

**Epidemiologic Evaluation of
Risk Factors Potentially
Affecting Health Outcomes in
Texas Communities Near
Industrial Operations**
**Work Order No. 5 [PCR 23748]; Contract
No.: 582-20-10533**

AUGUST 23, 2021

ToxStrategies

Innovative solutions
Sound science

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Acronyms

ACS	American Community Survey
BRFSS	Behavioral Risk Factor Surveillance System
CDC	Centers for Disease Control and Prevention
CI	Confidence Intervals
GEOID	Geographic Identifier
MACT	Maximum Achievable Control Technology
PLACES	Population Level Analysis and Community Estimates
TCEQ	Texas Commission on Environmental Quality
TD	Toxicology, Risk Assessment, and Research Division

Executive Summary

A community's collective health status may be impacted by multiple factors, including environmental, hereditary, behavioral, demographic, and socioeconomic variables. While the Texas Commission on Environmental Quality (TCEQ) has access to or can obtain information about environmental exposures, often the Agency is lacking information on other health-related factors such as lifestyle and demographic factors. Such information would provide the Agency with a greater understanding of the comprehensive, multifaceted health status of a community. Therefore, ToxStrategies, Inc. was tasked with conducting an initial assessment to determine the availability of socioeconomic, demographic, and behavioral risk factor data in Texas communities near industrial operations. At the direction of the TCEQ Toxicology, Risk Assessment, and Research Division (TD), this initial assessment was focused specifically on communities in close proximity to refinery operations. The goal of this scoping exercise was to identify data sources including available information concerning risk factors and summarize the characteristics of the communities of interest.

As a first step, the TCEQ TD provided a list of refinery operations in Texas to include in this assessment. Next, to identify communities of interest near those refineries, all 26 refineries in Texas were mapped in ArcGIS using the GPS coordinates (latitude and longitude) of the approximate center of each refinery and a map of 2010 census tract boundaries (the most recent year available) was overlaid. A two-mile radius was drawn around the center point of each refinery and all census tracts that intersected with the two-mile radius were identified. Using a map of households by census block, the proportion of the census tract population residing within the two-mile radius was determined. Census tracts with at least 10% of their population residing within the two-mile radius (n=134; 93 unique) were selected as the communities of interest. Distance from a refinery was used as the measure of "exposure" in this initial assessment, but it is important to note that it is well recognized that distance is not a reliable surrogate for exposure. Evaluation of other factors such as predominant wind direction would be an important consideration in identifying census tracts potentially impacted by emissions. While this is beyond the scope of this initial assessment, this type of refined analysis may be considered in future assessments undertaken by the TCEQ.

Demographic data from the 2010 decennial census (age, sex, race, ethnicity, urbanicity), socioeconomic data from the 2019 American Community Survey (unemployment, education, median household income, poverty) were pulled for all census tracts of interest. Health-related risk factor data (prevalence of smoking, obesity, lack of physical activity, etc.) at the census tract level were also downloaded from the Centers for Disease Control and Prevention (CDC) Population Level Analysis and Community Estimates (PLACES) project. County-level census and PLACES data were also downloaded to contextualize the tracts.

Next, the census tracts of interest were matched to comparison census tracts that were demographically similar but located >5 miles away from any refinery. An individual matching algorithm identified up to 5 comparison tracts matched on age, sex, race, and socioeconomic characteristics. Census data and health-related risk factor data were then presented for the tracts of interest and the matched comparison tracts. As this initial assessment was purely descriptive and intended solely to compile available information, no statistical comparisons were conducted.

The results for the census tracts of interest that are close to refineries demonstrated that these areas are generally low-income minority communities, and the prevalence of health-related risk factors such as obesity, smoking, and lack of physical activity trended higher in these areas than the corresponding counties and the demographically similar comparison areas. The prevalence of preventive measures such as dental visits, cervical and colon cancer screening, and clinical preventive services were generally lower in the tracts of interest than their corresponding counties. These data indicate that health-related risk factors in these areas may differ from comparable areas not located near refinery operations, and any analyses of disease outcomes would need to account for these potential confounding factors in any future analyses. Nonetheless, the results described herein for this initial assessment provides useful information for characterizing communities living in close proximity to refinery operations and, as such, provides TCEQ with additional information regarding the many facets of health status in these areas.

1 Background

Periodically, questions are raised concerning impact of industrial operations on the health of individuals residing in nearby communities. It is well established that there are many factors that influence individual health and disease status including heredity (family history), lifestyle (e.g., diet, exercise, alcohol, sleep-deprivation, etc.), environmental, and socioeconomic factors (e.g., income, education, access to healthcare, etc.). While the TCEQ often has access to state-of-the-science tools to assess potential environmental impacts such as data from comprehensive air monitoring networks, mobile monitoring data, air modeling data, etc., information on these other health-related risk factors would provide the TCEQ with important data that would facilitate a greater understanding of the many facets of health status for these communities.

As a first step to understanding the potential impact of these factors on the health of individuals in communities near industrial operations, TCEQ requested that ToxStrategies characterize the demographics and health-related behavioral risk factors (e.g., smoking, obesity, etc.) of communities living near industrial operations. The goal of this project is to compile information that may be useful to the TCEQ by providing a greater understanding of the prevalence of general health-related risk factors within the communities of interest.

2 Methods

2.1 Selection of Communities of Interest (Task 1)

To minimize potential for selection bias that may arise by only selecting some, but not all, communities of interest, TCEQ recommended focusing on refinery operations in this initial assessment and selecting all communities residing near refineries in Texas as the communities of interest. To identify refineries in Texas, TCEQ provided ToxStrategies with the TCEQ Refinery MACT (maximum achievable control technology) Rule quarterly report¹. Further evaluation of the facilities covered by the Refinery MACT Rule resulted in the exclusion of two facilities listed in the report that were tank farms rather than refineries (i.e., Phillips 66 Borger JTF and Flint Hills Refinery Corpus Christi, Mid Terminal). Using the MACT Rule report and Google Maps (satellite view), the GPS coordinates of the approximate center of each refinery were identified. The GPS coordinates rather than the address of each refinery were used as the address may represent a different location than the refinery (e.g., corporate office). The final 26 refineries included in this assessment are presented in Table 1.

Table 1. List of Refineries in Texas

Refinery Name	Address	Degrees Latitude*	Degrees Longitude*
Marathon Galveston Bay Refinery	2401 5th Ave S, Texas City, TX 77590	29.37307671	-94.92366654
Shell Oil Deer Park	5900 TX-225, Deer Park, TX 77536	29.72227783	-95.1265339
Kinder Morgan Crude and Condensate Galena Park	407 Clinton Dr, Galena Park, TX 77547	29.73629372	-95.21903673
Valero Corpus Christi Three Rivers Refinery	301 Le Roy St, Three Rivers, TX 78071	28.45907267	-98.18488363
Phillips 66 Borger	Spur 119 North, Borger, TX 79007	35.69763566	-101.364359
Delek Tyler Refinery	425 McMurrey Dr, Tyler, TX 75702	32.35650941	-95.27887178
Western Refining	6816 Gateway Blvd E, El Paso, TX 79915	31.7725316	-106.3971797
Big Spring Refinery	200 I-20 Frontage Rd, Big Spring, TX 79720	32.26737477	-101.4195862
ExxonMobil Beaumont	1795 Burt St, Beaumont, TX 77701	30.06405517	-94.07684388
Valero Port Arthur	1801 S Gulfway Dr, Port Arthur, TX 77640	29.86368634	-93.97233982
Motiva Port Arthur Refinery	2555 Savannah Ave, Port Arthur, TX 77640	29.88667294	-93.96242918
Total Port Arthur Refinery	7600 32nd St, Port Arthur, TX 77642	29.9607905	-93.88431146
ExxonMobil Baytown Refinery	3525 Decker Dr, Baytown, TX 77520	29.74077722	-95.0148292
Houston Refining	12000 Lawndale St, Houston, TX 77017	29.71325957	-95.23576823
Pasadena Refining	111 Red Bluff Rd, Pasadena, TX 77506	29.72355393	-95.20741017
Phillips 66 Sweeny Refinery	8189 Old FM 524 Rd, Old Ocean, TX 77463	29.07292767	-95.74985541
Valero Houston	9701 Manchester St, Houston, TX 77012	29.72221747	-95.25632717
CITGO Corpus Christi Refinery East Plant	1308 Oak Park Ave, Corpus Christi, TX 78407	27.80938278	-97.42737646
CITGO Corpus Christi Refinery West Plant	6745 Up River Rd, Corpus Christi, TX 78409	27.8142305	-97.49650231

Refinery Name	Address	Degrees Latitude*	Degrees Longitude*
Flint Hills Resources Corpus Christi, East Refinery	1607 Nueces Bay Blvd, Corpus Christi, TX 78407	27.80559708	-97.42511935
Flint Hills Resources Corpus Christi, West Refinery	8125 Up River Rd, Corpus Christi, TX 78409	27.83251316	-97.52588424
Magellan Processing L.P.	1802 Poth Ln, Corpus Christi, TX 78407	27.80915711	-97.43619815
Valero Corpus Christi Refinery, East Plant	1147 Cantwell Ln, Corpus Christi, TX 78407	27.81238988	-97.44619786
Valero McKee Refinery	6701 FM 119, Sunray, TX 79086	35.9539535	-101.880084
Valero Texas City	1301 Loop 197 S, Texas City, TX 77590	29.36882462	-94.90882729
Valero Corpus Christi Refinery, West Plant	5998 Co Rd 54, Corpus Christi, TX 78409	27.81700986	-97.48225015

*GPS coordinates of the approximate center of each refinery

ToxStrategies imported the location of each refinery into ArcGIS software, using the longitude and latitude that corresponded to the center of the facility. As the smallest available geographic unit of outcome data (Census data; risk factor data from the CDC PLACES) was census tracts, census tracts in close proximity to each refinery were assessed. A shapefile containing a map of census tracts (from the 2010 decennial census, the latest available data) in Texas was available from the US census². The census tract boundaries were overlaid onto the map containing the refineries' locations.

Upon examination of several example refineries with overlaid census tract boundaries, it became clear that some refineries located in more rural areas (e.g., Phillips 66 Borger, Figure 1) are incorporated fully within a single census tract, while other refineries are located in more urban areas with multiple census tracts bordering the refinery's property line (e.g., Delek Tyler, Figure 2). Due to these varying scenarios and given that some refineries are nearly 1 mile in diameter, TCEQ and ToxStrategies agreed to consider the census tracts intersecting within a two-mile radius of each refinery as selection criteria for census tracts that are in close proximity to a refinery (i.e., communities of interest).

Figure 1. Census Tracts Near Phillips 66 Borger Refinery

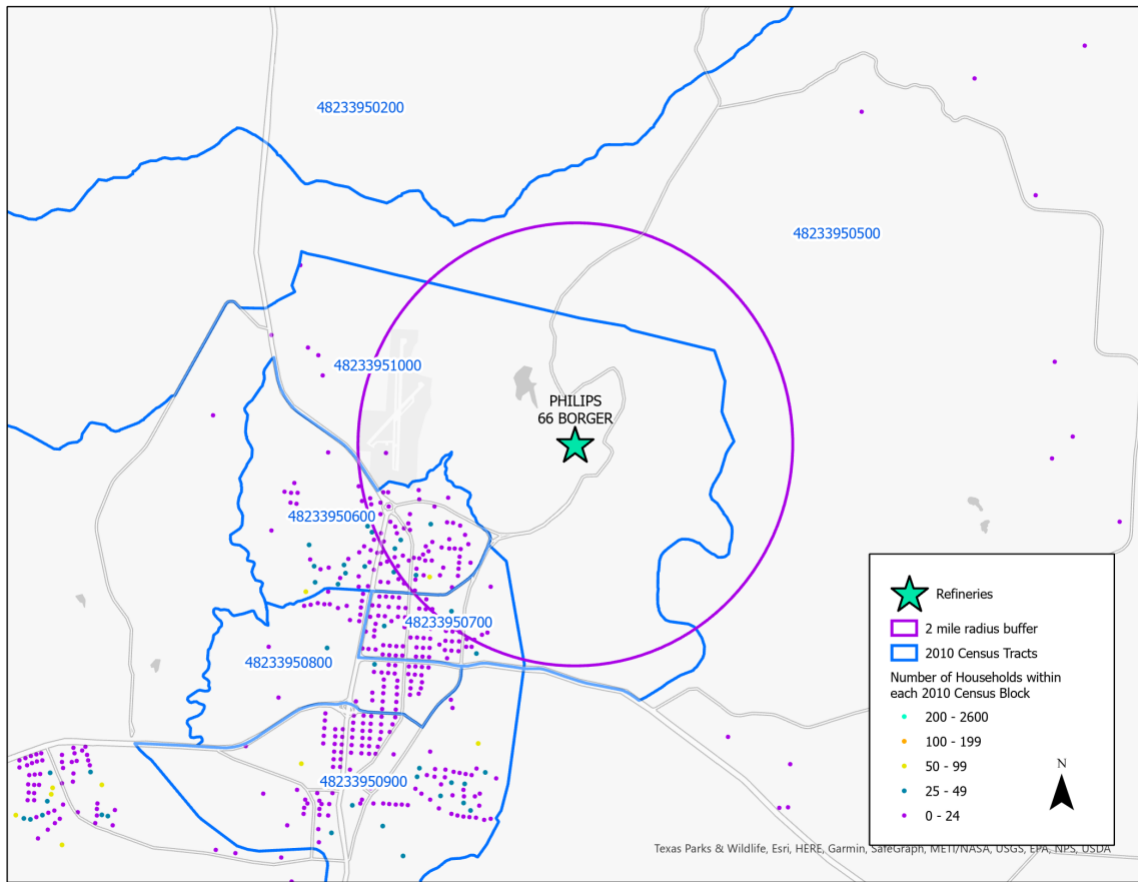
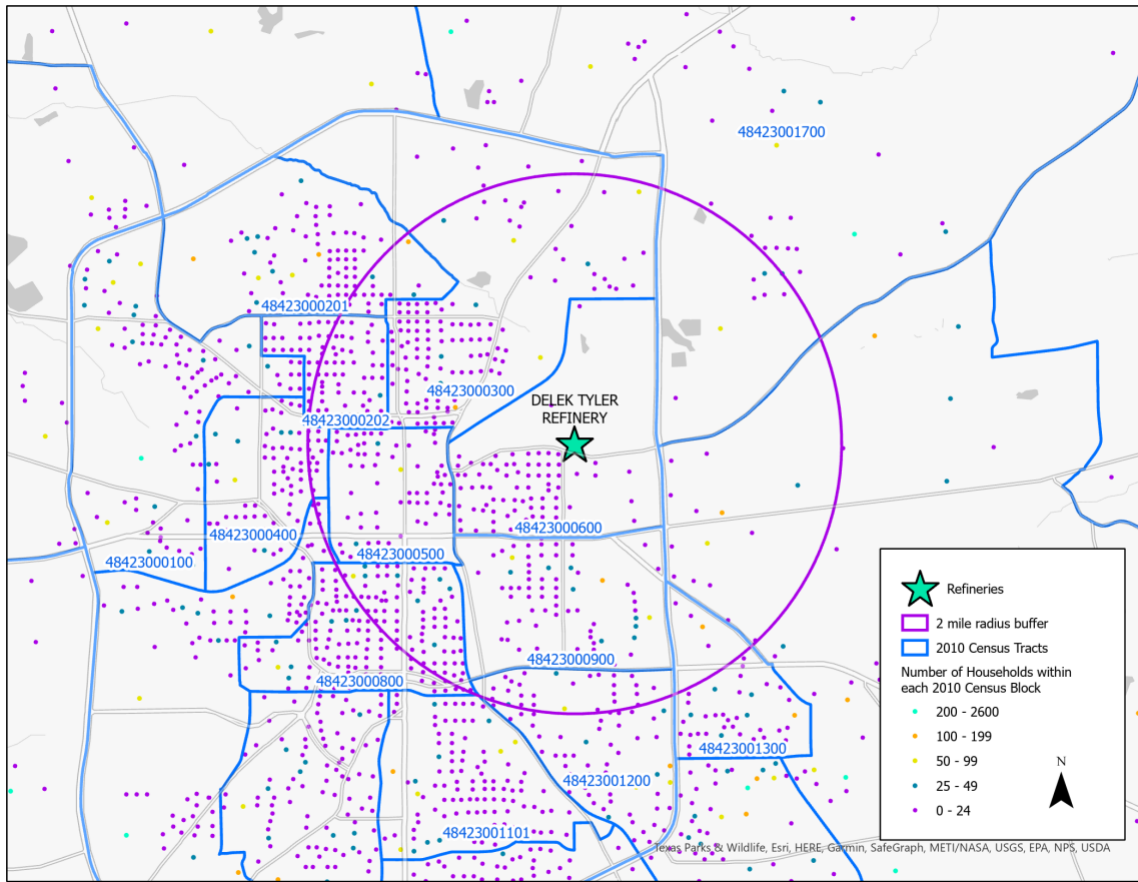


