A summary of these DPM emissions calculations is provided in Appendix A.

DPM emissions were also recalculated using equipment- and power-specific emissions factors for particulate matter available from the SCAQMD for off-road equipment. These off-road emissions factors were developed from CARB's off-road model and prepared for SCAQMD's Air Quality Analysis Guidance Handbook. The estimated off-road emissions factors are available on the SCAQMD website (http://www.aqmd.gov/ceqa/handbook/offroad/offroad.html). The emissions factors are categorized based on equipment category and horsepower rating for the average fleet make-up for each year through 2025. The load factor ratings are built into the emissions factors to account for variable loads during operation.

The total annual facility emissions (in pounds per year [lbs/yr] and grams per second [g/s]) and maximum hourly facility emissions (in pounds per hour [lbs/hr] and g/s) by substance are presented in Table 1-1. The sources at the facility operate 24 hours per day, 365 days per year. No emissions scaling or factors were used on operating emissions in this HRA. Diesel engine emissions were annualized to give an annual average emissions rate for the year.

3.3 Air Quality Modeling

Air quality modeling was conducted for the emissions sources at the facility in accordance with SCAQMD guidelines. Annual and peak 1-hour ground-level air concentrations (expressed in micrograms/cubic-meter) were determined. The multi-source air quality modeling was conducted using the HARP (Version 1.4d), a single integrated software package that integrates air dispersion modeling with risk analysis and mapping capabilities. HARP uses the ISCST3 air dispersion model (version 99155) in its dispersion module. ISCST3 accounts for site-specific terrain, meteorological conditions, and emissions parameters (such as stack exit velocities and temperatures) to estimate ambient concentrations.

The ISCST3 dispersion modeling module in HARP was used in the urban mode with model option switches set to mostly default settings, with specific non-regulatory default settings used as required by SCAQMD guidance. Because ISCST3 is a single-pollutant analysis model, the air dispersion patterns for HARP were developed using unit emissions rates (1 g/s) for all the emissions sources. HARP then scales the ISCST3 modeling results from each source using the actual emissions of each TAC from that source to convert the ISCST3 results to actual concentrations. Table 3-1 shows the summary of the modeling options selected for the HRA. The output of the ISCST3 modeling analyses was used in the risk assessment module of HARP for characterizing risks, and is discussed in Section 4, Risk Characterization. All dispersion modeling inputs and outputs are provided electronically in Appendix D.

Table 3-1: Summary of Modeling Options

Modeling Parameters	Assumption	Comments
Model Control Options		
Use of regulatory default?	No	Calms processing not used
Urban or rural?	Urban	SCAQMD policy for all air quality impact analyses in its jurisdiction
Gradual plume rise?	No	Default
Stack tip downwash?	Yes	Default
Buoyancy induced dispersion?	Yes	Default
Calms processing?	No	Calms processing is inappropriate for SCAQMD meteorological data, as:

Table 3-1: Summary of Modeling Options

Modeling Parameters	Assumption	Comments
		➢ Wind speeds in SCAQMD stations are always 1 m/s or greater, and wind direction is always recorded for all wind speeds. ➢ SCAQMD data is site-specific, not National Weather Service data, and, therefore, calms processing is not applicable. ➢ Many sites in the South Coast Air Basin experience high frequency of calms that correspond with pollutant build-up and, therefore, this data cannot be eliminated.
Missing data processing?	No	Default
Source Options		
Include building downwash?	Yes	Default
Lowbound option?	No	Default
Meteorology Options		
Meteorological data	Long Beach, 1981	SCAQMD has made available 1981 meteorological datasets for dispersion modeling. The nearest representative meteorological station was chosen for modeling.

Source: Compiled from SCAQMD Supplemental Guidelines for HRA, 2011

The methods and requirements used to conduct the air dispersion modeling analysis in HARP for estimating concentrations of toxic air pollutants are presented below.

Meteorological Data

Air dispersion analysis was conducted using 1 year of SCAQMD hourly meteorological data for Long Beach, the nearest representative meteorological station operated by the SCAQMD. The SCAQMD provides 1981 meteorological data to use in dispersion modeling with the ISCST3 air quality model. The wind-rose for the Long Beach station presented in Figure 3-1 shows a prominent wind flow from the west, which is expected to disperse the pollutants to the east, causing higher concentrations in that direction on an annual basis. The results from the risk assessment correlate well with this wind pattern. The meteorological file is provided in Appendix D.

Modeled Sources and Source Parameters

Sources of toxic air emissions from facility operations were modeled as point and area sources. A detailed list of modeled sources and their release parameters are presented in Appendix B.

Terrain

ISCST3 incorporates both simple and complex terrain algorithms that can be enabled to predict ground-level concentrations at receptors below stack height and above stack height. The HARP program assigns receptor elevations relative to sea level using United States Geological Survey (USGS) Digital Elevation Model (DEM) data.

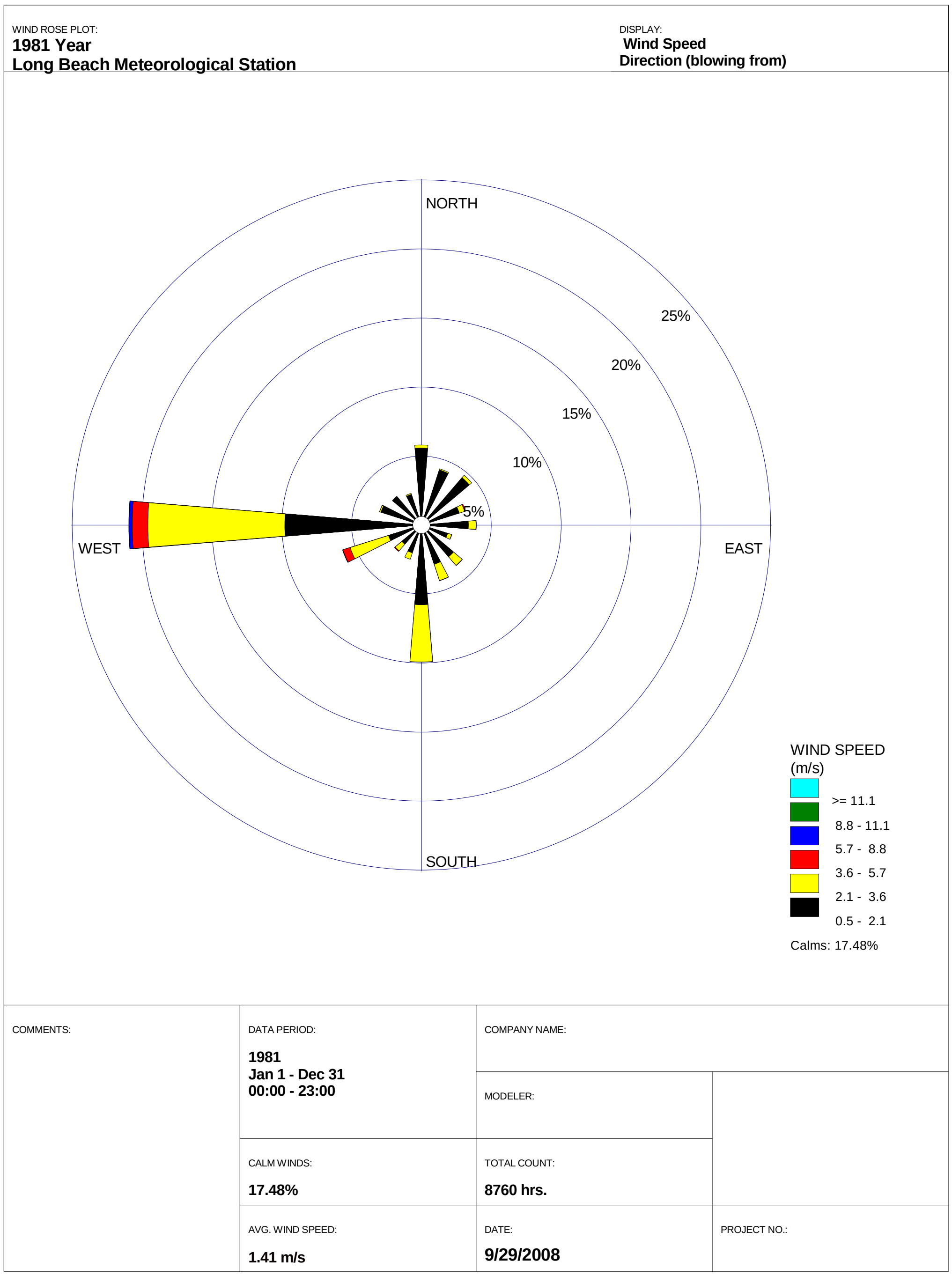
Receptors

Two types of receptors were modeled to evaluate health risks: Grid receptors were used to define the ZOI and PMI, and discrete (individual) receptors were used to assess maximum impacts within areas of anticipated off-site worker and residential exposure, as appropriate, along with sensitive receptor locations and census block centroids to evaluate population exposure. The ZOI and PMI modeling were performed using evenly spaced grid receptors. The MEIR and MEIW, sensitive receptor, and population cancer burden modeling were performed using discrete receptors, indicating that these are locations associated with individuals or populations. Table 3-2 shows the spacing and the number of receptors modeled. The residential, off-site worker and sensitive receptors for this HRA are the same as in the 2009 and 2011 HRAs. Figures 3-2 and 3-3 show the location of the residential and off-site worker receptors modeled in the HRA. Table 3-3 lists the sensitive receptors considered in this HRA, and Figure 3-4 shows their locations. A total of 48 sensitive receptors were identified within the ZOI. The locations of the off-site sensitive receptors were identified based on Google Maps and aerial photographs.

