UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

OFFICE OF

AIR
QUALITY
PLANNING

AND STANDARDS

MEMORANDUM

SUBJECT: Results of the Risk Assessment of Ethylene Oxide Emitting Facilities in Texas and Louisiana

FROM: Kelly Rimer
Health and Environmental Impacts Division

TO: Jeffrey Robinson
Air and Radiation Division, Region 6

The purpose of this memo is to follow up with you regarding your request that we provide technical assistance by conducting risk assessments on eight Texas (TX) and Louisiana (LA) facilities that emit ethylene oxide (EtO). Below we present a summary of the work conducted and the risk assessment results. We provide additional details in the attachment. We hope this information is useful to you as you reach out to the relevant states and communities.

In April 2021, the EPA's Office of Inspector General (OIG) released a report regarding risk communication surrounding ethylene oxide (EtO) emitting facilities. Table 1 in the attachment lists the relevant facilities. The report recommended the EPA's Office of Air and Radiation (OAR) work with regional offices to assess and communicate preliminary air toxics risk information to the public. In response to this, EPA Region 6 requested our assistance to perform a risk analysis of eight EtO-emitting facilities in Louisiana and Texas. In coordination with Region 6, we estimated cancer risks and noncancer hazards from potential exposure to hazardous air pollutants (HAPs) from these eight facilities.

We used data from the 2018 National Emissions Inventory (NEI), in conjunction with revisions from Region 6 and the states, to estimate cancer risks and noncancer hazards from potential exposure to the reported HAPs. The estimated maximum individual cancer risk due to emissions from each facility ranged from 10-in-1 million to 2,000 -in-1 million, and EtO is the primary contributor to this risk. Approximately 6,600,000 people live within 50 kilometers of the eight modeled facilities, and 89,909 people are estimated to have cancer risks above 100-in-1 million. Results for the chronic noncancer risk assessment indicate that one facility had a hazard index (HI) above 1, with an HI of 3, due to chlorine emissions.

Additional information regarding the methodology used in the risk assessment, as well as more detailed results, can be found in the attached document: *'Region 6 Risk Assessment'*.

Please let us know if you have questions or would like to discuss.

cc: Ruben Casso, Region 6
Michael Moeller, OAQPS

ATTACHMENT: Results of the Region 6 Risk Assessment

In April 2021, the OIG released a report regarding risk communication surrounding ethylene oxide (EtO) emitting facilities. The report recommended OAR work with regional offices to assess and communicate preliminary air toxics risk information to the public. In response to this, EPA Region 6 requested OAQPS assistance to perform a risk analysis of eight EtO-emitting facilities in Louisiana and Texas. In coordination with Region 6, we estimated cancer risks and noncancer hazards from potential exposure to HAPs from these eight facilities. The facilities are listed in Table 1 below, with five in Louisiana and three in Texas:

Table 1: Facility List

Facility Name	Location	EIS Facility ID
BCP Ingredients	St. Gabriel, LA	7451011
Taminco US (Eastman Corp.)	St. Gabriel, LA	5504811
Union Carbide Corp., St. Charles Operations	Taft, LA	7202911
Sasol Chemicals (USA) – Lake Charles Complex	Westlake, LA	8468011
Air Products Performance Manufacturing Inc. – Reserve Plan (Evonik)	Reserve, LA	5287111
Huntsman, Port Neches Operations	Port Neches, TX	4945211
Eastman Chemical Texas Operations	Longview, TX	4941511
Shell Technology Center Houston	Houston, TX	3736811

Emissions and Source Data

For this assessment, facility-specific HAP emissions data was based on the most recent and publicly available 2018 National Emissions Inventory (NEI) collected from the Emissions Inventory System (EIS) Gateway. The NEI database contains information about sources that emit HAP, and it contains annual air pollutant emissions estimates. The 2018 NEI dataset is primarily comprised of data submitted directly by the state agencies (Louisiana Department of Environmental Quality and Texas Commission on Environmental Quality), augmented by data from EPA, where needed, to fill data gaps. Further information on the NEI can be found on the EPA's web site at: https://www.epa.gov/air-emissions-inventories/national-emissions-inventory.