Figure 2. Census Tracts Near Delek Tyler Refinery



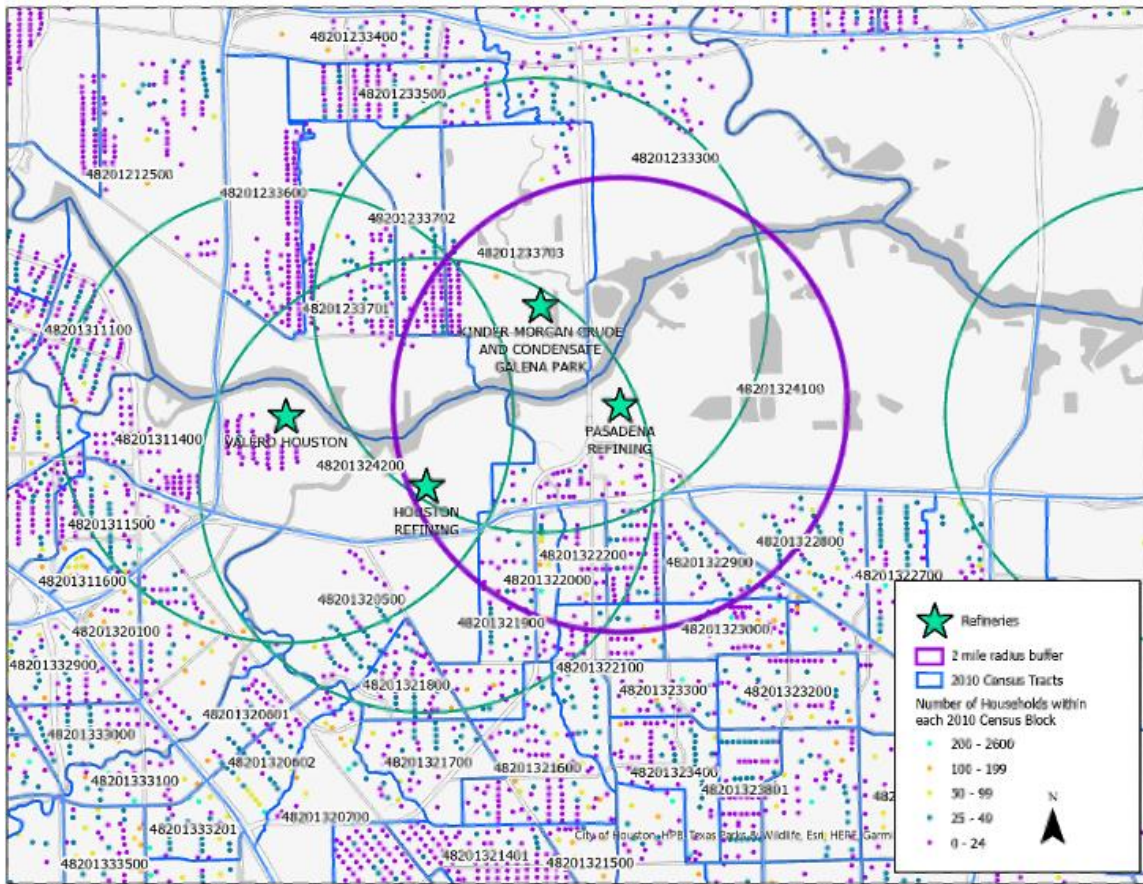
Esri's ArcGIS Pro software was used to create a two-mile radius around each refinery's identified midpoint, with any census tracts intersecting the two-mile radius identified using the *Intersect* function. Census tracts are small, relatively permanent statistical subdivisions of a county with a unique numerical code. Tracts are designed to be permanent to allow statistical comparisons over time, though tract definitions may be updated each decade based on population size. The spatial area of a given census tract varies by population density, as tracts include an average of 4,000 inhabitants (range: 1,200 to 8,000). Census tract boundaries generally follow visible and identifiable features (roads, bodies of water, etc.) but are always located within state and county boundaries³. Census tracts are defined using geographic identifiers (GEOID), an 11-digit code wherein the first 2 digits correspond to the state (e.g., Texas: 48), the next 3 to the county (e.g., Harris County: 201), and the final 6 to the census tract (e.g., Tract 2231.00: 223100; full GEOID for tract is 48201223100).

Given that census tracts are generally peculiarly shaped polygons, the two-mile radius intersected with various proportions of census tracts. For example, as shown in Figure 3

(Pasadena Refining), some census tracts (i.e., 48201322900, 48201322000) are nearly completely enclosed within the two-mile radius, while others (i.e., 48201320500, 48201324200) have only a very small area that intersects with the radius. Simply including all census tracts that intersected with the two-mile radius may skew the analyses if only a small proportion of the tract's population lives within the area that intersects with the two-mile radius. Thus, the weighted block centroid retrieval approach was used to select census tracts of interest. In this approach, census block data is used to determine the proportion of each tract's population living within the boundary. Census blocks are the smallest available geographic unit in the US census. While only a small subset of data is available at census block level due to small population size, the population size of census blocks can apportion the population of a census tract that falls within and outside of the two-mile radius. A shapefile containing the populations of the 2010 US census blocks as centroids, made available by Esri, was added to the map of the refineries and 2010 US census tract boundaries⁴.

Next, the census tract population living within the two-mile radius was summed and divided by the total tract population to determine the proportion living within the two-mile circle. For example, as shown in Figure 3 (Pasadena Refining), some census tracts (i.e., 48201322200, 48201324100) have 100% of their populations located within the circle, while others (i.e., 48201324200, 48201320500) technically intersect with the radius but have 0% of the tract population residing within the circle. To incorporate the majority of refineries in the analyses, census tracts with at least 10% of their population located within the two-mile radius were selected as the communities of interest. Sensitivity analyses were conducted using cutoffs of 50% (i.e., majority of tract population lives within radius) as well as >0-<10% (i.e., small number of tract population lives within radius).

Figure 3. Census Tracts Near Pasadena Refining



2.2 Demographic Data from US Census (Task 2)

Demographic data at the census tract level was available from the 2010 US Census. The Census is mandated by the US Constitution and is conducted every ten years. Each resident of the country is counted, and results are used to apportion the number of House Representatives each state receives. The 2010 decennial census was one of the shortest forms in history, asking residents only 10 questions⁵. The 2020 US Census data was not yet publicly released at the time of this analysis and was, therefore, unavailable for analyses. Variables available from the 2010 Census data were sex, age, race, ethnicity, and urbanicity. Data was downloaded from the Census website for all census tracts in Texas⁶.

More detailed demographic and socioeconomic data are captured in the American Community Survey (ACS). The ACS is an ongoing, annual survey sent to a sample of addresses in all 50 states, the District of Columbia, and Puerto Rico. Questions included in the ACS ask about topics not covered in the decennial census, such as employment, education, internet access, and transportation. As the ACS is only sent to a sample of residents, data are modeled using the sample to represent the entire census block, tract, county, and state. Therefore, while the decennial census represents measured

data, the ACS presents modeled estimates⁷. ACS data are presented as 1-year and 5-year estimates. In the current study, 5-year estimates were used as they represent increased statistical reliability for smaller geographic areas and small population groups. Variables for 5-year estimates of unemployment, median household income, education, and poverty from 2015-2019 were downloaded from the US Census website for all census tracts and counties in Texas. County-level data that corresponded with the census tracts of interest were also downloaded to contextualize the tracts. The county-level data were presented with the tract-level data to consider whether the demographic makeup and other selected risk factor variables from ACS for the tract of interest was representative of the entire county.

2.3 Risk Factor Data from PLACES (500 Cities Project) (Task 3)

“PLACES (Population Level Analysis and Community Estimates): Local Data for Better Health” is a collaboration between the US Centers for Disease Control and Prevention (CDC), the Robert Wood Johnson Foundation, and the CDC foundation. PLACES is an extension of the CDC’s 500 Cities Project that provides city and census tract estimates for chronic disease risk factors, health outcomes, and use of clinical preventive services for the 500 largest US cities beginning in 2015 and covers all the census tracts of interest in this analysis. In PLACES, model-based small area estimation methods are used to estimate 27 measures, including unhealthy behaviors (e.g., current smoking), health outcomes (e.g., coronary heart disease, diabetes), and prevention practices (e.g., health insurance coverage, cholesterol screening) beginning in 2020. These estimates are available through a public, interactive PLACES website that allows users to view, explore, and download county-, place-, census tract-, and zip code tabulation area-level data for all populated areas in the United States⁸.

The primary data sources for PLACES are the CDC Behavioral Risk Factor Surveillance System (BRFSS), the 2010 Census population, and ACS estimates. The small area estimation approach is a multilevel statistical modeling framework. An innovative peer-reviewed multilevel regression and poststratification approach links geocoded health surveys and high spatial resolution population demographic and socioeconomic data. This approach is flexible and accounts for associations between individual health outcomes, individual characteristics, and spatial contexts and factors at multiple levels (e.g., state, county). Individual disease risk and health behaviors are predicted in a multilevel modeling framework and geographic distributions of population disease burden and health behaviors are estimated. CDC has conducted internal and external validation studies and confirmed a strong consistency between the model-based estimates and direct BRFSS survey estimates at state and county levels using aggregated modeled estimates of census blocks and tracts^{9,10}.

Publicly available data were downloaded from the PLACES data portal for the 2020 release of census tract-level data collected in 2018. In this initial assessment, the specific parameters of interest included unhealthy behaviors and prevention variables available

in PLACES and outlined below. Estimates were available as crude prevalence and 95% confidence intervals (CI) for the following variables:

Unhealthy behaviors:

- Binge drinking
- Current smoking
- No leisure-time physical activity
- Obesity
- Sleeping <7 hours

Prevention:

- Current lack of health insurance among adults aged 18-64
- Visits to doctor for routine checkup within the past year
- Visits to dentist or dental clinic
- Adults taking medicine for high blood pressure control
- Cholesterol screening
- Mammography use among women aged 50-74 years
- Cervical cancer screening among women aged 21-65 years
- Colon cancer screening (fecal occult blood test, sigmoidoscopy, or colonoscopy among adults aged 50-75 years)
- Men and women aged ≥ 65 years who are up to date on a core set of clinical preventive services (men: flu shot past year, Pneumococcal polysaccharides vaccine shot ever, colorectal cancer screening; women: same as above and mammogram past 2 years)

Unless otherwise specified, all estimates were specific to the adult (≥ 18 years) population. County-level estimates were also downloaded to contextualize the census tracts of interest. Because the available data are crude prevalence estimates not adjusted for any confounding variables, no statistical tests were conducted for comparison between the census tract-level and county-level estimates.

2.4 Health-Related Risk Factor Prevalence in Communities of Interest and Comparison Communities (Task 4)

2.4.1 Selection of Comparison Communities

Comparison communities were identified for all census tracts of interest. A matching algorithm was used to identify comparison census tracts in Texas that were demographically similar to the tract of interest but located >5 miles away from any refinery (outside of a 5-mile radius of each refinery). In this manner, the matched tracts were generally comparable to the tract of interest but without the potential exposure associated with being located close to a refinery. Using 2010 US Census data and 2019 5-year ACS estimates, census tracts of interest were matched to comparison tracts

based on sex (% male), age (% 65+ years), race (% Black), and socioeconomic data (median household income, % with less than college education, % unemployed, % under the poverty line in the last year). Comparison tracts were required to have age, sex, and black race variables within 5% of the tract of interest, socioeconomic variables within 10%, and median household income within \$10,000. This ensured that the comparison tracts were comparable to the tract of interest for all variables. The algorithm identified the top five census tracts that matched each tract of interest. With this approach, comparison census tracts were demographically and socioeconomically similar to the census tracts of interest but were not located in close proximity to a refinery. Matching analyses were conducted using SAS/STAT Software, version 9.4.

2.4.2 Risk Factor Prevalence Among Communities of Interest and Comparison Communities

The prevalence of health-related risk factors (from CDC PLACES) in the census tracts of interest and matched comparison tracts was evaluated. As this initial assessment was purely descriptive and intended solely to compile available information, in addition to the limitations of the publicly available data (crude estimates not adjusted for any confounding factors), no statistical tests were conducted to assess the difference in risk factors between communities.