Coordinate System

All source, receptor locations, and corresponding digital terrain data were represented in the UTM coordinate system using NAD 83 for Zone 11. The base maps used for plotting results in this HRA report were obtained from GoogleEarth.

Figure 3-1: Wind Rose for the Long Beach Meteorological Station (1981)



WRPLOT View - Lakes Environmental Software

Table 3-2: Receptor Spacing

Receptor Type	Spacing	Number of Receptors Modeled
Boundary	10 meters (m)	640
Grid (for PMI)	100 m	925
Grid (for ZOI)	250 m	3,577
Residential	100 m	704
Worker	100 m	1,320
Sensitive	Not Applicable	48

Table 3-3: Sensitive Receptors Included in the HRA

Number	HARP Receptor ID	Receptor Name	Type	UTM Easting (km)[a]	UTM Northing (km)[a]
1	1	Wilmington Park Elementary School	School	384.671	3739.127
2	2	Wilmington Park Children's Center	Day Care Center	384.666	3739.257
3	3	Holy Family Grammar School	School	384.401	3739.366
4	4	Bethune Mary School	School	386.714	3739.912
5	5	Wyo Tech National Institute of Tech	School	387.041	3739.64
6	6	Long Beach Japanese School	School	387.304	3739.447
7	7	Long Beach Job Corp Dynamic Educational	School	387.472	3739.724
8	8	Cabrillo High School	School	387.473	3739.922
9	9	West Child Development Center	Day Care Center	387.474	3740.168
10	10	Long Beach Unified School District	School	387.287	3740.345
11	11	Will J. Reid High School	School	387.037	3740.324
12	12	Elizabeth Hudson Elementary School	School	387.091	3740.595
13	13	Long Beach Unified School District	School	387.092	3740.782
14	14	St. Lucy's School	School	387.423	3740.492
15	15	Garfield Head Start Elementary School	School	387.692	3740.405
16	16	William Logan Stephens Junior High	School	387.367	3741.657
17	17	John Muir Elementary School	School	387.914	3742.03
18	18	Long Beach Unified School District	School	388.016	3742.135
19	19	Webster Elementary School	School	387.461	3742.435
20	20	Broad Avenue Elementary School	School	383.158	3740.8

Table 3-3: Sensitive Receptors Included in the HRA

Number	HARP Receptor ID	Receptor Name	Type	UTM Easting (km)[a]	UTM Northing (km)[a]
21	21	Wilmington Christian School	School	383.005	3740.658
22	22	Banning High School	School	383.286	3740.026
23	23	First Baptist Christian School	School	383.278	3739.681
24	24	Avalon High School	School	383.044	3739.793
25	25	Banning-Marine Avenue Adult Center	Care Center	383.919	3739.919
26	26	Fries Avenue Elementary School	School	382.836	3739.449
27	27	Wilmington Junior High School	School	382.039	3740.361
28	28	Pacific Harbor Elementary School	School	381.989	3740.01
29	29	Gulf Avenue Elementary School	School	382.229	3739.216
30	30	Sts. Peter & Paul School	School	382.456	3738.335
31	31	Banning Elementary School	School	382.774	3737.978
32	32	Li'l Cowpoke Pre-School	School	383.104	3737.974
33	33	Hawaiian Avenue Elementary	School	381.812	3737.989
34	34	Vermont Christian School	School	381.747	3738.428
35	35	Hawaiian Avenue Children's Center	Day Care Center	381.811	3737.926
36	36	National Polytechnic College of Science	School	382.894	3736.196
37	37	Child Time Learning Center	Day Care Center	388.951	3737.098
38	38	Cesar Chavez Elementary School	School	388.75	3737.361
39	39	Edison Elementary School	School	388.83	3737.705
40	40	Thomas A. Edison State Pre-School	School	388.9	3737.881
41	41	Anaheim Head Start	School	389.189	3738.665
42	42	Regency High School	School	389.116	3738.789
43	43	Mary Bethune School	School	389.232	3738.849
44	44	Washington Middle School	School	389.361	3738.974
45	45	Long Beach Day Nursery	School	389.275	3739.143
46	46	Long Beach Unified School District	School	389.33	3739.407
47	47	Long Beach School for Adult	School	389.368	3739.487
48	48	Long Beach California Safe Program	School	389.536	3739.931