Emission source location parameters were updated, where appropriate, with state-submitted revisions and quality assurance checks in Google Earth. Emission values were updated specifically for Shell Technology, Eastman Texas Operations and Huntsman Port Neches facilities. Shell Technology and Eastman submitted 2018 emission revisions to Region 6, and

these were incorporated into the final dataset. Region 6 provided emission event release reports for Huntsman Port Neches, and these were also added to the dataset. All revisions and updates made from the original 2018 NEI dataset are noted in the included excel file: 'data_input_changes_05_27_21'

Dispersion modeling for inhalation exposure assessment

For the risk analysis, we estimated inhalation exposure concentrations and associated health risks from each facility. To do this, we used the Human Exposure Model 4 (HEM-4 or HEM-AERMOD) modeling system – which combines the Human Exposure Model (HEM) with the American Meteorological Society/EPA Regulatory Model (AERMOD) dispersion modeling system. HEM-4 performs three main operations: atmospheric dispersion modeling, estimation of individual human exposures and health risks, and estimation of population risks.

The dispersion model in the HEM-4 modeling system, AERMOD version 19191, is a state-of-the-science Gaussian plume dispersion model that is preferred by EPA for modeling point, area, and volume sources of continuous air emissions from facility applications[1]. Further details on AERMOD can be found in the AERMOD User's Guide[2] and the AERMOD Implementation Guide[3]. The model is used to develop annual average ambient concentrations through the simulation of hour-by-hour dispersion from the emission sources into the surrounding atmosphere. Hourly emission rates used for this simulation are generated by evenly dividing the total annual emission rate from the inventory into the 8,760 hours of the year.

To perform the dispersion modeling and to develop the preliminary risk estimates, HEM-4 draws on three data libraries. The first is a library of meteorological data, which is used for dispersion calculations. This library includes one year (2019) of hourly surface and upper air observations from 824 meteorological stations selected to provide coverage of the United States and Puerto Rico. A second library of United States Census Bureau census block internal point locations and populations provides the basis of human exposure calculations (using the 2010 Census). In addition, for each census block, the census library includes the elevation and controlling hill height, which are also used in dispersion calculations. A third library of pollutant-specific dose-response values is used to estimate health risk.

The first step in the application of the HEM-4 modeling system is to predict ambient concentrations at locations of interest. The AERMOD model options employed are summarized in Table 2 below.

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1 USEPA, 2005a. Revision to the Guideline on Air Quality Models: Adoption of a Preferred General Purpose (Flat and Complex Terrain) Dispersion Model and Other Revisions; Final Rule. 40 CFR Part 51. https://www3.epa.gov/scram001/guidance/guide/appw_05.pdf

2 USEPA, 2018a User's Guide for the AMS/EPA Regulatory Model (AERMOD). EPA-454/B-18-001, U.S. Environmental Protection Agency, Research Triangle Park, NC. https://www3.epa.gov/ttn/scram/models/aermod/aermod_userguide.pdf

3 USEPA, 2018b. AERMOD Implementation Guide. EPA-454/B-18-003, U.S. Environmental Protection Agency, Research Triangle Park, NC. https://www3.epa.gov/ttn/scram/models/aermod/aermod_implementation_guide.pdf

Table 2: AERMOD version 19191 Model Options for RTR Modeling

Modeling Option	*Selected Parameter for chronic exposure*
Type of calculations	Hourly Ambient Concentration
Source types	Point Area
Receptor orientation	Polar (13 rings and 16 radials) Discrete (census block centroids) and user-supplied receptors
Terrain characterization	Actual from USGS 1/3-arc-second DEM data
Building downwash	Not Included
Plume deposition/depletion	Not Included
Urban source option	Site Specific
Meteorology	1-year representative NWS from nearest site (824 stations) for year 2019

The HEM-4 modeling system estimates ambient concentrations at the geographic centroids of census blocks and at other receptor locations that can be specified by the user. See Appendix B of this document (Dispersion Model Receptor Revisions and Additions) for a discussion of user receptors and centroid location changes specific to this assessment. HEM-4 accounts for the effects of multiple facilities when estimating concentration impacts at each block centroid. We estimated the impacts of all HAP emitted by the facilities and assessed chronic exposure and risk for all census blocks with at least one resident (i.e., locations where people may reasonably be assumed to reside rather than receptor points at the fence line of a facility).