3 Results

3.1 Selection of Communities of Interest

Using ArcGIS, all census tracts within a two-mile radius of the midpoint for each of the 26 refineries in Texas were determined. The list of census tracts by refinery is provided in Attachment B Table B1. A map of census tracts and the two-mile buffer is provided for each refinery (Appendix A Figure A1-Figure A26). There were 141 total unique census tracts in Texas that were within 2 miles of a refinery (total 227 when summed across refineries, as some tracts were within two miles of multiple refineries). The number of census tracts within 2 miles of a given refinery ranged from 1 (Valero Corpus Christi Three Rivers) to 20 (Houston Refining). The proportion of each census tract's population that resided within the radius ranged from 0-100% with a mean of 38% and a median of 22%; 134 (59%; 93 unique) tracts had $\geq 10\%$ of their population within the two-mile radius. These tracts were selected as the communities of interest. The number of census tracts of interest by refinery ranged from 0 (Phillips 66 Sweeny; Valero McKee) to 12 (Western Refining). As no census tracts of interest were available for Phillips 66 Sweeny and Valero McKee, these refineries were dropped from the analysis. The list of census tracts of interest ($\geq 10\%$ of population residing within two-mile radius) is shown in Attachment B Table B2.

3.2 Census Data in the Communities of Interest

Demographic data from the 2010 decennial census and socioeconomic data from the 2019 5-year ACS estimates were summarized for all census tracts of interest. Due to the size of the tables, the demographic and socioeconomic data for all census tracts of interest (n=134; 93 unique) are presented in Attachment B Table B3. Data for all tracts combined as well as county-level data are presented for contextualization.

3.2.1 All Tracts of Interest

The characteristics of census tracts of interest across all refineries were typically >90% urban and generally had a higher proportion of Hispanic and Black residents, higher proportion without a college degree and below the poverty line, and lower median household income than the county-wide levels. However, without conducting statistical tests, it is unclear if these are true differences or if they are due to chance or confounding.

3.2.2 Example Area: Pasadena Refining

As an example, the census data for all census tracts of interest (n=9) near Pasadena Refining (Figure 3) are presented in Table 2. All census tracts of interest near Pasadena Refining were 100% urban and the median age varied from 25 to 29.5 years (mean 27.8). In comparison, the median age of Harris County as a whole was 32.2.

The majority of the population in all the tracts of interest with ≥10% of their population within two miles of Pasadena Refining were of Hispanic ethnicity (mean 85%, range 81.3-90.2%), while Harris County was 40.8% Hispanic. Most of the tracts of interest were majority White race (which includes people of Hispanic ethnicity; range 66.0-80.4%, mean 73.1%), and all tracts had a higher proportion of White residents than the county-wide level of 59.3% for Harris County. Among White residents of the tracts of interest, most were Hispanic White (mean 81.9%, range 77.9-89.2%). The proportion of Black residents was lower in all the tracts of interest (mean 1.8%, range 0.9-5.1%) than in Harris County (19.7%). The tracts of interest also had a higher proportion of “Other Race” residents (mean 25.7%, range 19.4-31.3%) than Harris County (15.6%). The “Other Race” category includes all other responses not included in the categories of White, Black, Asian, Native Hawaiian or Other Pacific Islander, or American Indian/Alaska Native. Respondents in this category may include multiracial groups or a specific Hispanic or Latino group (e.g., Mexican, Puerto Rican, Cuban).

The proportion of residents with less than a college degree among the tracts of interest varied between 90.7% and 97.8% (mean 95.4%), which was considerably higher than the Harris County rate of 68.5%. The proportion unemployed ranged from 2.4% to 12.7% (mean 7.6%). The median household income ranged from \$32,232 to \$58,243, but all tracts were lower than the median household income of Harris County (\$61,705). The proportion of residents below the poverty line in the last year varied across the tracts of interest (range 5.9-25.9%, mean 17.3%).

Table 2. Demographic Data for Census Tracts of Interest Near Pasadena Refining

Census Tract GEOID	48201233702	48201233703	48201321900	48201322000	48201322100	48201322200	48201322800	48201322900	48201324100	All Tracts Combined	Harris County
% Residing Within two-mile Radius	42.27%	49.51%	28.85%	95.70%	21.73%	100.00%	37.25%	79.86%	100.00%	61.68%	-
<i>2010 Decennial Census</i>											
Sex											
Male	50.90%	50.10%	51.00%	54.50%	51.20%	51.40%	51.40%	50.80%	51.00%	51.37%	49.80%
Female	49.10%	49.90%	49.00%	45.50%	48.80%	48.60%	48.60%	49.20%	49.00%	48.63%	50.20%
Age											
Median Age	28.1	27.5	28.2	25	28.5	27.2	29.5	26.7	29.2	27.77	32.2
≥65 Years	6.90%	7.80%	7.10%	1.90%	6.00%	7.20%	7.50%	5.30%	5.70%	6.16%	8.10%
Urbanicity											
Urban	100%	100%	100%	100%	100%	100%	100%	100%	100%	100.00%	98.80%
Rural	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.20%
Ethnicity											
Hispanic	90.20%	83.90%	83.70%	88.50%	81.30%	85.00%	81.40%	84.60%	85.30%	84.88%	40.80%
Race											
White	68.50%	70.20%	77.00%	66.00%	75.40%	73.70%	80.40%	73.30%	73.70%	73.13%	59.30%
Non-Hispanic White	13.10%	21.50%	19.50%	10.80%	22.00%	18.40%	22.10%	18.30%	16.90%	18.07%	57.20%
Hispanic White	86.90%	78.50%	80.50%	89.20%	78.00%	81.60%	77.90%	81.70%	83.10%	81.93%	42.80%
Black	0.90%	1.00%	1.60%	5.10%	1.80%	1.00%	1.10%	2.00%	1.60%	1.79%	19.70%
Non-Hispanic Black	61.50%	59.30%	60.00%	75.90%	77.00%	94.10%	47.80%	64.60%	72.70%	68.10%	96.00%
Hispanic Black	38.50%	40.70%	40.00%	24.10%	23.00%	5.90%	52.20%	35.40%	27.30%	31.90%	4.00%
American Indian/Alaska Native	1.50%	1.60%	1.10%	0.80%	1.50%	0.60%	0.90%	1.00%	0.80%	1.09%	1.10%
Asian	0.10%	0.00%	0.40%	0.90%	0.80%	0.80%	0.40%	0.40%	1.10%	0.54%	6.60%
Native Hawaiian/Pacific Islander	0.10%	0.10%	0.00%	0.10%	0.00%	0.20%	0.10%	0.20%	0.20%	0.11%	0.20%
Other	31.30%	29.40%	22.50%	29.70%	23.10%	25.60%	19.40%	25.20%	24.90%	25.68%	15.60%

Census Tract GEOID	48201233702	48201233703	48201321900	48201322000	48201322100	48201322200	48201322800	48201322900	48201324100	All Tracts Combined	Harris County
<i>American Community Survey, 2015-2019</i>											
Less than College Degree	95.20%	94.90%	95.70%	96.20%	96.20%	95.90%	96.20%	97.80%	90.70%	95.42%	68.50%
Unemployed	6.20%	2.40%	8.60%	8.30%	12.70%	11.70%	4.00%	4.70%	9.90%	7.61%	3.90%
Median Household Income	49,013	58,243	50,379	39,286	43,179	32,232	53,616	52,090	41,950	46,665	61705
Poverty Last Year	21.30%	11.20%	13.70%	25.90%	17.00%	23.10%	16.60%	5.90%	21.30%	17.33%	13.00%

GEOID, Geographic Identifier

3.3 Risk Factor Data in the Communities of Interest

Health-related risk factors available from CDC PLACES 2020 were summarized for all tracts of interest as well as by refinery and corresponding county (Attachment B Table B4).

3.3.1 All Census Tracts of Interest

Considering the census tracts of interest across all refineries, the crude prevalence of the health-related risk factors (smoking, obesity, sleeping <7 hours per day, and lack of leisure-time physical activity) as well as the proportion of residents without healthcare coverage was generally higher among the census tracts of interest than the county-wide levels. Several preventive measures (dentist visits, cervical and colon cancer screening, and clinical preventive services for males and females) trended lower in the tracts of interest than their corresponding counties. However, without conducting statistical tests for these differences, the role of chance, bias, and confounding cannot be ruled out.

3.3.2 Example Area: Pasadena Refining

As an example, data for the census tracts of interest near Pasadena Refining are presented in Table 3. The prevalence of multiple health-related risk factors (current smoking, obesity, lack of leisure-time physical activity) also trended higher among the tracts of interest than Harris County. The prevalence of residents without health care coverage was notably higher among the tracts of interest (mean 48.4%, range 43.9-53.3%) than Harris County as a whole (28.9%). The prevalence of other preventive measures (routine check-ups, dentist visits, colon cancer screening, and clinical preventive services) trended lower among the tracts of interest than Harris County as a whole. However, no statistical tests were done to compare the prevalence of risk factors between census tracts of interest and corresponding counties, and the role of chance, bias, and confounding cannot be ruled out.

Table 3. Risk Factor Data for Census Tracts of Interest Near Pasadena Refining (CDC PLACES, 2018)

Census Tract GEOID	48201233702	48201233703	48201321900	48201322000	48201322100	48201322200	48201322800	48201322900	48201324100	All Tracts Combined	Harris County
% Residing Within Two-Mile Radius	42.27%	49.51%	28.85%	95.70%	21.73%	100.00%	37.25%	79.86%	100.00%	61.68%	-
Binge Drinking	15.0%	15.6%	15.4%	16.9%	15.5%	14.9%	16.3%	17.0%	15.1%	15.7%	15.3%
Current Smoking	20.3%	19.2%	20.4%	22.6%	21.3%	22.1%	18.3%	18.6%	20.5%	20.4%	15.9%
No Leisure-Time Physical Activity	40.6%	37.5%	39.0%	39.4%	39.2%	41.5%	35.4%	35.5%	39.0%	38.6%	28.4%
Obesity	42.1%	40.3%	40.7%	42.7%	41.5%	43.0%	39.3%	38.3%	42.4%	41.1%	36.3%
Sleeping <7 Hours per Day	39.7%	38.8%	39.2%	41.5%	39.9%	40.4%	38.4%	38.5%	40.0%	39.6%	38.2%
Without Health Care Coverage	50.9%	47.1%	48.3%	53.3%	47.8%	51.1%	43.9%	46.6%	46.5%	48.4%	28.9%
Routine Check-ups	68.2%	68.7%	68.3%	64.5%	68.0%	68.0%	68.8%	67.2%	68.7%	67.8%	73.0%
Dental Visits	43.7%	47.3%	45.5%	40.1%	44.6%	41.5%	50.8%	49.6%	45.1%	45.4%	59.1%
Medication for High Blood Pressure	67.3%	68.3%	67.8%	57.8%	67.3%	67.5%	68.0%	64.7%	68.1%	66.3%	71.7%
Cholesterol Screening	73.2%	73.4%	73.8%	66.4%	71.8%	72.1%	75.3%	72.0%	73.3%	72.4%	79.5%
Mammography	73.4%	72.0%	72.3%	74.2%	72.4%	73.6%	72.7%	72.0%	73.9%	72.9%	72.4%
Cervical Cancer Screening	76.8%	78.5%	77.8%	76.5%	76.6%	75.0%	80.3%	78.9%	77.7%	77.6%	81.8%
Colon Cancer Screening	41.5%	43.9%	42.8%	37.2%	42.2%	41.5%	46.9%	44.2%	42.2%	42.5%	55.4%
Up-to-Date on Clinical Preventive Services (Men)	17.1%	20.0%	18.7%	16.9%	17.9%	17.5%	20.0%	20.0%	17.5%	18.4%	23.2%
Up-to-Date on Clinical Preventive Services (Women)	15.9%	17.6%	16.4%	15.5%	16.1%	15.7%	18.4%	18.0%	16.5%	16.7%	22.9%

3.4 Matched Comparison Communities

Using the individual matching algorithm, census tracts of interest were matched to comparison tracts in Texas that were >5 miles away from any refinery. Tracts were matched on demographic and socioeconomic factors. Three tracts of interest could not be matched to any comparison tracts. These included tracts 48245005100 (Valero Port Arthur and Motiva Port Arthur), 48245006100 (Valero Port Arthur and Motiva Port Arthur), and 48355006400 (CITGO Corpus Christi Refinery East Plant, Flint Hills Resources Corpus Christi East Refinery, and Magellan Processing LP). Comparison tracts were not able to be identified for these three tracts as they were comprised of unique populations. For the remaining tracts of interest, the number of matches ranged from 1-5, with 89% of tracts having 5 matches each. The demographic, socioeconomic, and risk factor data for all census tracts of interest and matched comparison tracts is presented in Attachment B Table B5.

3.4.1 All Census Tracts of Interest

The demographic and risk factor data for the matched comparisons for all census tracts of interest are presented in Attachment B Table B5. The tracts of interest were well-matched demographically and socioeconomically to their comparison tracts, but the prevalence of the evaluated health-related risk factors was variable across the tracts of interest and the comparisons. These results indicate that health-related risk factors must be accounted for in analyses comparing disease outcomes even in demographically similar areas.

3.4.2 Example Area: Pasadena Refining

As an example, data for one of the census tracts of interest near Pasadena Refining (Tract GEOID 48201322200) and its comparison tracts are presented in

Table 4. In this example, two of the matched comparison tracts were located in Hidalgo County, one in El Paso County, one in Harris County, and one in Webb County (Figure 4). When comparing the census data for the tract of interest and the matched comparisons, the demographic factors that were not included in the matching (% female, median age, urbanicity, race other than Black) were generally similar, with the exception of race, as the tract of interest had a notably high proportion of “Other race” residents (26.3%). The “other race” category includes all other responses not included in the categories of White, Black, Asian, Native Hawaiian or Other Pacific Islander, or American Indian/Alaska Native. Respondents in this category may include multiracial groups or a specific Hispanic or Latino group (e.g., Mexican, Puerto Rican, Cuban). The comparison tracts generally had a higher proportion of White and Hispanic residents than the tract of interest.

The prevalence of health-related risk factors, also presented in

Table 4, were generally comparable between the tract of interest and the comparison tracts, except for smoking and lack of leisure time physical activity, which trended higher in the tract of interest. The prevalence of preventive measures was also comparable between the tract of interest and their comparisons, though cervical and colon cancer screening trended lower in the tract of interest. However, as no statistical comparisons were conducted, it is unclear if this is a true difference or simply due to chance or confounding.