[a] UTM Zone 11, NAD83, Clarke1866

Figure 3-2: Location of Modeled Residential Receptors

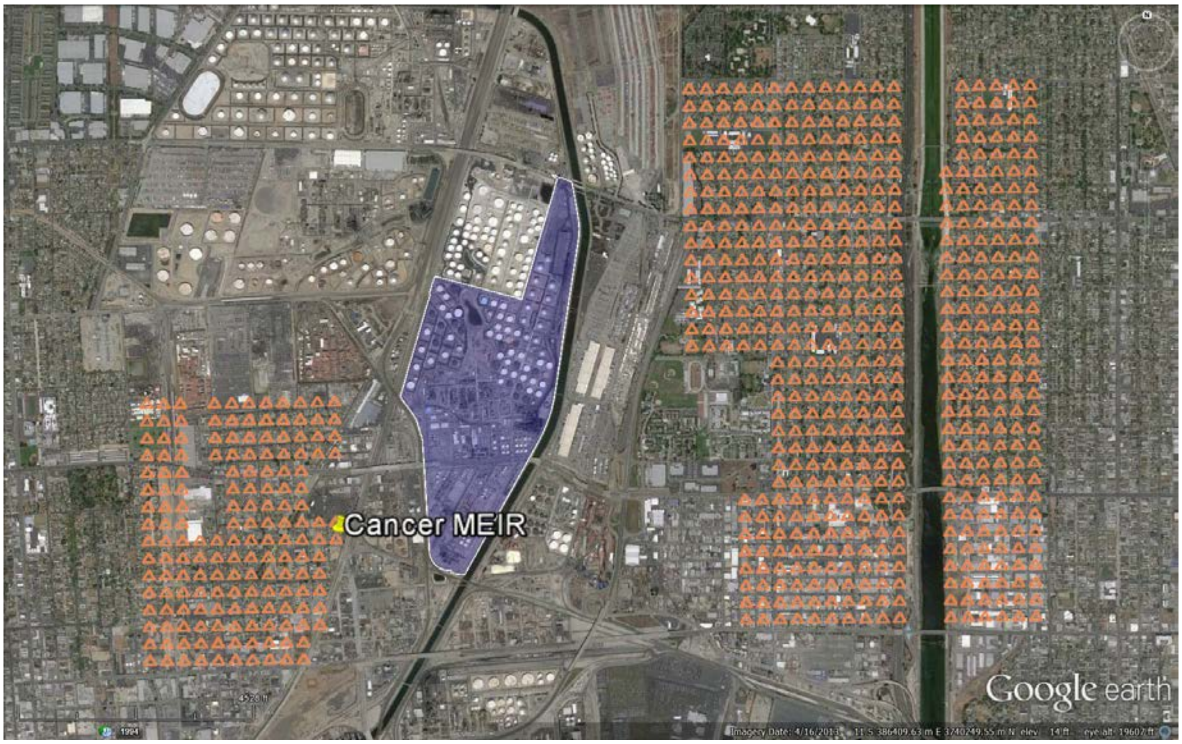


Figure 3-3: Location of Modeled Worker Receptors

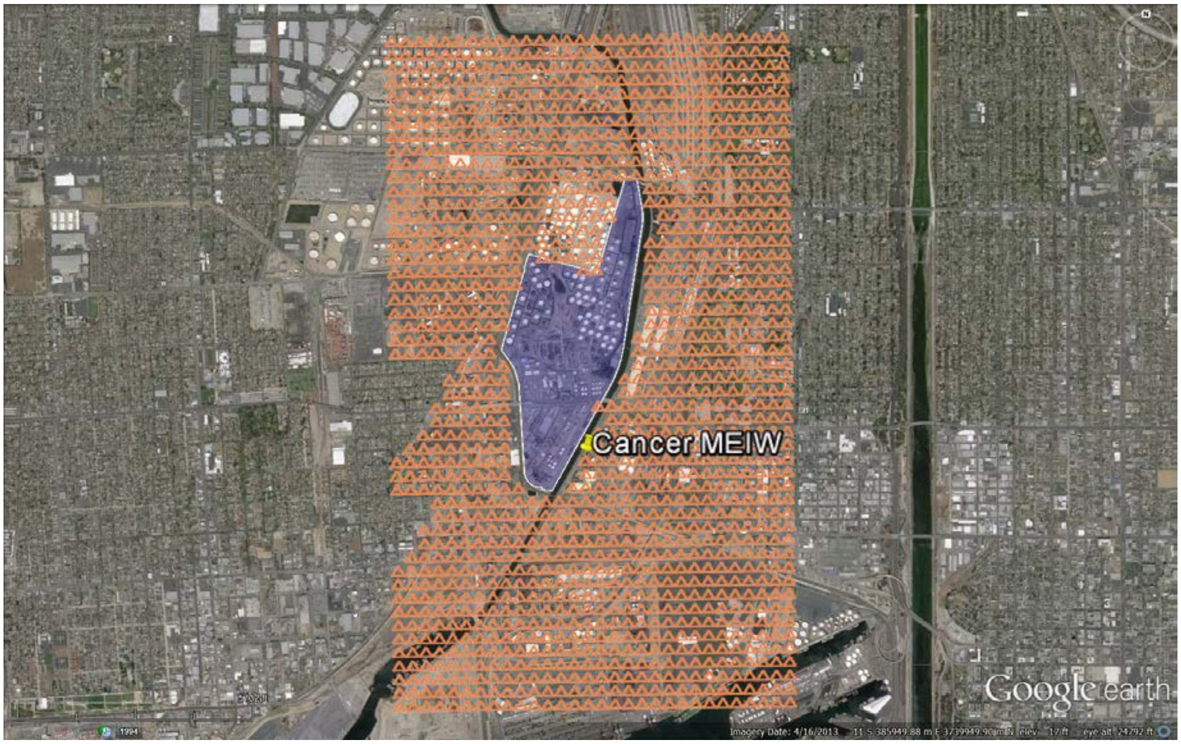
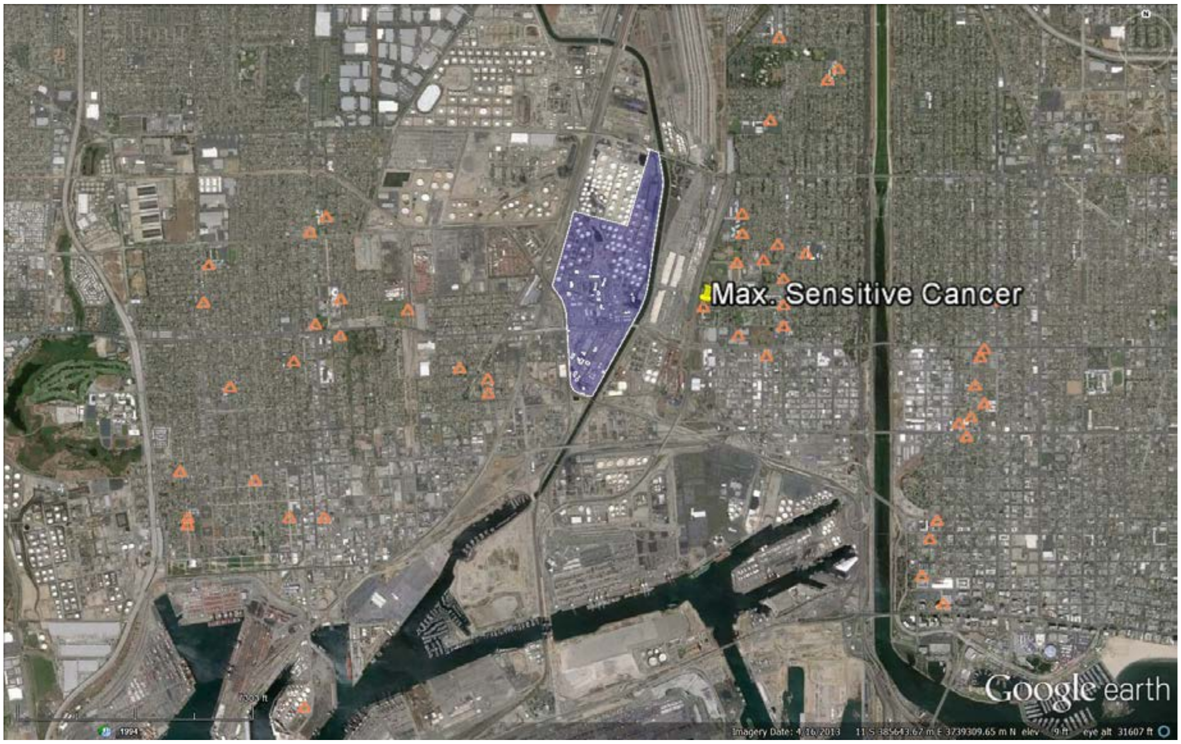


Figure 3-4: Location of Modeled Sensitive Receptors



4.0 Risk Characterization

This HRA evaluated cancer risk (multi-pathway analysis) and non-cancer acute and chronic health impacts for residential, off-site worker, and sensitive receptor locations, and identified points of maximum impact and population cancer burden. The HRA evaluated cancer risk and non-cancer health hazards using the risk module of the HARP model based on the annual average and peak 1-hour ground-level concentrations predicted from the dispersion module. Carcinogenic risks and potential non-carcinogenic chronic health effects were calculated using the annual ground-level concentrations, and the acute non-cancer health hazards were determined using the predicted maximum 1-hour ground-level concentrations. Chemical substance toxicity factors used in this analysis were obtained from the list of approved health values by the OEHHA and CARB for use in facility health risk assessments conducted for the AB 2588 Air Toxics Hot Spots Program (updated August 2010). The approved health values are incorporated into HARP Version 1.4d and cannot be modified by the user. All HARP risk modeling files are presented electronically in Appendix D.

The following HARP modeling options were used for the risk analysis to estimate cancer and non-cancer impacts at the maximum exposed points, as required by CARB guidance:

- 70-Year Resident Cancer Risk – Derived (Adjusted) Method
- Worker Cancer Risk – Point Estimate
- Chronic Hazard Index – Derived (OEHHA) Method
- Acute Hazard Index – Acute Simple HI (Concurrent Max)

The exposure pathways that were analyzed consisted of all pathways recommended for a health risk assessment by CARB/OEHHA. Exposure pathways that were enabled included homegrown produce, dermal absorption, soil ingestion, and mother's milk, in addition to the inhalation pathway. Exposure routes for the ingestion of local fish, poultry, livestock, and drinking water were considered but not incorporated in this risk analysis because there are no such areas within the LAR area of influence.

Cancer Risk Assessment Methodology

The HRA analysis included estimates of health risks associated with long-term exposures resulting from emissions of carcinogenic agents. The maximum individual residential and sensitive receptor cancer risks are estimates of the highest increased cancer risk any off-site resident or sensitive receptor location can expect from a lifetime (70 years) of exposure to continuous emissions of TACs from the facility. The maximum individual off-site worker cancer risk is an estimate of the highest increased cancer risk the maximum exposed off-site worker can expect from a 40-year exposure to continuous emissions of TACs from the facility. The actual cancer risks are not expected to be any higher than the predicted risks, and are likely to be substantially lower due to the conservatism inherent in a risk assessment conducted using the HARP model following CARB/OEHHA guidance.

The cancer risk due to inhalation of TACs is estimated in HARP by first calculating the dose to an individual of each air toxic using a specified breathing rate for each receptor type. The calculated dose for each receptor type is then multiplied by the inhalation cancer potency factor for each air toxic and summed across all air toxics for each receptor. HARP also performs non-inhalation dose calculations for multi-pathway air toxics and determines the cancer risk due to non-inhalation pathways of exposure. For a multi-pathway assessment of cancer risk, HARP calculates the individual cancer risk by summing the contributions due to inhalation and non-inhalation pathways.