Dose-response assessment

Sources of chronic dose-response information

Dose-response assessments (carcinogenic and non-carcinogenic) for chronic exposure (either by inhalation or ingestion) for the HAP reported in the emissions inventory are based on the EPA Office of Air Quality Planning and Standards' (OAQPS) existing recommendations for HAP[4]. This information has been obtained from various sources and prioritized according to (1) conceptual consistency with EPA risk assessment guidelines and (2) level of peer review received. The prioritization process was aimed at incorporating into our assessments the best available science with respect to dose-response information. The recommendations are based on the following sources, in order of priority:

1) **U.S. Environmental Protection Agency (EPA).** EPA has developed dose-response assessments for chronic exposure for many HAP. These assessments typically provide a

4 USEPA, 2014a. Table 1. Prioritized Chronic Dose-Response Values (5/9/14). Office of Air Quality Planning and Standards. https://www.epa.gov/fera/dose-response-assessment-assessing-health-risks-associated-exposure-hazardous-air-pollutants

qualitative statement regarding the strength of scientific data and specify a reference concentration (RfC, for inhalation) or reference dose (RfD, for ingestion) to protect against effects other than cancer and/or a unit risk estimate (URE, for inhalation) or slope factor (SF, for ingestion) to estimate the probability of developing cancer. The RfC is defined as an "estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime." The RfD is "an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime." The URE is defined as "the upper-bound excess cancer risk estimated to result from continuous lifetime exposure to an agent at a concentration of 1 $\mu g/m^3$ in air." The SF is "an upper bound, approximating a 95 percent confidence limit, on the increased cancer risk from a lifetime exposure to an agent. This estimate, [is] usually expressed in units of proportion (of a population) affected per mg/kg-day…"

EPA disseminates dose-response assessment information in several forms, based on the level of review. The Integrated Risk Information System (IRIS) is an EPA database that contains scientific health assessment information, including dose-response information. All IRIS assessments since 1996 have also undergone independent external peer review. The current IRIS process includes review by EPA scientists, interagency reviewers from other federal agencies, and the public, as well as peer review by independent scientists external to EPA. New IRIS values are developed and old IRIS values are updated as new health effects data become available. Refer to the IRIS Agenda for detailed information on status and scheduling of current individual IRIS assessments and updates. EPA's science policy approach, under the current carcinogen guidelines, is to use linear low-dose extrapolation as a default option for carcinogens for which the mode of action (MOA) has not been identified. We expect future EPA dose-response assessments to identify nonlinear MOAs where appropriate, and we will use those analyses (once they are peer reviewed) in our risk assessments. At this time, however, there are no available carcinogen dose-response assessments for inhalation exposure that are based on a nonlinear MOA.

2) **U.S. Agency for Toxic Substances and Disease Registry (ATSDR).** ATSDR, which is part of the US Department of Health and Human Services, develops and publishes Minimal Risk Levels (MRLs) for inhalation and oral exposure to many toxic substances. As stated on the ATSDR web site: "Following discussions with scientists within the Department of Health and Human Services (HHS) and the EPA, ATSDR chose to adopt a practice similar to that of the EPA's Reference Dose (RfD) and Reference Concentration (RfC) for deriving substance specific health guidance levels for non-neoplastic endpoints." The MRL is defined as "an estimate of daily human exposure to a substance that is likely to be without an appreciable risk of adverse effects (other than cancer) over a specified duration of exposure." ATSDR describes MRLs as substance-specific estimates to be used by health assessors to select environmental contaminants for further evaluation.