Figure 4. Pasadena Refining Census Tract of Interest (48201322200) and Matched Comparison Tracts

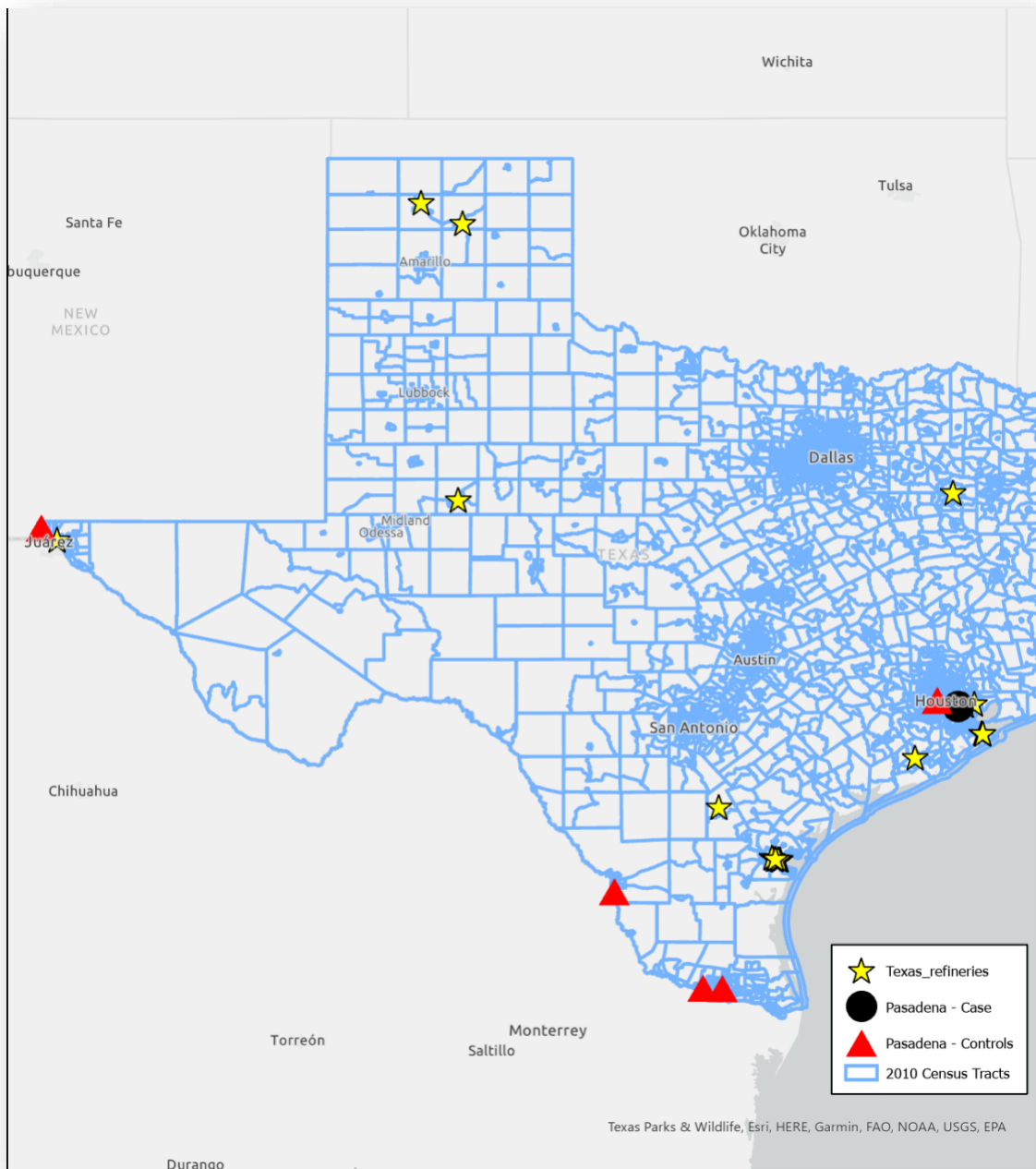


Table 4. Demographic, Socioeconomic, and Risk Factor Data for One Census Tract of Interest (48201322200; Pasadena Refining) and Matched Comparison Tracts

Census Tract GEOID	Census Tract of Interest: 48201322200	All Matches Combined	Match 1: 48141010221	Match 2: 48201520400	Match 3: 48215020201	Match 4: 48215021806	Match 5: 48479001807
County	Harris	-	El Paso	Harris	Hidalgo	Hidalgo	Webb
% Residing Within Two-Mile Radius	95%	-	-	-	-	-	-
2010 Decennial Census							
Sex							
Male	51.4%	49.7%	49.4%	52.2%	49.3%	49.2%	48.3%
Female	48.6%	50.3%	50.6%	47.8%	50.7%	50.8%	51.7%
Age							
Median Age	27.2	26.72	28.3	30.6	26.7	24.6	23.4
≥65 Years	7.2%	6.4%	7.4%	9.3%	6.1%	5.0%	4.3%
Urbanicity							
Urban	100.0%	99.3%	96.4%	100.0%	100.0%	100.0%	100.0%
Rural	0.0%	0.7%	3.6%	0.0%	0.0%	0.0%	0.0%
Ethnicity							
Hispanic	85.0%	93.4%	93.0%	80.4%	96.3%	99.1%	98.2%
Race							
White	73.7%	87.4%	93.1%	61.5%	99.4%	97.4%	85.6%
Non-Hispanic White	18.4%	7.2%	6.1%	23.7%	3.5%	0.8%	1.8%
Hispanic White	81.6%	92.8%	93.9%	76.3%	96.5%	99.2%	98.2%
Black	1.0%	1.5%	1.5%	5.3%	0.1%	0.1%	0.5%
Non-Hispanic Black	94.1%	54.1%	70.0%	80.9%	62.5%	54.5%	2.4%
Hispanic Black	5.9%	45.9%	30.0%	19.1%	37.5%	45.5%	97.6%
American Indian/Alaska Native	0.7%	0.6%	0.3%	2.0%	0.0%	0.1%	0.5%
Asian	0.8%	0.5%	0.6%	1.2%	0.2%	0.2%	0.3%
Native Hawaiian/ Pacific Islander	0.2%	0.1%	0.1%	0.2%	0.0%	0.1%	0.0%
Other	26.3%	11.4%	5.4%	34.2%	0.3%	2.6%	14.3%

Census Tract GEOID	Census Tract of Interest: 48201322200	All Matches Combined	Match 1: 48141010221	Match 2: 48201520400	Match 3: 48215020201	Match 4: 48215021806	Match 5: 48479001807
County	Harris	-	El Paso	Harris	Hidalgo	Hidalgo	Webb
American Community Survey, 2015-2019							
Less than College Degree	95.9%	89.4%	86.1%	91.2%	88.9%	91.3%	89.5%
Unemployed	11.7%	4.5%	3.2%	7.4%	4.8%	3.8%	3.2%
Median Household Income (\$)	32,232	32,433	31,234	31,471	31,366	31,938	36,157
Poverty Last Year	23.1%	26.8%	23.9%	23.8%	27.2%	30.6%	28.4%
CDC PLACES, 2018							
Risk Factors							
Binge Drinking	14.9%	15.6%	17.0%	13.9%	15.6%	15.1%	16.4%
Current Smoking	22.1%	19.0%	18.1%	22.7%	16.2%	18.6%	19.3%
No Leisure-Time Physical Activity	41.5%	38.5%	35.6%	42.8%	34.7%	38.4%	41.1%
Obesity	43.0%	44.1%	40.7%	44.6%	44.7%	47.1%	43.5%
Sleeping <7 Hours per Day	40.4%	38.8%	38.4%	40.9%	36.2%	37.7%	40.7%
Without Health Care Coverage	51.1%	49.9%	44.7%	48.8%	50.6%	54.2%	51.3%
Routine Check-ups	68.0%	68.5%	70.0%	69.3%	68.1%	67.1%	67.9%
Dental Visits	41.5%	43.3%	47.6%	39.9%	47.3%	41.1%	40.7%
Medication for High Blood Pressure	67.5%	69.0%	71.6%	70.9%	69.2%	67.0%	66.5%
Cholesterol Screening	72.1%	73.4%	76.2%	71.9%	74.5%	73.3%	71.0%
Mammography	73.6%	75.2%	75.5%	73.8%	75.8%	75.6%	75.1%
Cervical Cancer Screening	75.0%	77.9%	80.1%	74.7%	80.4%	77.8%	76.7%
Colon Cancer Screening	41.5%	44.7%	49.4%	42.8%	46.8%	44.7%	39.6%
Up-to-Date on Clinical Preventive Services (Men)	17.5%	15.5%	16.3%	16.7%	15.5%	13.5%	15.5%
Up-to-Date on Clinical Preventive Services (Women)	15.7%	17.0%	16.2%	15.0%	19.6%	17.8%	16.2%

3.5 Sensitivity Analyses

Sensitivity analyses were conducted evaluating the demographic, socioeconomic, and risk factor data for census tracts of interest with >50% of the population and those with >0-<10% of the population residing within the two-mile radius. Results for all census tracts are presented in Attachment C.

3.5.1 All Census Tracts of Interest

When evaluating the sensitivity analyses across all refineries, the census tracts of interest with $\geq 50\%$ of the population residing within the two-mile radius tended to be more urban and have a higher proportion of Hispanic residents than the overall proportions of the counties in which they are located (Attachment C Table C2). For example, when compared to Harris County as a whole (40.8% Hispanic), the census tracts with $\geq 50\%$ of their populations residing within two miles of Kinder Morgan Crude and Condensate Galena Park (84.7% Hispanic), Houston Refining (86.6% Hispanic), ExxonMobil Baytown (62.6%), Pasadena Refining (85.9% Hispanic), and Valero Houston (79.7% Hispanic) all had a substantially higher proportion of Hispanic residents. The tracts of interest also tended to have a higher proportion of residents with less than a college degree and a lower median household income than their corresponding counties. Continuing the example of Harris County, which has a median household income of \$61,705, the values for the tracts of interest were considerably lower (ExxonMobil Baytown: \$49,600; Houston Refining: \$44,983; Kinder Morgan Crude and Condensate Galena Park: \$48,445; Pasadena Refining: \$41,390; Valero Houston: \$38,878). Without ruling out the role of chance and confounding, these results indicate that the census tracts with the majority of their population residing within two miles of a refinery are generally composed of more Hispanic residents and have lower income areas than the counties in which they are located.

The tracts of interest with >0-<10% of their population residing within two miles of a refinery also tended to have a higher proportion of Hispanic residents and a lower median household income than their corresponding counties (Attachment C Table C6). These sensitivity analyses demonstrate that regardless of the cutoff used to define the census tracts of interest ($\geq 10\%$ of population residing within two-mile radius vs. $\geq 50\%$ or <10%), the trends for the demographic, socioeconomic, and health-related risk factor profiles of these areas are generally comparable.

3.5.2 Example Area: Pasadena Refining

As an example, sensitivity analyses for the Pasadena Refining are presented in Table 5.

As shown in Table 5, there were 4 census tracts within two miles of Pasadena Refining with the majority (50%-100%) of their populations residing within the radius. The tracts of interest generally trended younger in age, more Hispanic, less Black, lower college-

educated, lower-income, and higher unemployment than Harris County. The prevalence of smoking, obesity, and lack of leisure-time physical activity were generally higher among the tracts of interest than Harris County, and the proportion of residents without healthcare coverage was notably higher (mean 49.4% in tracts of interest vs. 28.9% in Harris County). The prevalence of cervical and colon cancer screening, dental visits, routine check-ups, and clinical preventive services trended lower among the tracts of interest than Harris County as a whole.

There were 2 census tracts with <10% of their population residing within the radius (1.0-3.0%). While the trends for these census tracts mirrored those of the census tracts with $\geq 50\%$ of residents residing within the two-mile radius, the population demographics were closer to those of Harris County than the $\geq 50\%$ tracts. Compared to the tracts with <10% of the population residing within the radius, the tracts with the majority of their populations residing within the two-mile radius trended younger in age and more Hispanic, with a lower median household income and a higher unemployment rate. The trends for health-related risk factors and prevalence measures were generally similar for the <10% tracts and the $\geq 50\%$ tracts compared to county-wide levels for Harris County.

Table 5. Sensitivity Analyses of Demographic, Socioeconomic, and Risk Factor Data for Census Tracts Near Pasadena Refining with ≥50% or >0- <10% of Population Residing Within Two-Mile Radius

Census Tract GEOID	48201322000	48201322200	48201322900	48201324100	All Tracts Combined	Harris County	48201233701	48201323000
% Residing Within Two-Mile Radius	95.7%	100%	79.9%	100%	93.9%	-	3.0%	1.0%
2010 Decennial Census								
Sex								
Male	54.50%	51.40%	50.80%	51.00%	51.9%	49.80%	50.70%	49.70%
Female	45.50%	48.60%	49.20%	49.00%	48.1%	50.20%	49.30%	50.30%
Age								
Median Age	25	27.2	26.7	29.2	27.025	32.2	30.4	25.4
≥65 Years	1.90%	7.20%	5.30%	5.70%	5.0%	8.10%	9.40%	5.20%
Urbanicity								
Urban	100%	100%	100%	100%	100.00%	98.80%	100%	100%
Rural	0.00%	0.00%	0.00%	0.00%	0.00%	1.20%	0.00%	0.00%
Ethnicity								
Hispanic	88.50%	85.00%	84.60%	85.30%	85.9%	40.80%	75.10%	85.80%
Race								
White	66.00%	73.70%	73.30%	73.70%	71.7%	59.30%	64.00%	70.80%
Non-Hispanic White	10.80%	18.40%	18.30%	16.90%	16.1%	57.20%	17.50%	16.70%
Hispanic White	89.20%	81.60%	81.70%	83.10%	83.9%	42.80%	82.50%	83.30%
Black	5.10%	1.00%	2.00%	1.60%	2.4%	19.70%	13.60%	3.00%
Non-Hispanic Black	75.90%	94.10%	64.60%	72.70%	76.9%	96.00%	98.20%	70.90%
Hispanic Black	24.10%	5.90%	35.40%	27.30%	23.1%	4.00%	1.80%	29.10%
American Indian/Alaska Native	0.80%	0.70%	1.00%	0.80%	0.8%	1.20%	0.70%	2.00%
Asian	0.90%	0.80%	0.40%	1.10%	0.8%	6.90%	0.30%	0.50%
Native Hawaiian/Pacific Islander	0.10%	0.20%	0.20%	0.20%	0.2%	0.20%	0.10%	0.10%
Other	30.80%	26.30%	25.90%	24.90%	27.2%	16.20%	24.40%	26.90%
2015-2019 American Community Survey								
Less than College Degree	96.20%	95.90%	97.80%	90.70%	95.2%	68.50%	88.40%	94.90%