Non-Cancer Hazard Index Assessment Methodology

Non-cancer health effects can be either due to chronic (long-term) or acute (short-term) exposure. In determining potential non-cancer health impacts from air toxics, it is assumed that there is a dose of the chemical of concern below which there would be no impact on human health. The air concentration corresponding to this dose is called the reference exposure level (REL). Non-cancer health risks are measured in terms of a multi-pathway HI (using all applicable exposure pathways), which is the calculated exposure of each contaminant divided by its REL. Hazard indices for those pollutants affecting the same target organ are summed, with the resulting totals expressed as HIs for each organ system.

Chronic toxicity is defined as adverse health effects from prolonged chemical exposure caused by accumulation of the toxic chemical in the body. Because chemical accumulation to toxic levels typically occurs slowly, symptoms of chronic effects usually do not appear until long after exposure commences. The potential for chronic health effects was evaluated in HARP by comparing the long-term exposure level from all pathways for each pollutant with the long-term exposure level for that substance below which minimal impact on human health is expected.

Acute toxicity is defined as adverse health effects caused by a short-term chemical exposure of no more than 24 hours. For most chemicals, the exposure required to produce acute effects is higher than levels required for causing chronic effects due to shorter exposure duration. The potential for acute health effects was evaluated by comparing the short-term exposure level from inhalation for each substance with the short-term exposure level for that substance. The acute HI is based on the maximum 1-hour emissions and modeling results. The chronic HI is based on the annual average emissions and modeling results.

This HRA identifies cancer risk and chronic and acute HIs for the following criteria or locations:

- Health Risk Levels at the Points of Maximum Impact
- Health Risk Levels at the Maximum Exposed Individuals
- Health Risk Levels at Selected Off-Site Sensitive Receptors
- Population-Wide Health Risk Impact Levels for Cancer Risk
- The Zone of Impact for Health Effects

Points of Maximum Impact

The PMI for cancer risk is equivalent to the highest individual excess cancer risk value occurring at any location on or outside of the facility property boundary, assuming a 70-year exposure to facility emissions. The PMI for each health effect was identified using fenceline receptors at 10-meter spacing, and an additional 100-meter grid extending up to 1.2 kilometers from the facility. This was done to ensure that the areas with highest impact were identified for cancer risk and acute and chronic HIs. As discussed in Section 4.1, the PMI occurred on the fenceline (with receptors placed every 10 meters).

Maximum Exposed Individuals

The locations of the off-site residential and worker receptor areas were identified based on Google Earth/Maps and USGS topographic maps. Additional receptors were added in the areas of maximum downwind concentrations to demonstrate that the maximum exposure locations were identified and modeled. A total of 704 residential and 1,320 off-site worker receptors were identified as potential maximum exposure candidates. The higher number of off-site worker receptors within the ZOI reflects the area surrounding the facility, which is mainly industrial. Figures 3-2 and 3-3 illustrate the residential and off-site worker receptors used to identify the MEIR and MEIW.

Sensitive Receptors

A total of 48 sensitive receptors were identified within the ZOI. The locations of the off-site sensitive receptors were identified based on Google Maps and aerial photographs. The list of off-site sensitive receptors used is provided in Table 3-3.

Population Cancer Burden

Cancer risk was assessed for the census tracts located within the ZOI. Census tract population data available in HARP includes a population-weighted center, or centroid, which is a single location that may be used to represent the population within the census tract. The census tracts are located within the cancer risk ZOI. The cancer burden was calculated by multiplying the total lifetime cancer risk at the centroid location by the number of persons in the population census tract. Cancer burden for residents was determined using a lifetime (70 years) exposure. Population burden estimates for non-cancer health hazards are not required. The assessed census tracts, population centroid locations, and number of individuals within the census tracts are included in Appendix D.

Zone of Impact

In accordance with SCAQMD guidelines, the ZOI was defined as the geographic area within which the total excess lifetime cancer risk to all emitted carcinogens is 1-in-1-million or greater, or a chronic or acute HI of 0.5 or greater. The ZOI is used to identify the extent of the health impacts (i.e., the boundaries of the analysis) from the facility.

4.1 Cancer Risk Estimates

Table 4-1 presents a summary of the cancer risk impact levels at the maximum impact points. The PMI, MEIR, and MEIW for cancer risk are shown in Figure 1-2 in Section 1, Executive Summary.

Table 4-1: Cancer Risk Maximum Impact Points

Receptor	UTM Easting (m)[a]	UTM Northing (m)[a]	Maximum Cancer Risk (per million)
PMI	385452.3	3739191.6	72.2
MEIR	384900	3739300	8.1
MEIW	385900	3739300	7.6
Sensitive (70-year)	386714	3739912	10.8
Sensitive (9-year, child)	386714	3739912	2.8
[a] UTM Zone 11, NAD83, Clarke 1886			

Point of Maximum Impact

Cancer risk at the PMI is 72.2-in-1-million. The PMI is located along the southeastern fenceline of the facility, directly downwind of the facility under the prevailing wind from the west. No individual is actually located at this exposure point for the 70-year exposure period required for the PMI estimate. Contributions by inhalation and non-inhalation pathways to the total risk at the PMI by source and by chemical are presented in Tables 4-2 and 4-3, respectively. As can be seen, a number of sources contribute primarily to the near-field cancer risk at the PMI.

Table 4-2: Source Contributions to Cancer Risk at the PMI

Source	Inhalation Pathway	Non-Inhalation Pathway				Total Cancer Risk	Percent
		Dermal	Soil	Mother's Milk	Home Grown Vegetables		
Engines-South (Portable and R219)	2.63E-05	--	--	--	--	2.63E-05	36%
Fluid Catalytic Cracking Unit	1.49E-05	1.28E-06	1.92E-07	--	1.63E-06	1.80E-05	25%
Fluid Catalytic Cracking Unit-H-4 Heater	6.95E-06	1.19E-06	1.81E-07	--	1.52E-06	9.84E-06	14%
Boiler House	2.32E-06	1.99E-07	2.98E-08	--	2.53E-07	2.80E-06	4%
Spray Paint-South	5.31E-07	3.37E-08	1.11E-06	--	7.91E-07	2.46E-06	3%
Engines-North (Portable and R219)	2.00E-06	--	--	--	--	2.00E-06	3%
Cogen Fugitives	1.52E-06	1.31E-07	1.96E-08	--	1.66E-07	1.84E-06	3%
Alkyl Unit	1.38E-06	1.19E-07	1.78E-08	--	1.51E-07	1.67E-06	2%
Alkyl Feed Treater	6.72E-07	5.78E-08	8.65E-09	--	7.33E-08	8.11E-07	1%
Fluid Catalytic Cracking Unit-H-2 Heater	5.16E-07	8.87E-08	1.34E-08	--	1.13E-07	7.31E-07	1%
Other	4.41E-06	5.41E-07	3.08E-07	--	4.23E-07	5.75E-06	8%
Sum	**6.15E-05**	**3.64E-06**	**1.88E-06**	**--**	**5.12E-06**	**7.22E-05**	**100%**
Facility Emergency IC Engine Total	6.76E-07	--	--	--	--	6.76E-07	1%

Table 4-3: Chemical Contributions to Cancer Risk at the PMI

Chemical	Inhalation Pathway	Non-Inhalation Pathway				Total Cancer Risk	Percent
		Dermal	Soil	Mother's Milk	Home Grown Vegetables		
Diesel engine exhaust, particulate matter (Diesel PM)	2.90E-05	--	--	--	--	2.90E-05	40%
1,3-Butadiene	1.90E-05	--	--	--	--	1.90E-05	26%
Chromium, hexavalent (& compounds)	5.43E-06	--	--	--	--	5.43E-06	8%
Benzo[a]pyrene	1.42E-07	1.88E-06	2.82E-07	--	2.39E-06	4.70E-06	7%
Benzene	4.21E-06	--	--	--	--	4.21E-06	6%
Lead	5.89E-07	3.76E-08	1.24E-06	--	8.83E-07	2.75E-06	4%
Formaldehyde	1.53E-06	--	--	--	--	1.53E-06	2%
Benz[a]anthracene	3.84E-08	5.10E-07	7.64E-08	--	6.47E-07	1.27E-06	2%
Other	1.56E-06	1.21E-06	2.82E-07	--	1.20E-06	4.31E-06	6%
Sum	**6.15E-05**	**3.64E-06**	**1.88E-06**	**--**	**5.12E-06**	**7.22E-05**	**100%**

Maximum Exposed Individual Resident (MEIR)

Cancer risk at the MEIR is 8.1-in-1-million. The MEIR is located within the residential receptor grid to the southwest of the facility, as shown in Figure 3-2 of Section 3. Contributions by inhalation and non-inhalation pathways to the total risk at the MEIR by source and by chemical are presented in Tables 1-5 and 1-6 in Section 1. Approximately 17% of the risk at the MEIR is due to emissions from the Engines-South (Portable and Rule 219 exempt) (Table 1-5). Emissions of DPM contribute to approximately 34% of the MEIR cancer risk, followed by emissions of 1,3-butadiene (19%), hexavalent chromium (9%), arsenic (8%), and benzene (8%) (Table 1-6).