3) **California Environmental Protection Agency (CalEPA).** The CalEPA Office of Environmental Health Hazard Assessment has developed dose-response assessments for many substances, based both on carcinogenicity and health effects other than cancer. The process for developing these assessments is similar to that used by EPA to develop IRIS values and incorporates significant external scientific peer review. As stated in the CalEPA Technical Support Document for developing their chronic assessments, the guidelines for developing chronic inhalation exposure levels incorporate many recommendations of the U.S. EPA[5] and NAS[6]. The noncancer information includes available inhalation health risk guidance values expressed as chronic inhalation reference exposure levels (RELs). CalEPA defines the REL as "the concentration level at or below which no health effects are anticipated in the general human population." CalEPA's quantitative dose-response information on carcinogenicity by inhalation exposure is expressed in terms of the URE, defined similarly to EPA's URE.

Cancer Risk Results

To estimate individual lifetime cancer risks associated with exposure to HAP emissions from each facility, we summed the cancer risks for each of the HAP emitted by the modeled facility. We estimated cancer risk at every census block within 50 km of each facility. The maximum individual risk due to emissions from each facility ranged from 10-in-1 million to 2,000-in-1 million. An increased cancer risk of 2,000-in-1 million means that, for every million people that are exposed at the levels estimated at the highest risk census block, up to 2,000 of those people may develop cancer over their lifetime. The calculated risks are in excess of a person's chance of developing cancer for reasons other than the chemical exposures being evaluated. In general, the EPA considers excess cancer risks that are below about 1 chance in 1 million (1-in-1 million) to be negligible and excess cancer risks that range from 1-in-1 million to 100-in-1 million generally are considered to fall within the range of acceptability. Approximately 6,600,000 people live within 50 kilometers of the eight modeled facilities, and 89,809 people are estimated to have cancer risks above 100-in-1 million from HAP emitted from the facilities. EtO was by far the primary HAP cancer driver at every facility, contributing over 99% to the total cancer risk. Results for the cancer risk assessment are listed in Table 3 below.

Table 3: Cancer Risk Summary by Facility

Facility Name	Location	Maximum Individual Lifetime Cancer Risk (in 1 million)
BCP Ingredients	St. Gabriel, LA	10

5 USEPA, 1994. US Environmental Protection Agency. Methods for Derivation of Inhalation Reference Concentrations and Application of Inhalation Dosimetry. EPA/600/8-90/066F. Office of Research and Development. Washington, DC. https://www.epa.gov/risk/methods-derivation-inhalation-reference-concentrations-and-application-inhalation-dosimetry

6 National Academy of Sciences, 1994. National Research Council. Science and Judgement in Risk Assessment. Washington, DC: National Academy Press.

Taminco US (Eastman Corp.)	St. Gabriel, LA	30
Union Carbide Corp., St. Charles Operations	Taft, LA	700
Sasol Chemicals (USA) – Lake Charles Complex	Westlake, LA	300
Air Products Performance Manufacturing Inc. – Reserve Plan (Evonik)	Reserve, LA	600
Huntsman, Port Neches Operations	Port Neches, TX	2,000
Eastman Chemical Texas Operations	Longview, TX	300
Shell Technology Center Houston	Houston, TX	40

In addition to calculating the maximum individual risk, we estimated the distribution of individual cancer risks by summing the number of individuals within 50 km of the sources whose estimated risk falls within a specified risk range. These distributions have been split by state into Texas (Table 4A) and Louisiana (Table 4B) tables below. Individual facility distributions are presented in Appendix 1, tables A-1 – A-8.

Table 4A: Texas Facilities - Distribution of Cancer Risk for Racial and Ethnic Groups - 50 km Study Area Radius