Census Tract GEOID	48201322000	48201322200	48201322900	48201324100	All Tracts Combined	Harris County	48201233701	48201323000
% Residing Within Two-Mile Radius	95.7%	100%	79.9%	100%	93.9%	-	3.0%	1.0%
Unemployed	8.30%	11.70%	4.70%	9.90%	8.7%	3.90%	4.00%	7.90%
Median Household Income (\$)	\$39,286	\$32,232	\$52,090	41,950	\$ 41,390	61,705	39,492	31,343
Poverty Last Year	25.90%	23.10%	5.90%	21.30%	19.1%	13.00%	23.00%	42.60%
CDC PLACES, 2018								
Risk Factors								
Binge Drinking	16.9%	14.9%	17.0%	15.1%	16.0%	15.3%	14.0%	14.5%
Current Smoking	22.6%	22.1%	18.6%	20.5%	21.0%	15.9%	20.1%	25.9%
No Leisure-Time Physical Activity	39.4%	41.5%	35.5%	39.0%	38.9%	28.4%	39.3%	45.6%
Obesity	42.7%	43.0%	38.3%	42.4%	41.6%	36.3%	42.7%	44.8%
Sleeping <7 Hours per Day	41.5%	40.4%	38.5%	40.0%	40.1%	38.2%	40.4%	41.9%
Without Health Care Coverage	53.3%	51.1%	46.6%	46.5%	49.4%	28.9%	44.4%	56.0%
Routine Check-ups	64.5%	68.0%	67.2%	68.7%	67.1%	73.0%	71.2%	66.2%
Dental Visits	40.1%	41.5%	49.6%	45.1%	44.1%	59.1%	45.5%	34.8%
Medication for High Blood Pressure	57.8%	67.5%	64.7%	68.1%	64.5%	71.7%	72.3%	64.3%
Cholesterol Screening	66.4%	72.1%	72.0%	73.3%	71.0%	79.5%	75.5%	67.2%
Mammography	74.2%	73.6%	72.0%	73.9%	73.4%	72.4%	74.5%	71.7%
Cervical Cancer Screening	76.5%	75.0%	78.9%	77.7%	77.0%	81.8%	78.4%	72.2%
Colon Cancer Screening	37.2%	41.5%	44.2%	42.2%	41.3%	55.4%	44.5%	37.2%
Up-to-Date on Clinical Preventive Services (Men)	16.9%	17.5%	20.0%	17.5%	18.0%	23.2%	17.3%	15.2%
Up-to-Date on Clinical Preventive Services (Women)	15.5%	15.7%	18.0%	16.5%	16.4%	22.9%	14.9%	13.6%

3.6 Limitations

This initial assessment was conducted to characterize the demographics and health-related risk factors of Texas communities in close proximity to industrial operations. The intention of this project was not to determine a statistical association between living near a refinery and any particular characteristic. Further, the communities of interest, though living near a refinery, may not represent the areas most affected by refinery emissions, as no meteorological, residential history, time spent at residence data, or actual exposure data (e.g., air monitoring or air modeling data) was incorporated. The data presented in this report represent a cross-sectional snapshot of these communities at one point in time. The 2020 US Census data may demonstrate that the demographics and socioeconomic characteristics of these areas has changed since the 2010 Census.

Further, the publicly available data used in this project was presented at the group level and not the individual level. Any analyses conducted using these data may be subject to the ecologic fallacy, where the aggregate-level characteristics may not represent the individuals comprising the group. Additionally, the ACS data used for socioeconomic variables and the CDC PLACES risk factor data are modeled estimates using a sample of the population. The PLACES risk factor data in particular are crude prevalence estimates not adjusted for potential confounding variables such as age, sex, or race. PLACES utilizes data from the Behavioral Risk Factor Surveillance System, which is conducted via a telephone survey. As all outcomes are self-reported by participants, they are subject to recall bias. Any future analyses of risk factors and/or disease outcomes should consider using validated outcome measures. Due to these limitations, no statistical comparisons were conducted as a part of this assessment, and it cannot be determined if any observed differences are due to the role of chance or confounding.

4 Conclusions

This initial assessment represents a descriptive assessment aimed at characterizing the demographic and socioeconomic characteristics and health-related risk factors of communities residing within two miles of refinery operations across the State of Texas. Census data demonstrated that these areas are generally low-income minority communities compared to their corresponding counties as a whole. CDC PLACES data demonstrated that the prevalence of health-related risk factors such as obesity, smoking, and lack of physical activity trended higher and the prevalence of preventive measures such as dental visits and cervical and colon cancer screening trended lower in these areas than the corresponding counties and the demographically similar comparison areas. Further, these data indicate that the prevalence of health-related risk factors in communities in close proximity to a refinery may differ from demographically similar areas not located near a refinery, and, as such, demonstrate that any future analyses of disease outcome comparisons should account for these potential confounding factors. Nonetheless, these data will provide TCEQ with a greater understanding of the multifaceted health status and health-related risk factors of these communities.

5 References

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APPENDIX A

Supplemental Figures

Figure A1. Census Tracts Near Marathon Galveston Bay Refinery with Two-Mile Radius

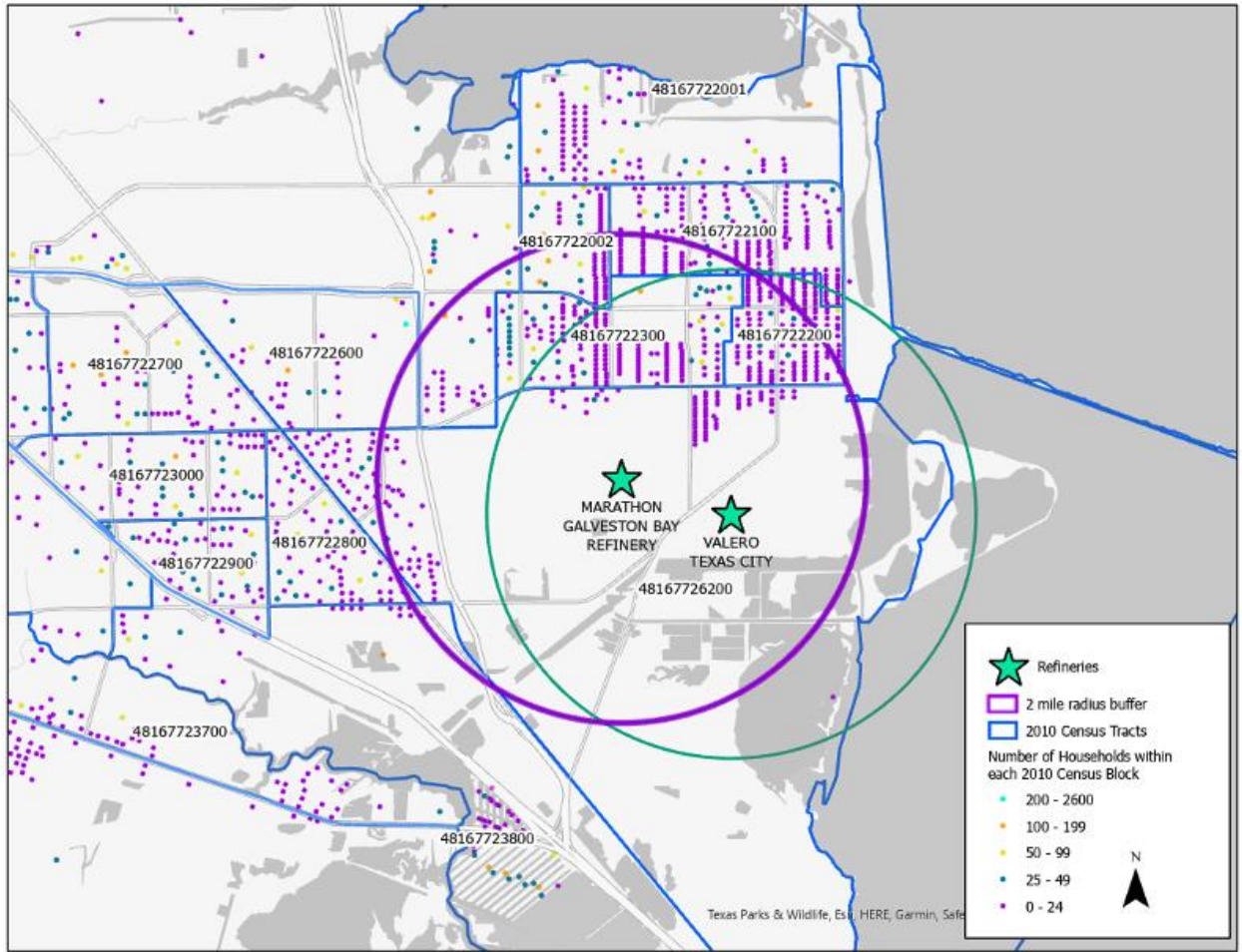


Figure A2. Census Tracts Near Shell Oil Deer Park Refinery with Two-Mile Radius

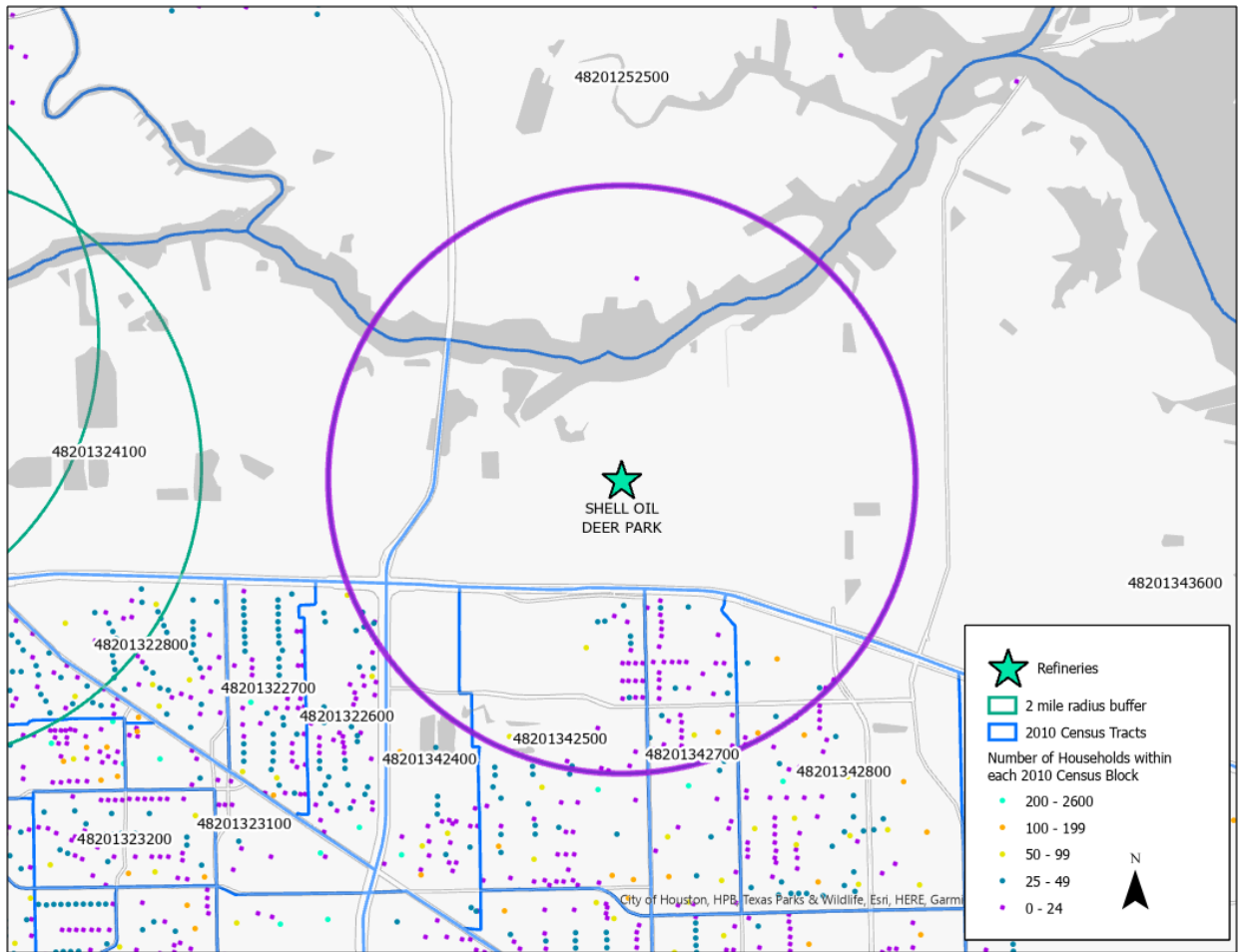


Figure A3. Census Tracts Near Kinder Morgan Crude and Condensate Galena Park with Two-Mile Radius

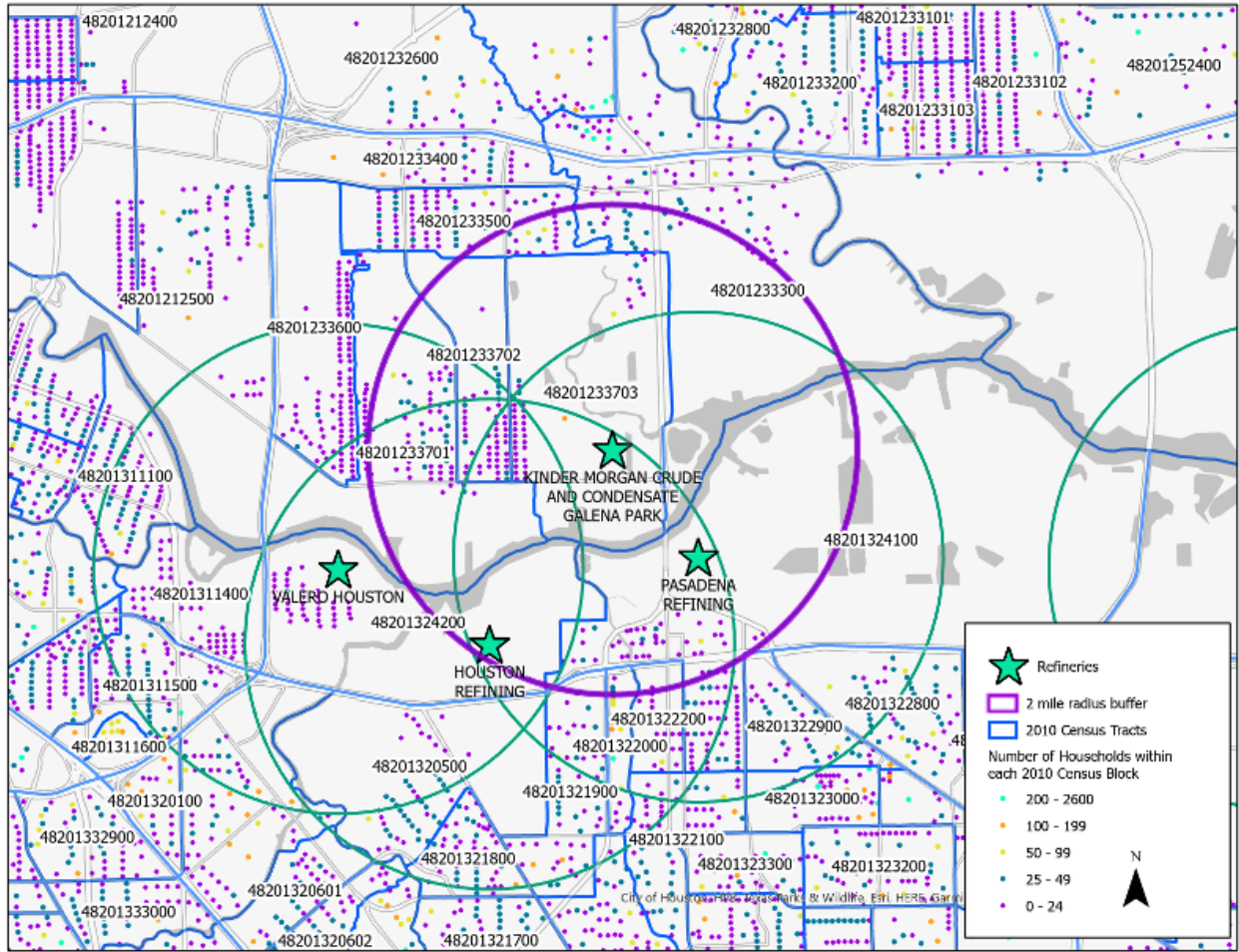


Figure A4. Census Tracts Near Valero Corpus Christi Three Rivers Refinery with Two-Mile Radius