Maximum Exposed Individual Worker (MEIW)

The cancer risk at the MEIW is approximately 7.6-in-1-million. The MEIW is located adjacent to the southeastern fenceline of the facility, as shown in Figure 3-3 of Section 3. Contributions by inhalation and non-inhalation pathways to the total risk at the MEIW by source and chemical are presented in Tables 1-7 and 1-8 in Section 1. At the MEIW, 42% of the cancer risk was attributed to emissions from Engines-South (Portable and Rule 219 Exempt) followed by approximately 8% from the Fluid Catalytic Cracking Unit-H-4 Heater (Table 1-7). DPM emissions contributed to 48% of the total cancer risk, followed by 1,3-butadiene emissions at 16% (Table 1-8).

Sensitive Receptors

Cancer risk at the maximum exposed sensitive receptor, based on a 70-year exposure, is 10.8-in-1-million. The maximum exposed sensitive receptor lies to the east of the facility, as shown in Figure 3-4 of Section 3. Tables 4-4 and 4-5 present the source and the chemical contributions at the maximum exposed sensitive receptor by pollutant and source. Twenty-five percent of the cancer risk at the sensitive receptor is due to emissions from the Engines-North (Portable and R219), followed by 8% due to emissions from the Crude and Delayed Coker Unit.

Table 4-4: Source Contributions to Cancer Risk at the Maximum Exposed Sensitive Receptor (70-Year Exposure)

Source	Inhalation Pathway	Non-Inhalation Pathway				Total Cancer Risk	Percent
		Dermal	Soil	Mother's Milk	Home Grown Vegetables		
Engines-North (Portable and R219)	2.72E-06	--	--	--	--	2.72E-06	25%
Crude and Delayed Coker Unit	6.80E-07	5.85E-08	8.76E-09	--	7.42E-08	8.21E-07	8%
Gas Compression	4.69E-07	4.03E-08	6.04E-09	--	5.11E-08	5.66E-07	5%
Engines-South (Portable and R219)	5.51E-07	--	--	--	--	5.51E-07	5%
Benzene Saturation Unit and HTU-1	3.96E-07	3.41E-08	5.11E-09	--	4.32E-08	4.79E-07	4%
Spray Paint-North	7.75E-08	4.92E-09	1.62E-07	--	1.16E-07	3.60E-07	3%
No.9 & 10 Boilers	1.45E-07	1.03E-07	4.69E-08	--	2.16E-08	3.16E-07	3%
HTU-2, CRU-2,HTU-3	2.51E-07	2.16E-08	3.23E-09	--	2.74E-08	3.03E-07	3%
No.7 & 8 Boilers	1.24E-07	8.84E-08	4.03E-08	--	1.86E-08	2.72E-07	3%
Fugitives from HGU-1	2.25E-07	1.94E-08	2.90E-09	--	2.46E-08	2.72E-07	3%
Other	3.36E-06	3.58E-07	1.49E-07	--	2.43E-07	4.14E-06	38%
Sum	**9.00E-06**	**7.28E-07**	**4.24E-07**	**--**	**6.20E-07**	**1.08E-05**	**100%**
Facility Emergency IC Engine Total	3.16E-07	--	--	--	--	3.16E-07	3%

Table 4-5: Chemical Contributions to Cancer Risk at the Maximum Exposed Sensitive Receptor (70-Year Exposure)

Chemical	Inhalation Pathway	Non-Inhalation Pathway				Total Cancer Risk	Percent
		Dermal	Soil	Mother's Milk	Home Grown Vegetables		
Diesel engine exhaust, particulate matter (Diesel PM)	3.59E-06	--	--	--	--	3.59E-06	33%
1,3-Butadiene	2.49E-06	--	--	--	--	2.49E-06	23%
Benzene	9.49E-07	--	--	--	--	9.49E-07	9%
Chromium, hexavalent (& compounds)	8.36E-07	--	--	--	--	8.36E-07	8%
Arsenic	1.53E-07	3.67E-07	1.79E-07	--	3.28E-08	7.33E-07	7%
Benzo[a]pyrene	1.30E-08	1.73E-07	2.58E-08	--	2.19E-07	4.30E-07	4%
Lead	9.15E-08	5.83E-09	1.92E-07	--	1.37E-07	4.27E-07	4%
Nickel	3.40E-07	--	--	--	--	3.40E-07	3%
Other	5.38E-07	1.82E-07	2.72E-08	--	2.31E-07	1.01E-06	9%
Sum	**9.00E-06**	**7.28E-07**	**4.24E-07**	**--**	**6.20E-07**	**1.08E-05**	**100%**

4.2 Non-Carcinogenic Chronic Health Effects

The maximum chronic HI at the maximum impact points are shown in Table 4-6. The PMI is located on the eastern fenceline, and the MEIR and MEIW are located to the southeast of the facility. The maximum chronic HI endpoint is the respiratory system. Nickel and arsenic emissions are the primary contributors to chronic HI at the PMI (approximately 94%). Because these risks are all below public notification and significance health-risk levels, detailed tables by source and pollutant contributions are not presented.

Table 4-6: Summary of Non-Carcinogenic Chronic Risks for PMI, MEIR, MEIW, and Sensitive Receptor

Receptor	UTM Easting (m)[a]	UTM Northing (m)[a]	Risk (per million for cancer, hazard index for non-cancer)
Non-Cancer Chronic Hazard Index			
PMI	386197.0	3740155.6	0.84
MEIR	387300	3739500	0.23
MEIW	386000	3739500	0.43
Sensitive Receptor	387041	3739640	0.24
[a] UTM Zone 11, NAD83, CLARKE1866			

4.3 Non-Carcinogenic Acute Health Effects

The acute HI at the maximum impact points are shown in Table 4-7. The PMI is located along the fenceline of the facility. The MEIR is located in the residential area to the southwest of the facility; the MEIW is located north of the facility. Because the acute risks for the MEIR and MEIW are all below the public notification and significance health-risk levels, detailed tables by source and pollutant contributions are not presented.

Table 4-7: Summary of Non-Carcinogenic Acute Risks for PMI, MEIR, MEIW, and Sensitive Receptor

Receptor	UTM Easting (m)[a]	UTM Northing (m)[a]	Risk (per million for cancer, hazard index for non-cancer)
Non-Cancer Acute Hazard Index			
PMI	385983	3740687	0.30
MEIR	387000	3740500	0.06
MEIW	386300	3740200	0.23
Sensitive Receptor	386714	3739912	0.05
[a] UTM Zone 11, NAD83, CLARKE1866			

4.4 Population Cancer Burden

Population cancer burden is the population-weighted number of cancer cases based on the population within the ZOI. The population cancer burden was calculated for census block centroids within the ZOI, and is estimated at approximately 0.38. A summary of the cancer burden estimate is presented in Table 4-8.

Table 4-8: Summary of Cancer Risk Population Exposure Estimates

Cancer Risk (per million)	Estimated Number of Persons Exposed	Total Cancer Burden[1] (Number of Excess Cancer Cases)
1-10	18,003	0.38
10-100	40	0.0004
>100	0	n/a

[1] The cancer burden is the estimated number of excess cancer cases expected from a 70-year exposure to the modeled facility emissions.

4.5 Zone of Impact

The 1-in-1-million (1.0 x 10^{-6}) cancer risk ZOI extends approximately 6.2 miles (10 kilometers) to the east from the eastern facility boundary. The ZOI was determined using a 70-year residential exposure period. A plot of the 1-in-1-million cancer risk isopleth is presented as Figure 1-2 in Section 1. A plot of the 10-in-1-million cancer risk isopleth for a 70-year residential exposure is shown in Figure 1-3. There is no ZOI for chronic or acute health effects because grid receptor impacts were less than the significance threshold level of 0.5. Accordingly, no isopleth maps were developed for these non-cancer health effects.

5.0 References

California Air Resource Board (CARB). 2011. Hotspots Analysis and Reporting Program (HARP), Version 1.4d, January.

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South Coast Air Quality Management District (SCAQMD). 2006. Off-Road Mobile Source Emission Factors (Scenario Years 2007–2025). Available at http://www.aqmd.gov/ceqa/handbook/offroad/offroad.html. Accessed 2009.

South Coast Air Quality Management District (SCAQMD). 2011. Supplemental Guidelines for Preparing Risk Assessments to Comply with the Air Toxics "Hot Spots" Information and Assessment Act (AB2588). June.