Range of Lifetime Individual Cancer Risk from TX Facilities (Chance in One Million) [a]	**Number of People within 50 km of the Facility in Different Ranges for Lifetime Cancer Risk** [b]					
	Total Population	White	African American	Native American	Other and Multiracial	Hispanic or Latino[c]
0 to < 1	4,469,863	1,298,188	845,295	8,042	456,368	1,861,970
1 to < 5	46,495	9,510	12,660	83	11,792	12,450
5 to < 10	51,251	40,584	5,096	197	1,773	3,601
10 to < 20	63,888	41,398	14,769	270	2,390	5,061
20 to < 30	92,762	46,398	30,401	247	3,261	12,454
30 to < 40	33,712	15,630	10,873	20	663	6,525
40 to < 50	34,042	17,995	10,288	137	795	4,827
50 to < 100	42,390	19,476	12,700	103	2,000	8,111
100 to < 200	29,635	11,388	7,670	20	1,477	9,079
200 to < 300	28,499	12,483	5,781	56	1,743	8,436
>= 300	26,457	17,512	2,202	11	2,621	4,111
Total Number	4,918,994	1,530,562	957,735	9,186	484,884	1,936,627

Table 4B: Louisiana Facilities - Distribution of Cancer Risk for Racial and Ethnic Groups - 50 km Study Area Radius

Range of Lifetime Individual Cancer Risk from the LA Facilities (Chance in One Million) [a]	Number of People within 50 km of any Facility in Different Ranges for Lifetime Cancer Risk [b]					
	Total Population	White	African American	Native American	Other and Multiracial	Hispanic or Latino[c]
0 to < 1	1,434,603	832,238	441,233	4,028	59,678	97,426
1 to < 5	188,469	105,343	69,190	524	6,730	6,682
5 to < 10	46,147	31,942	10,755	83	1,257	2,109
10 to < 20	13,379	8,772	4,052	24	199	331
20 to < 30	9,363	5,581	3,295	30	121	336
30 to < 40	3,520	2,985	363	0	67	104
40 to < 50	2,051	1,280	525	0	76	169
50 to < 100	1,818	1,171	558	0	17	72
100 to < 200	3,381	2,339	936	46	16	43
200 to < 300	1,488	801	670	3	1	13
>= 300	349	155	192	0	0	2
Total Number	1,704,568	992,610	531,769	4,739	68,163	107,288

Notes:
[a] Modeled risks are for a 70-year lifetime, based on the predicted outdoor concentration and not adjusted for exposure factors. Risks from R6_05_24_21 emissions are modeled at the census block level.
[b] Distributions by race are based on demographic information at the census block group level.
[c] In order to avoid double counting, the "Hispanic or Latino" category is treated as a distinct demographic category for these analyses. A person is identified as one of five racial/ethnic categories above: White, African American, Native American, Other and Multiracial, or Hispanic/Latino.

Chronic Noncancer Hazard Results

To assess the risk of noncancer health effects from chronic exposure to HAP, we calculated target organ-specific hazard index (TOSHI). We sum the HQ for each of the HAP that affects a common target organ or target organ system to obtain a TOSHI. The HQ is the estimated exposure divided by the chronic noncancer dose-response value. If the HI value is less than 1, adverse health effects are not expected for that suite of chemicals. As exposures increase above the reference level (HIs increasingly greater than 1), the potential for adverse effects increases.

Results for the chronic screening-level noncancer risk assessment indicate that one facility had an HI above 1. Specifically, Sasol Chemicals had an estimated HI of 3 with chlorine as the risk driver and the respiratory system as the target organ. 97 people are estimated to be exposed to TOSHI levels above 1.

Appendix A

Distribution of Cancer Risk by Facility

Table A-1. Huntsman, Port Neches - Distribution of Cancer Risk for Racial and Ethnic Groups						
Range of Lifetime Individual Cancer Risk from Facility 4945211 (Chance in One Million) [a]	Number of People within 50 km of the Facility in Different Ranges for Lifetime Cancer Risk [b]					
	Total Population	White	African American	Native American	Other and Multiracial	Hispanic or Latino[c]
0 to < 1	0	0	0	0	0	0
1 to < 5	952	899	13	0	30	10
5 to < 10	45,894	39,505	2,671	164	933	2,621
10 to < 20	62,819	41,198	14,300	251	2,264	4,805
20 to < 30	91,639	46,220	29,866	223	3,144	12,187
30 to < 40	33,190	15,404	10,697	17	658	6,413
40 to < 50	33,413	17,842	9,988	131	768	4,684
50 to < 100	40,904	18,888	12,364	97	1,951	7,605
100 to < 200	27,922	10,998	6,907	18	1,416	8,583
200 to < 300	27,576	12,303	5,277	54	1,727	8,215
>= 300	26,427	17,507	2,181	11	2,621	4,107
Total Number	390,736	220,763	94,263	967	15,512	59,231
Average Risk (Chance in One Million)[a]	70	70	50	40	100	100