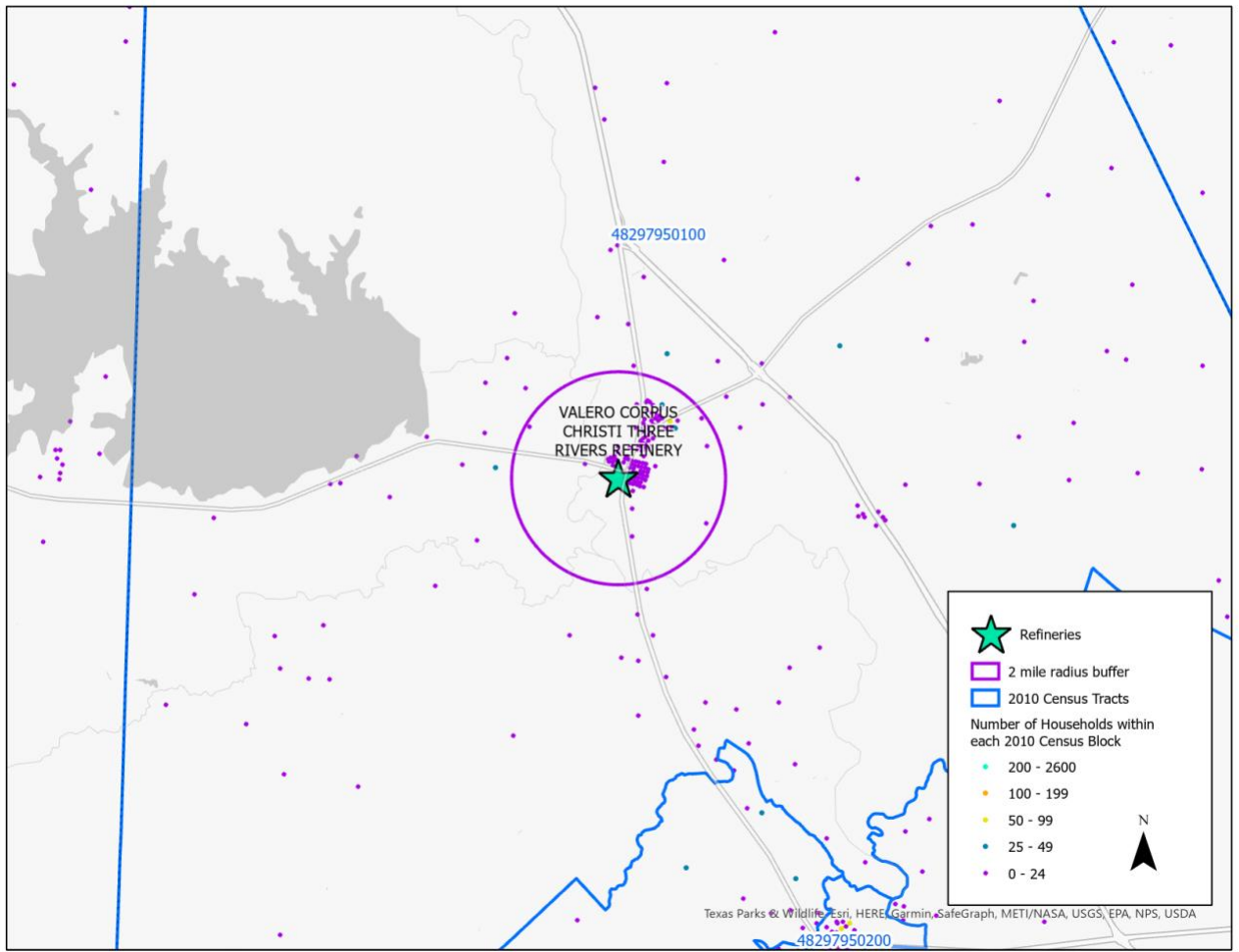


Figure A5. Census Tracts Near Phillips 66 Borger Refinery with Two-Mile Radius

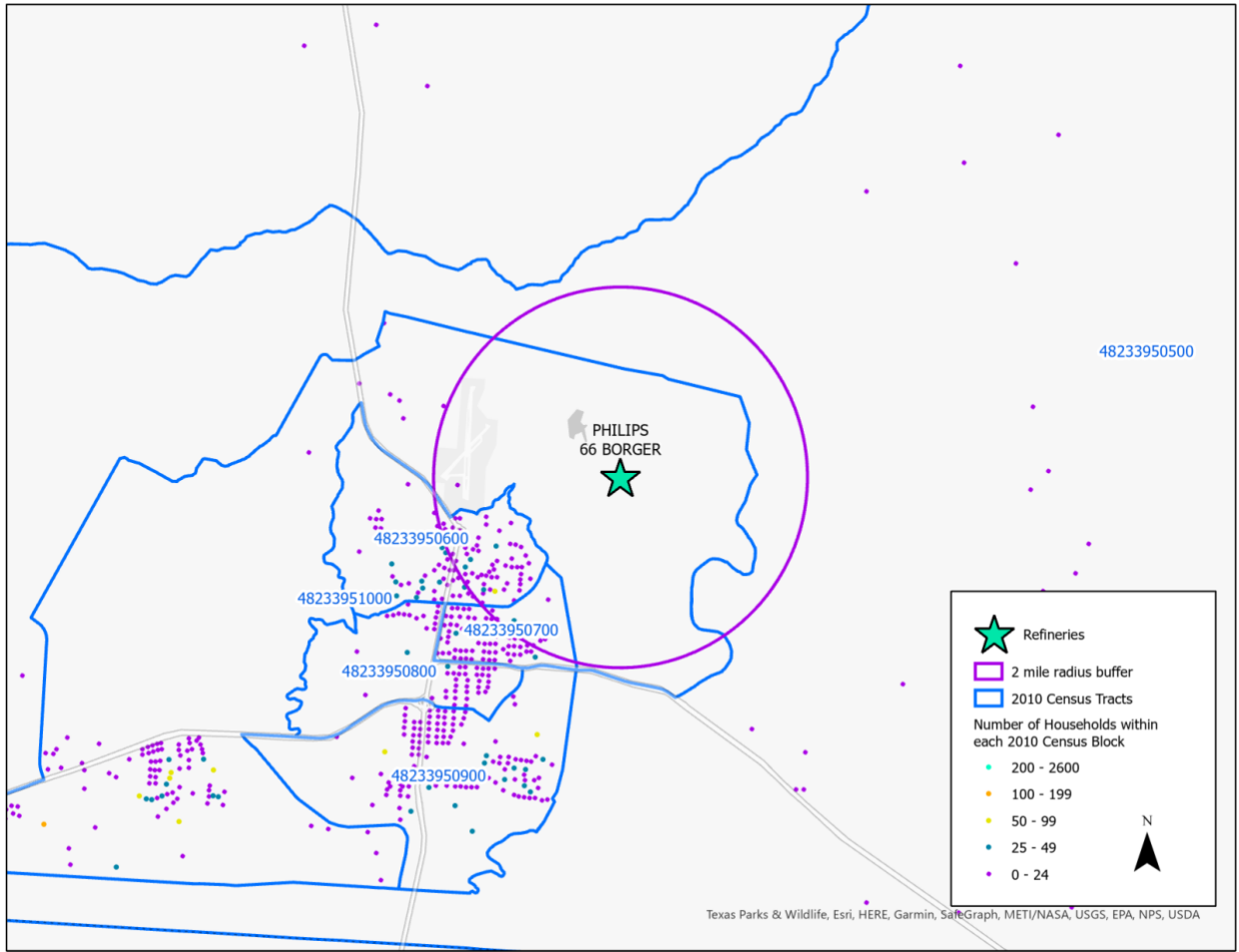


Figure A6. Census Tracts Near Delek Tyler Refinery with Two-Mile Radius

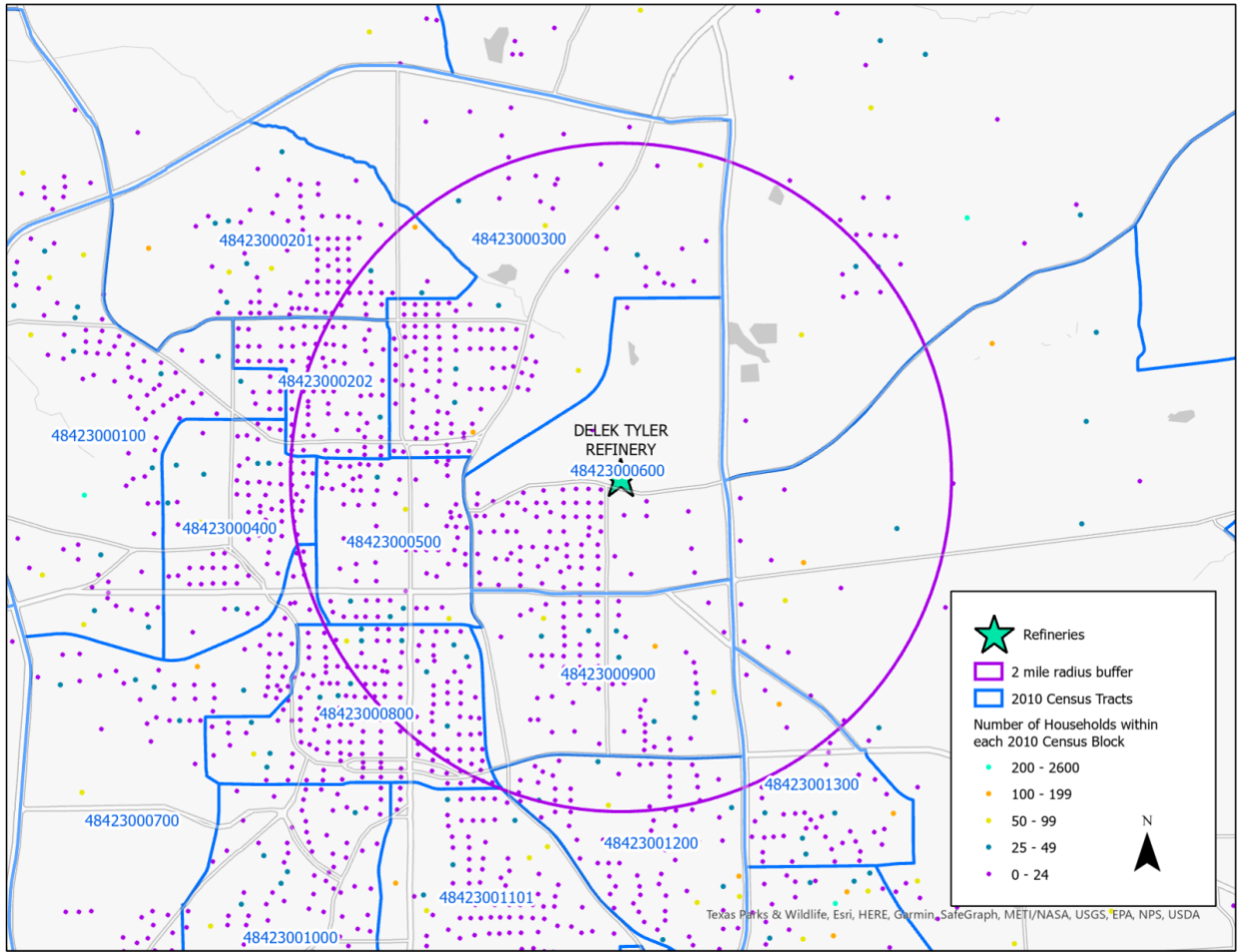


Figure A8. Census Tracts Near Big Spring Refinery with Two-Mile Radius

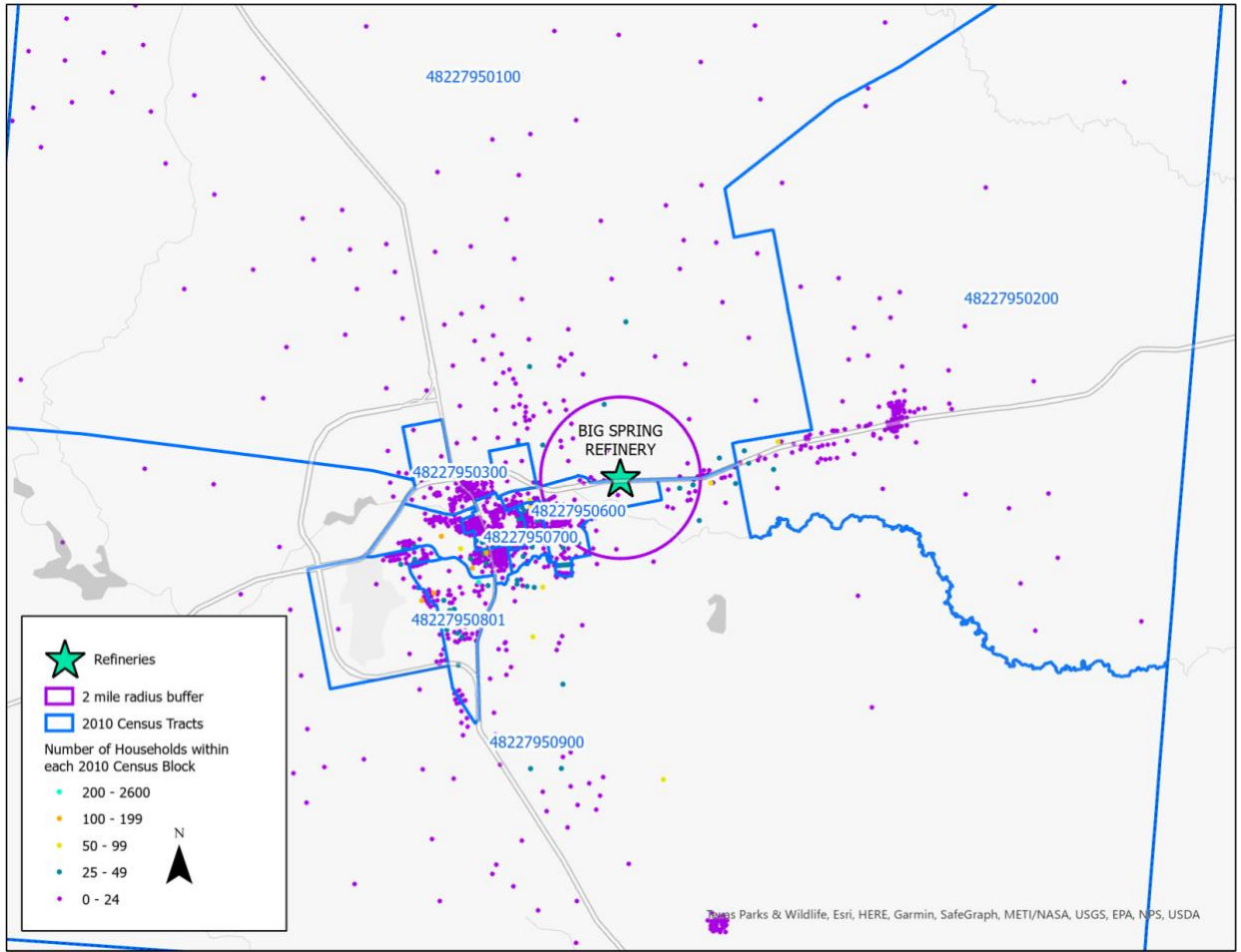


Figure A9. Census Tracts Near ExxonMobil Beaumont Refinery with Two-Mile Radius