Appendix A

Diesel Particulate Matter Emissions Calculations

Tesoro LAR – SCAQMD Rule 219 Exempt Equipment

Rule 219 Exempt Equipment	Hp	Average Annual Fuel Used (gal)	BSFC (lbs/BHp-hr)	Density of Diesel (lbs/gal)	Hr/gal	Hours of operation (Hr)	DPM Emission Factor (lbs/Hr)	Average Annual DPM Emissions (lbs/yr)	Emergency Use Factor (%)	Emergency DPM Emissions (lbs/yr)	Routine Annual DPM Emissions (lbs/yr)	Routine Hours of Operation (hrs/yr)
Fuel Type - Diesel (Tesoro-Owned)												
Rule 219 exempt equipment-welding machines	450	282	0.41	7.1	0.04	11	0.0615	0.67	15%	0.1	0.57	9.231

Equipment	Hp	Average Annual Fuel Used (gal)	BSFC (lbs/BHp-hr)	Density of Diesel (lbs/gal)	Hr/gal	Hours of operation (Hr)	DPM Emission Factor (lbs/Hr)	Average Annual DPM Emissions (lbs/yr)	Emergency Use (hrs/yr)	Emergency DPM Emissions (lbs/yr)	Routine Annual DPM Emissions (lbs/yr)	Routine Hours of Operation (hrs/yr)
Fuel Type - Diesel (Tesoro-Owned)												
Air Compressors-Cummins-D1100	435	5,396	0.41	7.1	0.04	215	0.0889	19.10	195.7	17.40	1.698	19.10
Air Compressors-Cummins-D1101	435	5,345	0.41	7.1	0.04	213	0.0889	18.92	193.88	17.24	1.682	18.92
Air Compressors-Cummins-D1102	435	5,356	0.41	7.1	0.04	213	0.0889	18.95	194.25	17.27	1.685	18.95
Air Compressors (4) Behind BOHO	-	16,915	-	-		641	-	56.97	786.6	51.90	5.065	56.97
C-159 (D1103) Air Compressor at GCP	435	5,283	0.41	7.1	0.04	210	0.0889	18.70	191.6	17.03	1.662	18.70
C-160 (D1104) Air Compressor NE of DCU	435	5,320	0.41	7.1	0.04	212	0.0889	18.83	192.97	17.16	1.674	18.83
ENG-79 (D713) Firewater at Firehouse	146	2,117	0.47	7.1	0.10	219	0.0746	16.34	202.66	15.12	1.219	16.34
ENG-14 (D1659) Firewater at Tank 5000	375	4,576	0.41	7.1	0.05	211	0.1087	22.97	188.33	20.47	2.497	22.97
ENG-1 (D1123) Firewater at Tank 5400	287	3,301	0.41	7.1	0.06	199	0.1087	21.65	177.55	19.30	2.353	21.65
ENG-76 (D1617) Firewater at Tank 55000	475	6,830	0.41	7.1	0.04	249	0.1087	27.07	221.93	24.12	2.940	27.07
ENG-78 (D1618) Firewater at Tank 13501	475	6,830	0.41	7.1	0.04	249	0.1087	27.07	221.93	24.12	2.940	27.07
ENG-77 (D1645) Firewater South of FCCU	500	7,189	0.41	7.1	0.03	249	0.1087	27.07	221.93	24.12	2.940	27.07
SUBTOTAL	*2	**58,361**				**2,439**		**236.65**		**213.35**	**23.29**	**236.67**

*2 *As reported on Form B-4 in the 2006-2007 LAR AER, less emergency use for permitted stationary ICE's.*

Tesoro LAR – Equipment Fuel Usage													
Equipment	Hp	[a]Percentage of total rental fuel use	Average Annual Fuel Used (gal)	BSFC (lbs/BHp-hr)	Density of Diesel (lbs/gal)	Hr/gal	Hours of operation (Hr)	Emission Factor (lbs/Hr)	Average Annual Emissions (lbs/yr)	Emergency Use Factor (%)	Emergency Emissions (lbs/yr)	Routine Annual Emissions (lbs/yr)	Routine Hours of Operation (hrs/yr)
Fuel Type - Diesel (Rental)													
Compressors	150	21.02%	16,851	0.47	7.1	0.10	1,697	0.0615	104.37	15%	15.66	88.71	1,442
Compressors	250	21.02%	16,851	0.47	7.1	0.06	1,018	0.0557	56.72	15%	8.51	48.21	865
Generators	200	13.25%	10,624	0.47	7.1	0.08	802	0.0795	63.79	15%	9.57	54.22	682
Generators	500	13.25%	10,624	0.41	7.1	0.03	368	0.1084	39.88	15%	5.98	33.90	313
Light Towers	50	5.02%	4,023	0.54	7.1	0.26	1,058	0.0317	33.54	15%	5.03	28.51	899
Pumps	150	2.10%	1,687	0.47	7.1	0.10	170	0.0816	13.86	15%	2.08	11.78	144
Pumps	250	2.10%	1,687	0.47	7.1	0.06	102	0.0727	7.41	15%	1.11	6.30	87
Welders	250	1.14%	914	0.47	7.1	0.06	55	0.0481	2.66	15%	0.40	2.26	47
Welders	400	1.14%	914	0.41	7.1	0.04	40	0.0615	2.43	15%	0.36	2.07	34
Others	150	9.96%	7,987	0.47	7.1	0.10	804	0.0746	60.00	15%	9.00	51.00	684
Others	250	9.96%	7,987	0.47	7.1	0.06	483	0.0614	29.63	15%	4.44	25.19	410
SUBTOTAL		**	**80,148**				**6,597**					**352.15**	**5,608**

***This number is now a percentage (based on 2006-2007 AER) of average fuel used from 2007 (as reported Form B-4 in the 2006-2007 LAR AER, less emergency use for permitted stationary*

[a] *This percentage is based on the fuel consumed by each equipment type as per the 2007 AER calculation conducted for 2009 HRA engine emissions.*

Appendix B

Modeled Source Parameters

Stack Name	Stack Height (feet)	Stack Diam. (feet)	Exit Temp. (deg. F)	Exit Vel. (ft/min)	UTMx (km)	UTMy (km)	Type	Syinit	Szinit	Xinit	Yinit	Angle
Cooling tower number 6	44.00	56.10	87.80	1397.62	385.485	3739.309	POINT	0.00	0.00	0.00	0.00	0.00
Cooling tower number 7	37.99	41.67	102.20	2200.76	385.477	3739.485	POINT	0.00	0.00	0.00	0.00	0.00
Cooling tower number 8	37.99	36.09	100.40	1228.33	385.725	3739.987	POINT	0.00	0.00	0.00	0.00	0.00
Cooling tower number 9	41.01	51.51	100.40	1385.81	385.725	3740.041	POINT	0.00	0.00	0.00	0.00	0.00
Cooling tower number 10	49.02	32.81	96.80	1433.05	385.740	3739.317	POINT	0.00	0.00	0.00	0.00	0.00
Cooling tower number 11	49.02	48.23	96.80	1169.28	385.716	3740.205	POINT	0.00	0.00	0.00	0.00	0.00
Cooling tower number 12	69.00	48.56	98.60	1895.65	385.667	3740.205	POINT	0.00	0.00	0.00	0.00	0.00
Cooling tower number 13	52.00	39.70	80.60	1600.37	385.531	3740.253	POINT	0.00	0.00	0.00	0.00	0.00
Crude unit heater	160.00	4.99	410.00	2088.56	386.031	3740.034	POINT	0.00	0.00	0.00	0.00	0.00
Delayed coking unit coker heater-H101	183.00	9.91	1160.60	1992.10	386.060	3739.992	POINT	0.00	0.00	0.00	0.00	0.00

Stack Name	Stack Height (feet)	Stack Diam. (feet)	Exit Temp. (deg. F)	Exit Vel. (ft/min)	UTMx (km)	UTMy (km)	Type	Syinit	Szinit	Xinit	Yinit	Angle
Delayed coking unit fresh feed heater-H100	175.00	8.50	665.60	972.43	386.057	3740.009	POINT	0.00	0.00	0.00	0.00	0.00
Hydro cracking unit- 300 and 301	183.00	5.18	845.60	773.61	385.669	3740.030	POINT	0.00	0.00	0.00	0.00	0.00
Hydro cracking unit HF- 302 and 303	183.00	6.20	739.40	1236.21	385.653	3740.030	POINT	0.00	0.00	0.00	0.00	0.00
Hydro cracking unit HF- 304	183.00	6.99	829.40	911.41	385.680	3740.030	POINT	0.00	0.00	0.00	0.00	0.00
Fluid catalytic cracking unit-H-3 Heater	120.01	9.19	1104.80	366.14	385.523	3739.272	POINT	0.00	0.00	0.00	0.00	0.00
Fluid catalytic cracking unit-H-4 Heater	79.99	5.51	300.20	5.91	385.503	3739.260	POINT	0.00	0.00	0.00	0.00	0.00
Fluid catalytic cracking unit- CO Boiler-BO 1	181.00	8.99	530.60	2958.63	385.546	3739.183	POINT	0.00	0.00	0.00	0.00	0.00