Table A-2. Eastman Texas Operations - Distribution of Cancer Risk for Racial and Ethnic Groups

Range of Lifetime Individual Cancer Risk from Facility 4941511 (Chance in One Million) [a]	Number of People within 50 km of the Facility in Different Ranges for Lifetime Cancer Risk [b]					
	Total Population	White	African American	Native American	Other and Multiracial	Hispanic or Latino[c]
0 to < 1	0	0	0	0	0	0
1 to < 5	0	0	0	0	0	0
5 to < 10	0	0	0	0	0	0
10 to < 20	0	0	0	0	0	0
20 to < 30	23	2	13	0	0	8
30 to < 40	522	226	176	3	5	112
40 to < 50	435	124	197	1	5	108
50 to < 100	1,486	588	336	6	49	506
100 to < 200	1,713	391	763	1	61	496
200 to < 300	923	180	504	2	16	221
>= 300	30	5	21	0	0	4
Total Number	5,132	1,517	2,010	13	137	1,455
Average Risk (Chance in One Million)[a]	100	90	100	90	100	100

Table A-3. Shell Technology - Distribution of Cancer Risk for Racial and Ethnic Groups						
Range of Lifetime Individual Cancer Risk from Facility 3736811 (Chance in One Million) [a]	Number of People within 50 km of the Facility in Different Ranges for Lifetime Cancer Risk [b]					
	Total Population	White	African American	Native American	Other and Multiracial	Hispanic or Latino[c]
0 to < 1	4,469,863	1,298,188	845,295	8,042	456,368	1,861,970
1 to < 5	45,543	8,611	12,648	83	11,762	12,440
5 to < 10	5,357	1,079	2,425	33	840	980
10 to < 20	1,069	199	469	19	126	256
20 to < 30	1,100	175	523	24	117	260
30 to < 40	0	0	0	0	0	0
40 to < 50	194	29	103	5	22	35
50 to < 100	0	0	0	0	0	0
100 to < 200	0	0	0	0	0	0
200 to < 300	0	0	0	0	0	0
>= 300	0	0	0	0	0	0
Total Number	4,523,126	1,308,282	861,462	8,207	469,235	1,875,940
Average Risk (Chance in One Million)[a]	0.1	0.09	0.1	0.2	0.2	0.08

Table A-4. Evonik - Distribution of Cancer Risk for Racial and Ethnic Groups						
Range of Lifetime Individual Cancer Risk from Facility 5287111 (Chance in One Million) [a]	Number of People within 50 km of the Facility in Different Ranges for Lifetime Cancer Risk [b]					
	Total Population	White	African American	Native American	Other and Multiracial	Hispanic or Latino[c]
0 to < 1	784,063	480,149	197,414	2,913	32,818	70,769
1 to < 5	56,940	30,006	23,297	58	1,193	2,387
5 to < 10	8,712	2,031	5,970	0	300	411
10 to < 20	4,668	1,203	3,361	0	23	82
20 to < 30	3,386	1,083	2,246	0	14	42
30 to < 40	933	613	243	0	7	71
40 to < 50	1,185	551	460	0	13	161
50 to < 100	547	251	225	0	5	66
100 to < 200	311	125	186	0	0	0
200 to < 300	269	108	161	0	0	0
>= 300	229	92	137	0	0	0
Total Number	861,243	516,211	233,701	2,970	34,372	73,988
Average Risk (Chance in One Million)[a]	1	0.8	2	0.4	0.5	0.7