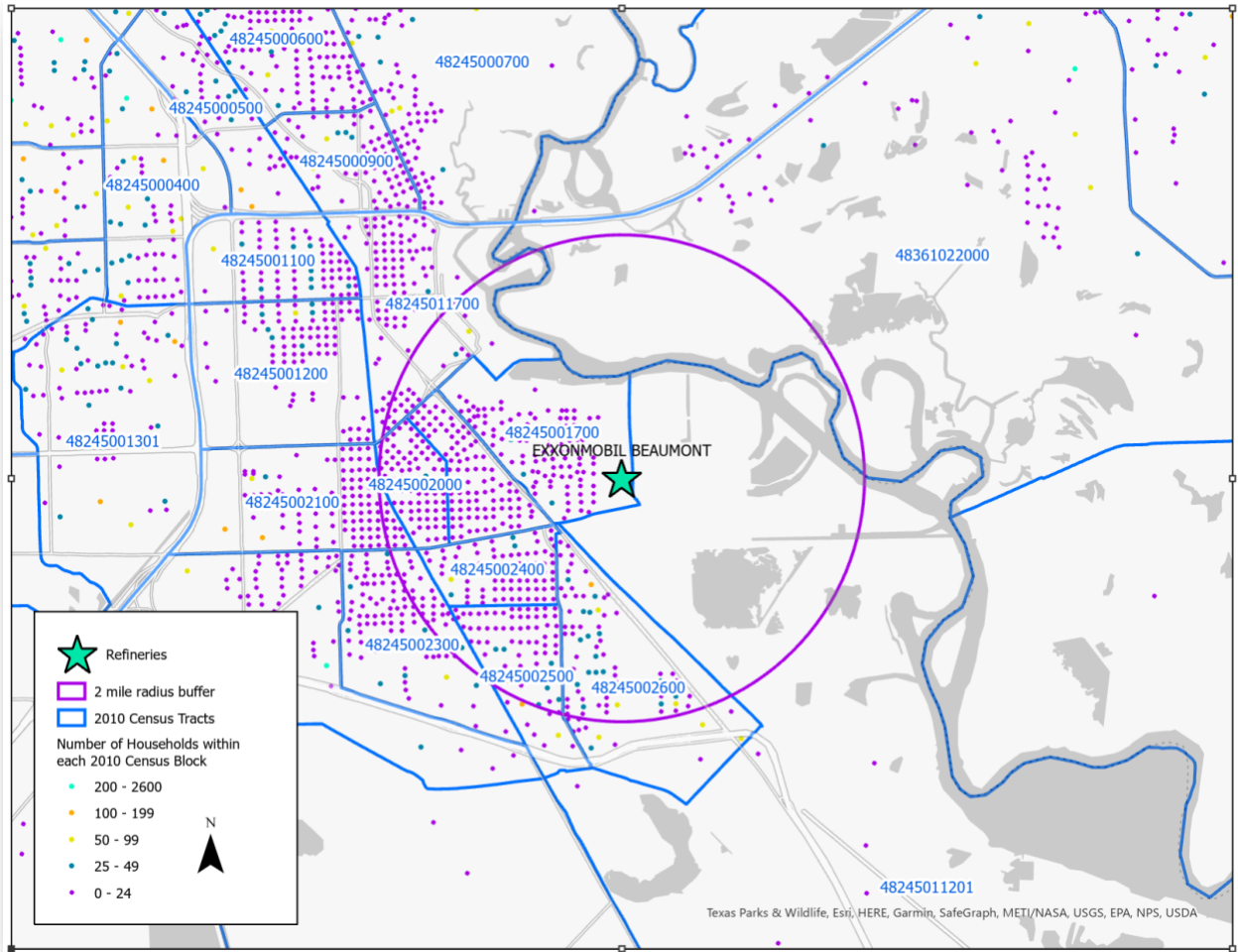


Figure A10. Census Tracts Near Valero Port Arthur Refinery with Two-Mile Radius

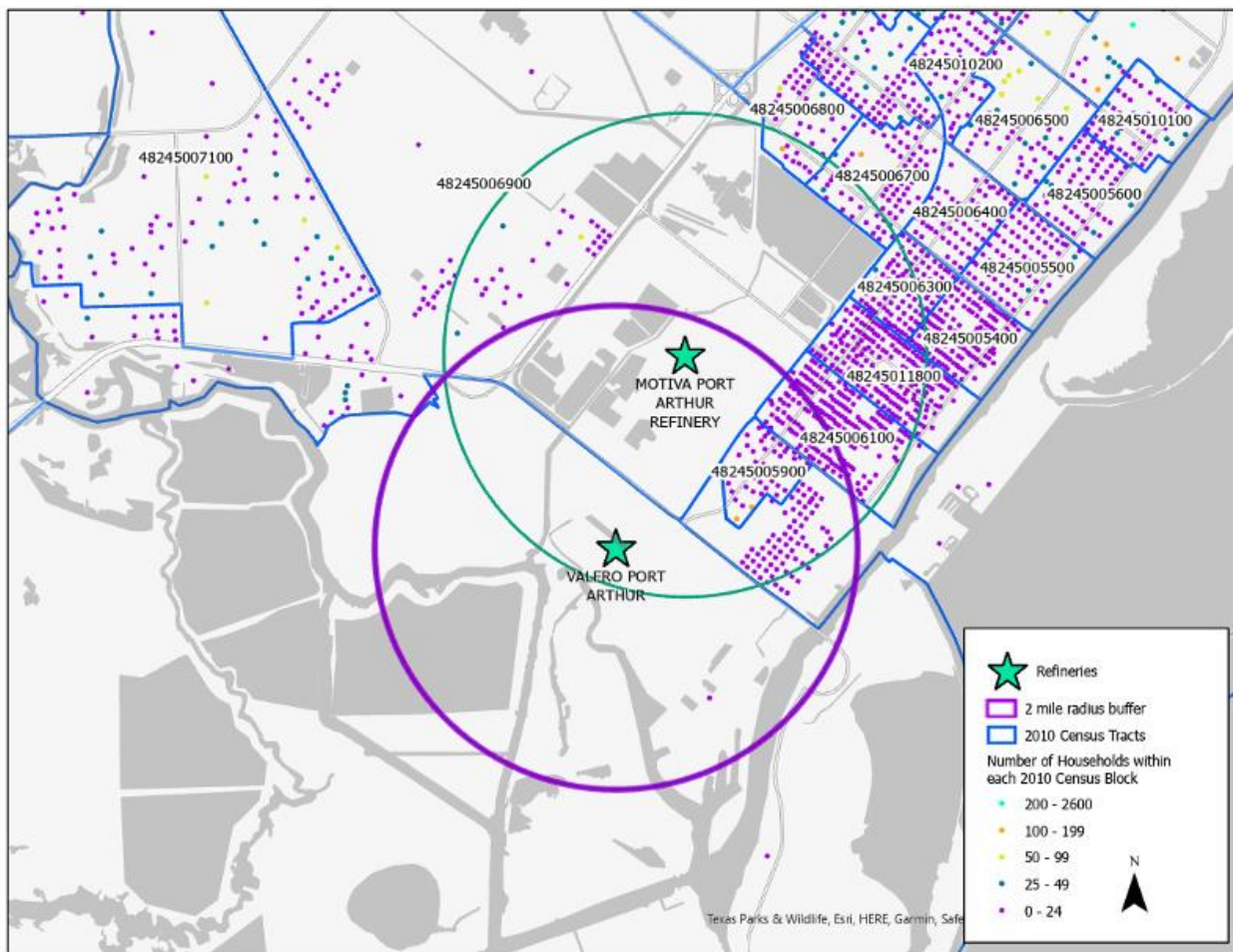


Figure A11. Census Tracts Near Motiva Port Arthur Refinery with Two-Mile Radius

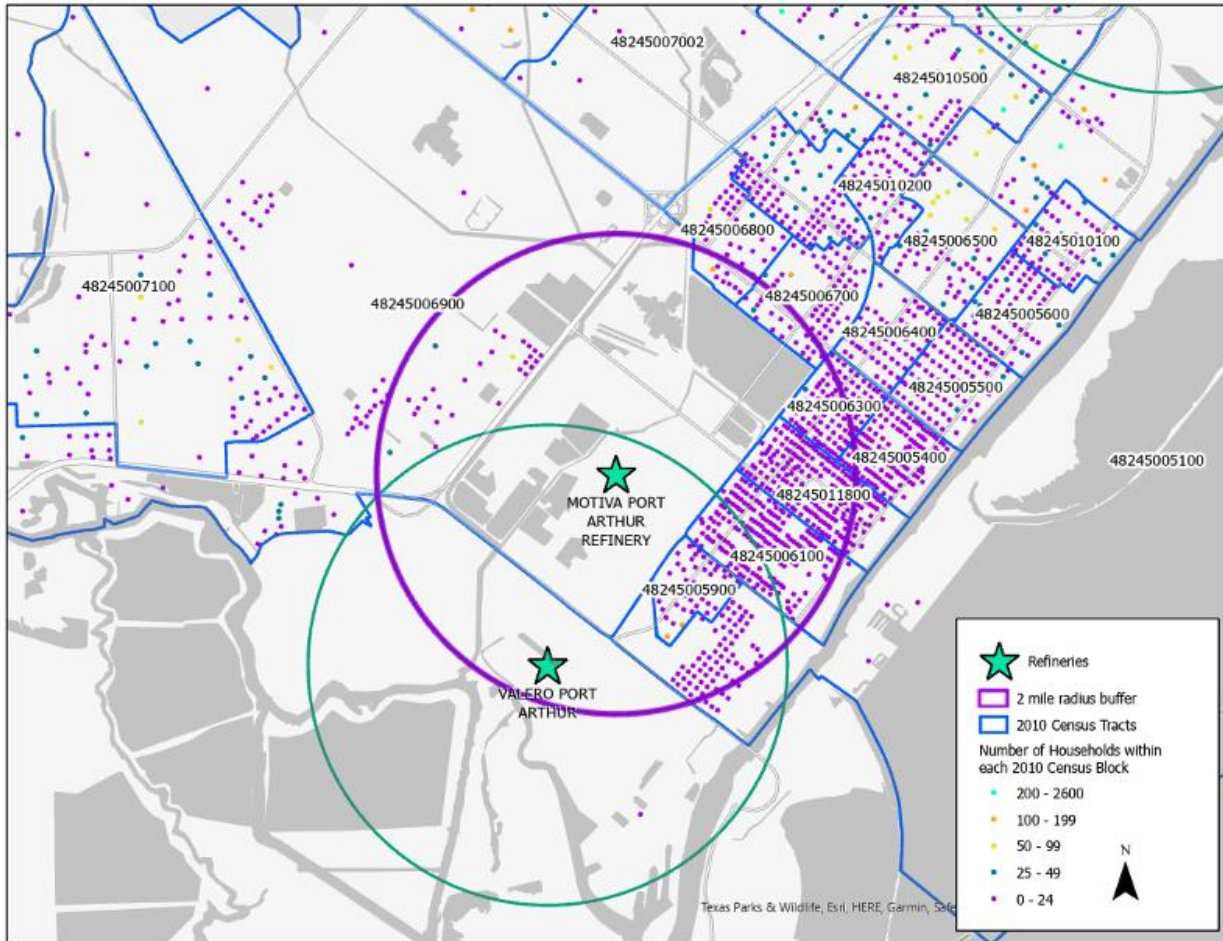


Figure A12. Census Tracts Near Total Port Arthur Refinery with Two-Mile Radius

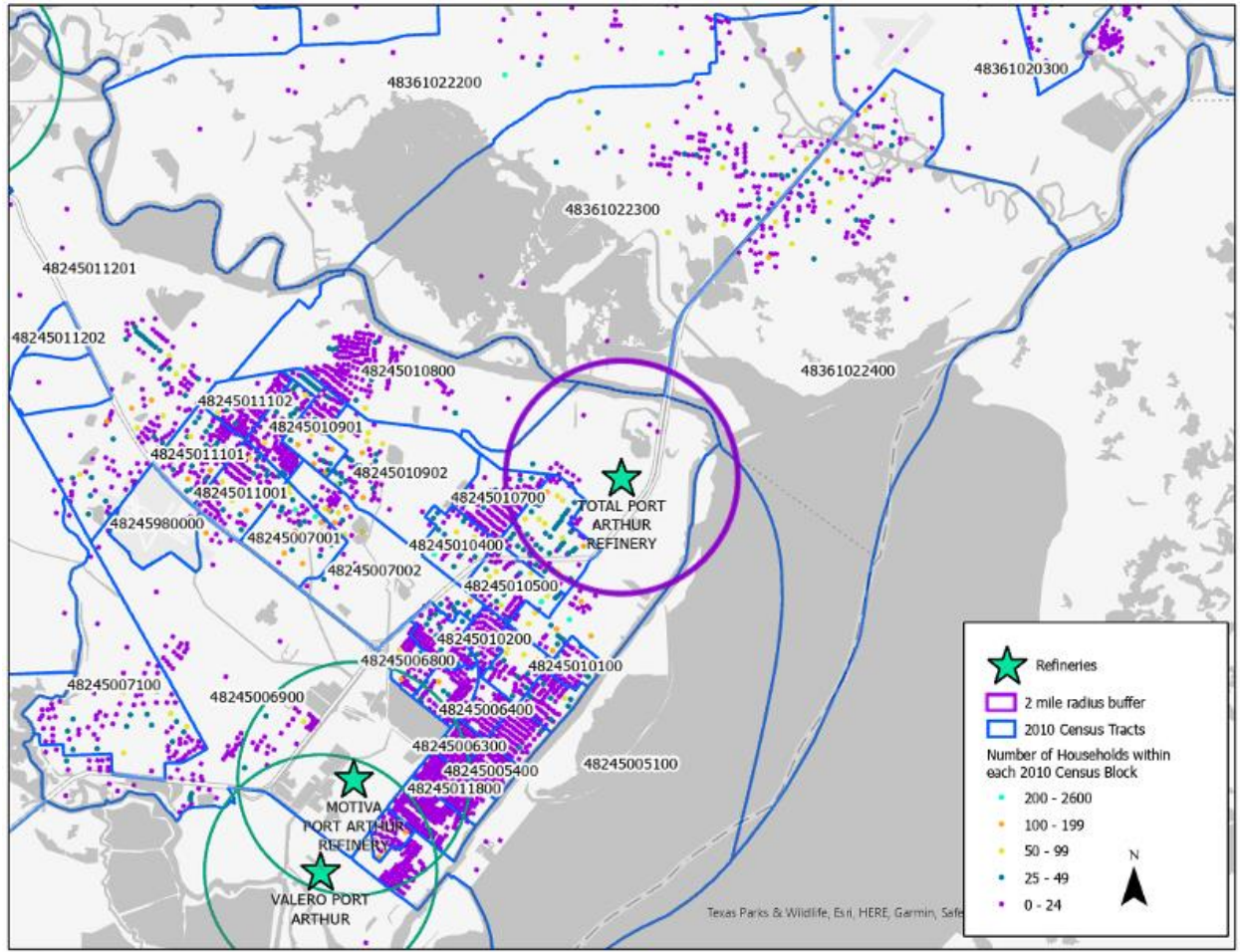