Stack Name	Stack Height (feet)	Stack Diam. (feet)	Exit Temp. (deg. F)	Exit Vel. (ft/min)	UTMx (km)	UTMy (km)	Type	Syinit	Szinit	Xinit	Yinit	Angle
Fluid catalytic cracking unit-H-2 Heater	87.99	6.00	660.20	96.46	385.513	3739.255	POINT	0.00	0.00	0.00	0.00	0.00
Hydrogen treatment unit-1 CHG Heater- H31	95.01	5.71	559.40	360.23	385.820	3740.027	POINT	0.00	0.00	0.00	0.00	0.00
CRU-2 F - 501A, 501B, 502 and 503/504-504	75.00	4.49	300.20	2472.41	385.783	3740.132	POINT	0.00	0.00	0.00	0.00	0.00
CRU-2 H510	100.00	4.49	649.40	287.40	385.759	3740.106	POINT	0.00	0.00	0.00	0.00	0.00
Hydrogen treatment unit-2 CHG Heater-H500	106.99	4.69	399.20	360.23	385.780	3740.158	POINT	0.00	0.00	0.00	0.00	0.00
CRU-3 HD-200, 201 and 202	137.99	6.20	780.80	1127.94	385.695	3740.128	POINT	0.00	0.00	0.00	0.00	0.00
CRU-3 HD-203	137.99	4.00	680.00	612.20	385.698	3740.115	POINT	0.00	0.00	0.00	0.00	0.00
Hydrogen treatment unit-3 H21/H22	116.01	5.71	640.40	185.04	385.778	3740.185	POINT	0.00	0.00	0.00	0.00	0.00

Stack Name	Stack Height (feet)	Stack Diam. (feet)	Exit Temp. (deg. F)	Exit Vel. (ft/min)	UTMx (km)	UTMy (km)	Type	Syinit	Szinit	Xinit	Yinit	Angle
Hydrogen treatment unit-3 H-30	87.99	4.00	575.60	1013.77	385.778	3740.173	POINT	0.00	0.00	0.00	0.00	0.00
East Flare	250.00	2.26	1500.80	68.90	385.729	3740.229	POINT	0.00	0.00	0.00	0.00	0.00
West Flare	250.00	2.26	1500.80	68.90	385.714	3740.441	POINT	0.00	0.00	0.00	0.00	0.00
No.7 & 8 boilers	64.99	6.99	500.00	407.48	385.566	3739.472	POINT	0.00	0.00	0.00	0.00	0.00
No.9 & 10 boilers	64.99	6.99	500.00	1295.26	385.580	3739.463	POINT	0.00	0.00	0.00	0.00	0.00
Cogen A	70.01	10.40	350.60	3179.10	385.670	3739.466	POINT	0.00	0.00	0.00	0.00	0.00
Cogen B	70.01	10.40	350.60	4086.56	385.684	3739.495	POINT	0.00	0.00	0.00	0.00	0.00
Hydrogen treatment unit-4	190.94	4.30	539.60	1104.32	385.484	3740.100	POINT	0.00	0.00	0.00	0.00	0.00
HYDROGEN TREATMENT UNIT-2	105.00	4.69	746.00	1342.00	385.506	3740.250	POINT	0.00	0.00	0.00	0.00	0.00
No. 6 Separator	0.00	0.00	0.00	0.00	386.049	3739.830	AREA	0.00	0.00	32.81	82.02	-3.00
Air floatation unit 1-2	0.00	0.00	0.00	0.00	386.096	3739.963	AREA	0.00	0.00	65.62	65.62	0.00
No. 7 Separator	0.00	0.00	0.00	0.00	385.623	3740.286	AREA	0.00	0.00	16.40	52.49	-73.00
No. 8 Separator	0.00	0.00	0.00	0.00	385.644	3740.649	AREA	0.00	0.00	16.40	45.93	-26.00

Stack Name	Stack Height (feet)	Stack Diam. (feet)	Exit Temp. (deg. F)	Exit Vel. (ft/min)	UTMx (km)	UTMy (km)	Type	Syinit	Szinit	Xinit	Yinit	Angle
Fluid Catalytic Cracking Unit	1.64	0.00	0.00	0.00	385.466	3739.206	AREA	0.00	0.76	393.70	337.92	0.00
Boiler House	1.64	0.00	0.00	0.00	385.522	3739.372	AREA	0.00	0.76	98.42	164.04	31.00
Cogen Fugitives	1.64	0.00	0.00	0.00	385.578	3739.366	AREA	0.00	0.76	164.04	590.54	31.00
Alkyl Unit	1.64	0.00	0.00	0.00	385.460	3739.498	AREA	0.00	0.76	164.04	344.48	31.00
Alkyl feed treater	1.64	0.00	0.00	0.00	385.558	3739.617	AREA	0.00	0.76	108.27	108.27	31.00
Benzene Saturation Unit and HTU-1	1.64	0.00	0.00	0.00	385.781	3739.985	AREA	0.00	0.76	164.04	328.08	-3.00
Gas compression	1.64	0.00	0.00	0.00	385.852	3739.992	AREA	0.00	0.76	196.85	196.85	-3.00
Crude and Delayed Coker Unit	1.64	0.00	0.00	0.00	385.954	3739.911	AREA	0.00	0.76	410.10	410.10	-3.00
Fixed roof tanks-11	1.64	0.00	0.00	0.00	385.515	3740.075	AREA	0.00	0.76	328.08	295.27	-3.00
HTU-2, CRU-2,HTU-3	1.64	0.00	0.00	0.00	385.731	3740.092	AREA	0.00	0.76	360.89	262.46	-3.00

Stack Name	Stack Height (feet)	Stack Diam. (feet)	Exit Temp. (deg. F)	Exit Vel. (ft/min)	UTMx (km)	UTMy (km)	Type	Syinit	Szinit	Xinit	Yinit	Angle
Receiving, purchacing & storage; HTU-4,HGU-2	1.64	0.00	0.00	0.00	385.461	3740.130	AREA	0.00	0.76	114.83	114.83	-3.00
Inline blending	1.64	0.00	0.00	0.00	385.947	3740.616	AREA	0.00	0.76	73.82	73.82	19.77
NH3 Loading	20.01	0.00	0.00	0.00	385.500	3740.039	AREA	0.00	9.31	8.86	8.86	0.00
HEATER H41 AT HTU-4	191.00	3.83	680.00	709.00	385.451	3740.094	POINT	0.00	0.00	0.00	0.00	0.00
Fixed roof tanks-1	29.10	0.00	0.00	0.00	385.826	3739.813	AREA	0.00	13.54	49.21	442.91	-3.00
Fixed roof tanks-2	35.01	0.00	0.00	0.00	385.624	3739.235	AREA	0.00	16.28	121.39	492.12	31.00
Fixed roof tanks-3	35.01	0.00	0.00	0.00	385.753	3739.495	AREA	0.00	16.28	114.83	147.64	31.00
Fixed roof tanks-4	35.01	0.00	0.00	0.00	385.881	3739.787	AREA	0.00	16.28	82.02	114.83	-3.00
Fixed roof tanks-5	35.01	0.00	0.00	0.00	385.958	3739.795	AREA	0.00	16.28	180.44	229.66	-3.00
External floating roof tanks-1	39.99	0.00	0.00	0.00	385.992	3740.541	AREA	0.00	18.60	219.81	1410.74	16.80
Fixed roof tanks-7	41.80	0.00	0.00	0.00	385.976	3740.082	AREA	0.00	19.44	410.10	1148.28	20.00
Fixed roof tanks-8	41.80	0.00	0.00	0.00	385.829	3740.191	AREA	0.00	19.44	492.12	1640.40	-14.95