Table A-5. Union Carbide - Distribution of Cancer Risk for Racial and Ethnic Groups						
Range of Lifetime Individual Cancer Risk from Facility 7202911 (Chance in One Million) [a]	Number of People within 50 km of the Facility in Different Ranges for Lifetime Cancer Risk [b]					
	Total Population	White	African American	Native American	Other and Multiracial	Hispanic or Latino[c]
0 to < 1	0	0	0	0	0	0
1 to < 5	0	0	0	0	0	0
5 to < 10	0	0	0	0	0	0
10 to < 20	0	0	0	0	0	0
20 to < 30	0	0	0	0	0	0
30 to < 40	0	0	0	0	0	0
40 to < 50	0	0	0	0	0	0
50 to < 100	0	0	0	0	0	0
100 to < 200	2,737	1,980	652	46	16	43
200 to < 300	1,067	580	470	3	1	13
>= 300	112	56	54	0	0	2
Total Number	3,916	2,615	1,176	50	17	58
Average Risk (Chance in One Million)[a]	100	100	100	100	100	100

Table A-6. BCP Ingredients - Distribution of Cancer Risk for Racial and Ethnic Groups						
Range of Lifetime Individual Cancer Risk from Facility 220477451011 (Chance in One Million) [a]	Number of People within 50 km of the Facility in Different Ranges for Lifetime Cancer Risk [b]					
	Total Population	White	African American	Native American	Other and Multiracial	Hispanic or Latino[c]
0 to < 1	757,935	415,212	280,439	988	30,078	31,218
1 to < 5	976	257	679	0	2	37
5 to < 10	618	127	461	0	1	28
10 to < 20	0	0	0	0	0	0
20 to < 30	0	0	0	0	0	0
30 to < 40	0	0	0	0	0	0
40 to < 50	0	0	0	0	0	0
50 to < 100	0	0	0	0	0	0
100 to < 200	0	0	0	0	0	0
200 to < 300	0	0	0	0	0	0
>= 300	0	0	0	0	0	0
Total Number	759,529	415,597	281,579	988	30,082	31,284
Average Risk (Chance in One Million)[a]	0.03	0.03	0.04	0.03	0.02	0.03

Table A-7. Taminco - Distribution of Cancer Risk for Racial and Ethnic Groups						
Range of Lifetime Individual Cancer Risk from Facility 5504811 (Chance in One Million) [a]	Number of People within 50 km of the Facility in Different Ranges for Lifetime Cancer Risk [b]					
	Total Population	White	African American	Native American	Other and Multiracial	Hispanic or Latino[c]
0 to < 1	750,190	412,622	275,564	954	29,945	31,106
1 to < 5	7,828	2,223	5,299	32	139	135
5 to < 10	272	67	197	0	0	8
10 to < 20	230	61	159	0	1	10
20 to < 30	496	102	370	0	1	23
30 to < 40	19	4	14	0	0	1
40 to < 50	0	0	0	0	0	0
50 to < 100	0	0	0	0	0	0
100 to < 200	0	0	0	0	0	0
200 to < 300	0	0	0	0	0	0
>= 300	0	0	0	0	0	0
Total Number	759,035	415,079	281,602	986	30,086	31,282
Average Risk (Chance in One Million)[a]	0.1	0.09	0.1	0.1	0.08	0.1

Table A-8. Sasol Chemicals - Distribution of Cancer Risk for Racial and Ethnic Groups

Range of Lifetime Individual Cancer Risk from Facility 8468011 (Chance in One Million) [a]	Number of People within 50 km of the Facility in Different Ranges for Lifetime Cancer Risk [b]					
	Total Population	White	African American	Native American	Other and Multiracial	Hispanic or Latino[c]
0 to < 1	72,036	55,743	10,447	333	2,109	3,404
1 to < 5	124,820	73,957	40,939	482	5,367	4,075
5 to < 10	36,890	29,764	4,407	83	957	1,678
10 to < 20	8,579	7,534	599	24	177	245
20 to < 30	5,271	4,339	535	30	105	262
30 to < 40	2,587	2,373	121	0	60	34
40 to < 50	847	725	51	0	63	8
50 to < 100	1,271	921	333	0	12	6
100 to < 200	333	235	98	0	0	0
200 to < 300	152	114	38	0	0	0
>= 300	8	7	1	0	0	0
Total Number	252,794	175,712	57,569	952	8,849	9,713
Average Risk (Chance in One Million)[a]	4	4	4	3	3	3