Stack Name	Stack Height (feet)	Stack Diam. (feet)	Exit Temp. (deg. F)	Exit Vel. (ft/min)	UTMx (km)	UTMy (km)	Type	Syinit	Szinit	Xinit	Yinit	Angle
Fixed roof tanks-9	41.80	0.00	0.00	0.00	385.431	3740.536	AREA	0.00	19.44	770.99	885.82	17.54
External floating roof tank, Fixed roof tanks	41.01	0.00	0.00	0.00	385.362	3740.321	AREA	0.00	19.07	885.82	721.78	17.64
Fixed roof tanks-10	41.14	0.00	0.00	0.00	385.315	3740.172	AREA	0.00	19.14	147.64	492.12	17.00
Catalyst regeneration unit-3 fugitives	137.99	0.00	0.00	0.00	385.679	3740.069	AREA	0.00	64.18	147.64	295.27	-3.00
Hydrocracking unit	183.00	0.00	0.00	0.00	385.628	3740.064	AREA	0.00	85.12	147.64	328.08	-3.00
No. 3 separator	1.64	0.00	0.00	0.00	385.612	3739.109	AREA	0.00	0.76	16.40	65.62	31.00
Fuel dispensing	3.94	0.00	0.00	0.00	385.594	3739.895	AREA	0.00	1.83	45.93	19.68	-3.00
HCOD fugitives, Tank 2513	1.64	0.00	0.00	0.00	385.723	3739.603	AREA	0.00	0.76	98.42	196.85	31.00
Dissolved air floatation Separator	1.64	0.00	0.00	0.00	385.736	3739.325	AREA	0.00	0.76	46.59	46.59	0.00
IGFU-1, IGFU-2, CPI-1, CPI-2	1.64	0.00	0.00	0.00	385.725	3739.360	AREA	0.00	0.76	59.05	39.37	31.00

Stack Name	Stack Height (feet)	Stack Diam. (feet)	Exit Temp. (deg. F)	Exit Vel. (ft/min)	UTMx (km)	UTMy (km)	Type	Syinit	Szinit	Xinit	Yinit	Angle
Delayed coking unit Coke Handling-1	4.00	0.00	0.00	0.00	386.084	3739.920	VOLUME	0.75	0.75	0.00	0.00	0.00
Delayed coking unit Coke Handling-2	4.00	0.00	0.00	0.00	386.084	3739.980	VOLUME	0.75	0.75	0.00	0.00	0.00
Delayed coking unit Coke Handling-3	4.00	0.00	0.00	0.00	386.082	3740.038	VOLUME	0.75	0.75	0.00	0.00	0.00
Delayed coking unit Coke Handling-4	4.00	0.00	0.00	0.00	386.119	3740.087	VOLUME	0.75	0.75	0.00	0.00	0.00
Delayed coking unit Coke Handling-5	4.00	0.00	0.00	0.00	386.151	3740.142	VOLUME	0.75	0.75	0.00	0.00	0.00
Delayed coking unit Coke Handling-6	4.00	0.00	0.00	0.00	386.174	3740.194	VOLUME	0.75	0.75	0.00	0.00	0.00
Delayed coking unit Coke Handling-7	4.00	0.00	0.00	0.00	386.185	3740.251	VOLUME	0.75	0.75	0.00	0.00	0.00
Delayed coking unit Coke Handling-8	4.00	0.00	0.00	0.00	386.200	3740.309	VOLUME	0.75	0.75	0.00	0.00	0.00

Stack Name	Stack Height (feet)	Stack Diam. (feet)	Exit Temp. (deg. F)	Exit Vel. (ft/min)	UTMx (km)	UTMy (km)	Type	Syinit	Szinit	Xinit	Yinit	Angle
Delayed coking unit Coke Handling-9	4.00	0.00	0.00	0.00	386.165	3740.453	VOLUME	0.75	0.75	0.00	0.00	0.00
Delayed coking unit Coke Handling-10	4.00	0.00	0.00	0.00	386.169	3740.469	VOLUME	0.75	0.75	0.00	0.00	0.00
Delayed coking unit Coke Handling-11	4.00	0.00	0.00	0.00	386.192	3740.562	VOLUME	0.75	0.75	0.00	0.00	0.00
Delayed coking unit Coke Handling-12	4.00	0.00	0.00	0.00	386.205	3740.608	VOLUME	0.75	0.75	0.00	0.00	0.00
Delayed coking unit Coke Handling-13	4.00	0.00	0.00	0.00	386.223	3740.678	VOLUME	0.75	0.75	0.00	0.00	0.00
Delayed coking unit Coke Handling-14	4.00	0.00	0.00	0.00	386.237	3740.729	VOLUME	0.75	0.75	0.00	0.00	0.00
Delayed coking unit Coke Handling-15	4.00	0.00	0.00	0.00	386.249	3740.781	VOLUME	0.75	0.75	0.00	0.00	0.00
Delayed coking unit Coke Handling-16	4.00	0.00	0.00	0.00	386.261	3740.814	VOLUME	0.75	0.75	0.00	0.00	0.00

Stack Name	Stack Height (feet)	Stack Diam. (feet)	Exit Temp. (deg. F)	Exit Vel. (ft/min)	UTMx (km)	UTMy (km)	Type	Syinit	Szinit	Xinit	Yinit	Angle
Delayed coking unit Coke Handling-17	4.00	0.00	0.00	0.00	386.269	3740.844	VOLUME	0.75	0.75	0.00	0.00	0.00
Delayed coking unit Coke Handling-18	4.00	0.00	0.00	0.00	386.269	3740.893	VOLUME	0.75	0.75	0.00	0.00	0.00
Delayed coking unit Coke Handling-19	4.00	0.00	0.00	0.00	386.289	3740.957	VOLUME	0.75	0.75	0.00	0.00	0.00
Delayed coking unit Coke Handling-20	4.00	0.00	0.00	0.00	386.289	3741.014	VOLUME	0.75	0.75	0.00	0.00	0.00
HEATER H42/43 AT HGU-2	100.00	10.00	301.00	793.00	385.479	3740.248	POINT	0.00	0.00	0.00	0.00	0.00
Spray Paint-North	6.56	0.00	0.00	0.00	385.436	3739.990	AREA	0.00	3.05	1399.98	590.54	0.00
Spray Paint-South	6.56	0.00	0.00	0.00	385.595	3739.286	AREA	0.00	3.05	799.99	499.99	-59.22
Welder @ Shop	4.92	0.00	0.00	0.00	385.612	3739.847	AREA	0.00	2.29	180.00	180.00	0.00
Fugitives from HGU-1	4.92	0.00	0.00	0.00	385.528	3740.083	AREA	0.00	2.29	260.00	260.00	-2.50
Engines-North (Portable and R219)	12.00	0.00	0.00	0.00	385.405	3739.983	AREA	0.00	5.58	1800.00	700.00	0.00

Stack Name	Stack Height (feet)	Stack Diam. (feet)	Exit Temp. (deg. F)	Exit Vel. (ft/min)	UTMx (km)	UTMy (km)	Type	Syinit	Szinit	Xinit	Yinit	Angle
Engines-South (Portable and R219)	12.00	0.00	0.00	0.00	385.624	3739.113	AREA	0.00	5.58	1800.00	700.00	-59.62
ENG-79 (D713) Firewater at Firehouse	14.99	0.66	761.27	4072.79	385.753	3739.927	POINT	0.00	0.00	0.00	0.00	0.00
Air Compressors (4) Behind BOHO	14.99	0.67	761.27	4072.79	385.539	3739.437	POINT	0.00	0.00	0.00	0.00	0.00
ENG-14 (D1659) Firewater at Tank 5000	14.99	0.67	761.27	4072.79	385.755	3739.902	POINT	0.00	0.00	0.00	0.00	0.00
C-159 (D1103) Air Compressor at GCP	14.99	0.67	761.27	4072.79	385.879	3740.025	POINT	0.00	0.00	0.00	0.00	0.00
C-160 (D1104) Air Compressor NE of DCU	14.99	0.67	761.27	4072.79	386.015	3740.013	POINT	0.00	0.00	0.00	0.00	0.00
ENG-1 (D1123) Firewater at Tank 5400	14.99	0.67	761.27	4072.79	385.444	3739.691	POINT	0.00	0.00	0.00	0.00	0.00
ENG-76 (D1617) Firewater at Tank 55000	14.99	0.67	761.27	4072.79	385.442	3740.029	POINT	0.00	0.00	0.00	0.00	0.00

Stack Name	Stack Height (feet)	Stack Diam. (feet)	Exit Temp. (deg. F)	Exit Vel. (ft/min)	UTMx (km)	UTMy (km)	Type	Syinit	Szinit	Xinit	Yinit	Angle
ENG-78 (D1618) Firewater at Tank 13501	14.99	0.67	761.27	4072.79	385.991	3739.865	POINT	0.00	0.00	0.00	0.00	0.00
ENG-77 (D1645) Firewater South of FCCU	14.99	0.67	761.27	4072.79	385.580	3739.150	POINT	0.00	0.00	0.00	0.00	0.00
ENG-15 (D134) Air Compressor South of Old Control Room	14.99	0.67	761.27	4072.79	385.600	3739.382	POINT	0.00	0.00	0.00	0.00	0.00

Appendix C

Facility Plot Plan

Appendix D

HARP Input and Output Files (on CD)