Notes:
[a] Modeled risks are for a 70-year lifetime, based on the predicted outdoor concentration and not adjusted for exposure factors. Risks from R6_05_24_21 emissions are modeled at the census block level.
[b] Distributions by race are based on demographic information at the census block group level.
[c] In order to avoid double counting, the "Hispanic or Latino" category is treated as a distinct demographic category for these analyses. A person is identified as one of five racial/ethnic categories above: White, African American, Native American, Other and Multiracial, or Hispanic/Latino.

Appendix B

Dispersion Model Receptor Revisions and Additions

Dispersion Model Receptor Revisions and Additions

To estimate ambient concentrations for evaluating long-term exposures, the HEM-4 model uses the geographic centroids of census blocks (currently utilizing the 2010 Census[7]) as dispersion model receptors. The census block centroids are generally good surrogates for where people live within a census block. A census block generally encompasses about 40 people or 10-15 households. However, in cases where a block centroid is located on industrial property, or where a census block is large and the centroid less likely to be representative of the block's residential locations, the block centroid may not be an appropriate surrogate.

Census block centroids that are on facility property can sometimes be identified by their proximity to emission sources. In cases where a census block centroid was within one kilometer of any emission source, we viewed aerial images of the facility to determine whether the block centroid was likely located on facility property. The selection of the one-kilometer distance reflects a compromise between too few and too many blocks identified as being potentially on facility property. Distances smaller than one kilometer could identify only block centroids very near the emission sources and could exclude some block centroids that are still within facility boundaries, particularly for large facilities. Distances significantly larger than one kilometer would identify many block centroids that are outside facility boundaries, particularly for small facilities. Where we confirmed a block centroid on facility property, we moved the block centroid to a location that best represents the residential locations in the block.

In addition, census block centroids for blocks with large areas may not be representative of residential locations. Risk estimates based on such centroids can be understated if there are residences nearer to a facility than the centroid, and overstated if the residences are farther from the facility than the centroid. To avoid understating the maximum individual risk associated with a facility, in some cases we relocated block centroids, or added dispersion model receptors other than the block centroid. We examined aerial images of all large census blocks within two kilometers of any emission source. Experience from previous risks characterizations show that in most cases the MIR is generally located within 1 km of the facility boundary, but because these facilities are relatively large, we extended that to two kilometers. If the block centroid did not represent the residential locations, we relocated it to better represent them. If residential locations could not be represented by a single receptor (that is, the residences were spread out over the block), we added additional receptors for residences nearer to the facility than the centroid.

The table below contains each census block for which we changed the centroid location because it was on facility property or was otherwise not representative of the residential locations in the block. The table also contains the locations of additional receptors that were included to represent residential locations nearer to the facility than the block centroid.

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7 2020 census data is not yet available, but we will use in the future when it is.

Table B-1. Revised Census Block Centroid Locations and Additional Receptors

Block No	Facility ID	New Lat	New Long	Action
482014518002026		29.72217	-95.634302	Move Centroid
481830014001006				Remove block
220950707001127		30.062538	-90.576379	Move Centroid
220950707001005		30.078022	-90.573618	Move Centroid
220479532003000		30.253791	-91.087379	Move Centroid
220479532003001		30.25492	-91.09241	Move Centroid
220190027002022				Remove block
220190027001059		30.249245	-93.307808	Move Centroid
482450109023099				Remove block
48183U00481				Remove block
	482034941511	32.452188	-94.680418	Additional receptor
	220477451011	30.255118	-91.057785	Additional receptor
	220955287111	30.063752	-90.574022	Additional receptor
	482454945211	29.95587	-93.931372	Additional receptor
	482013736811	29.72947	-95.638738	Additional receptor
	482013736811	29.729544	-95.636706	Additional receptor