Figure A13. Census Tracts Near ExxonMobil Baytown Refinery with Two-Mile Radius

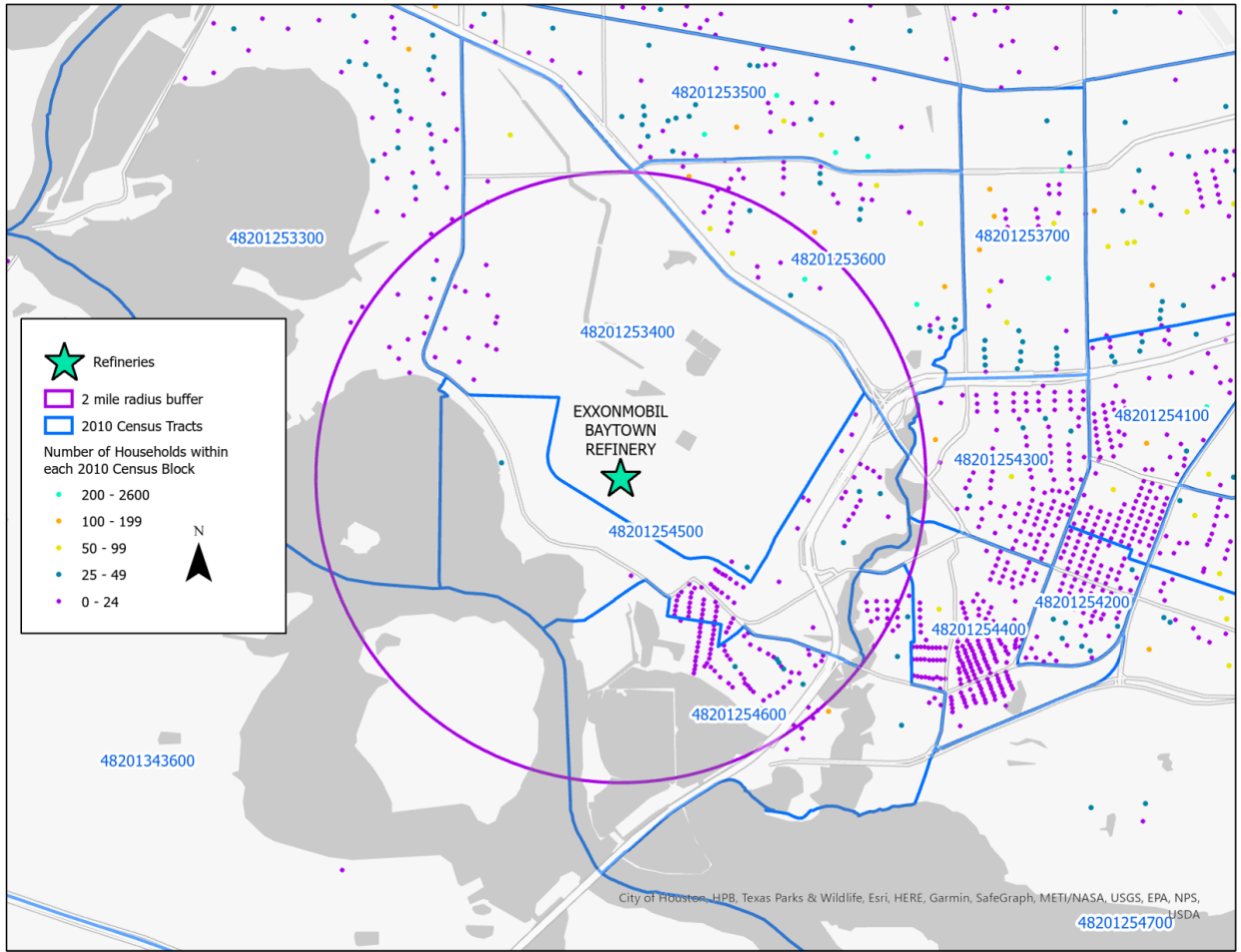


Figure A14. Census Tracts Near Houston Refining with Two-Mile Radius

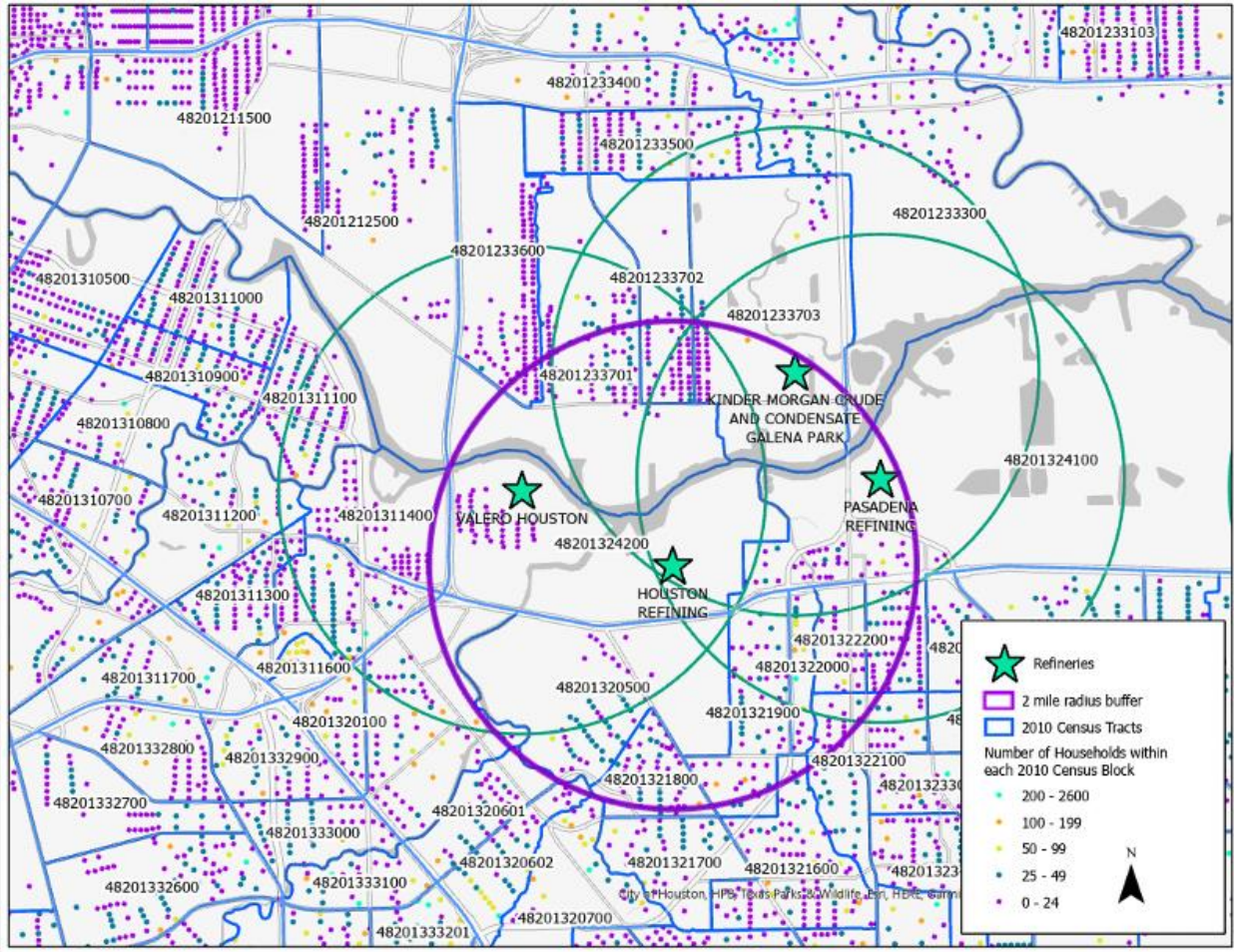


Figure A15. Census Tracts Near Pasadena Refining with Two-Mile Radius

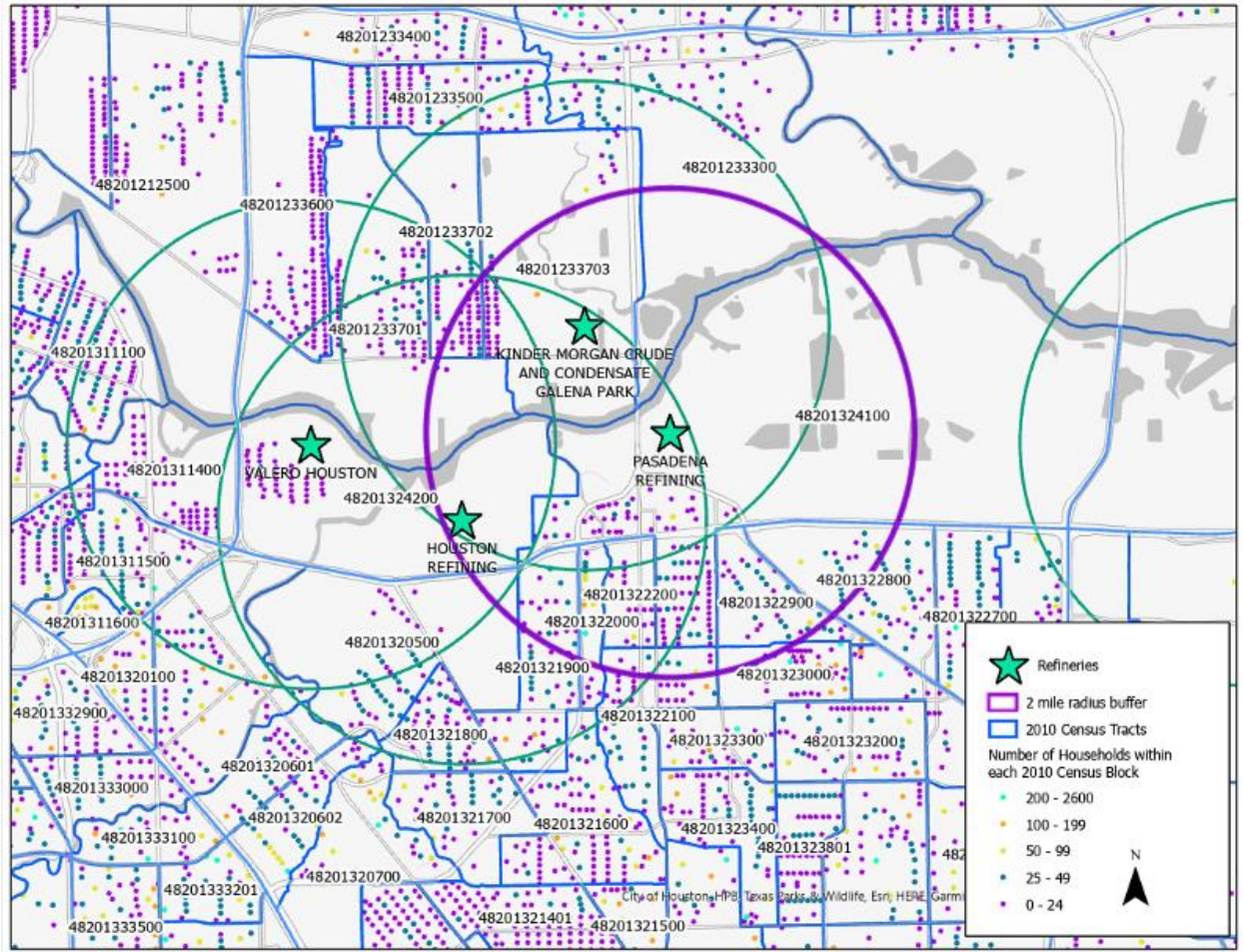


Figure A16. Census Tracts Near Phillips 66 Sweeny Refinery with Two-Mile Radius

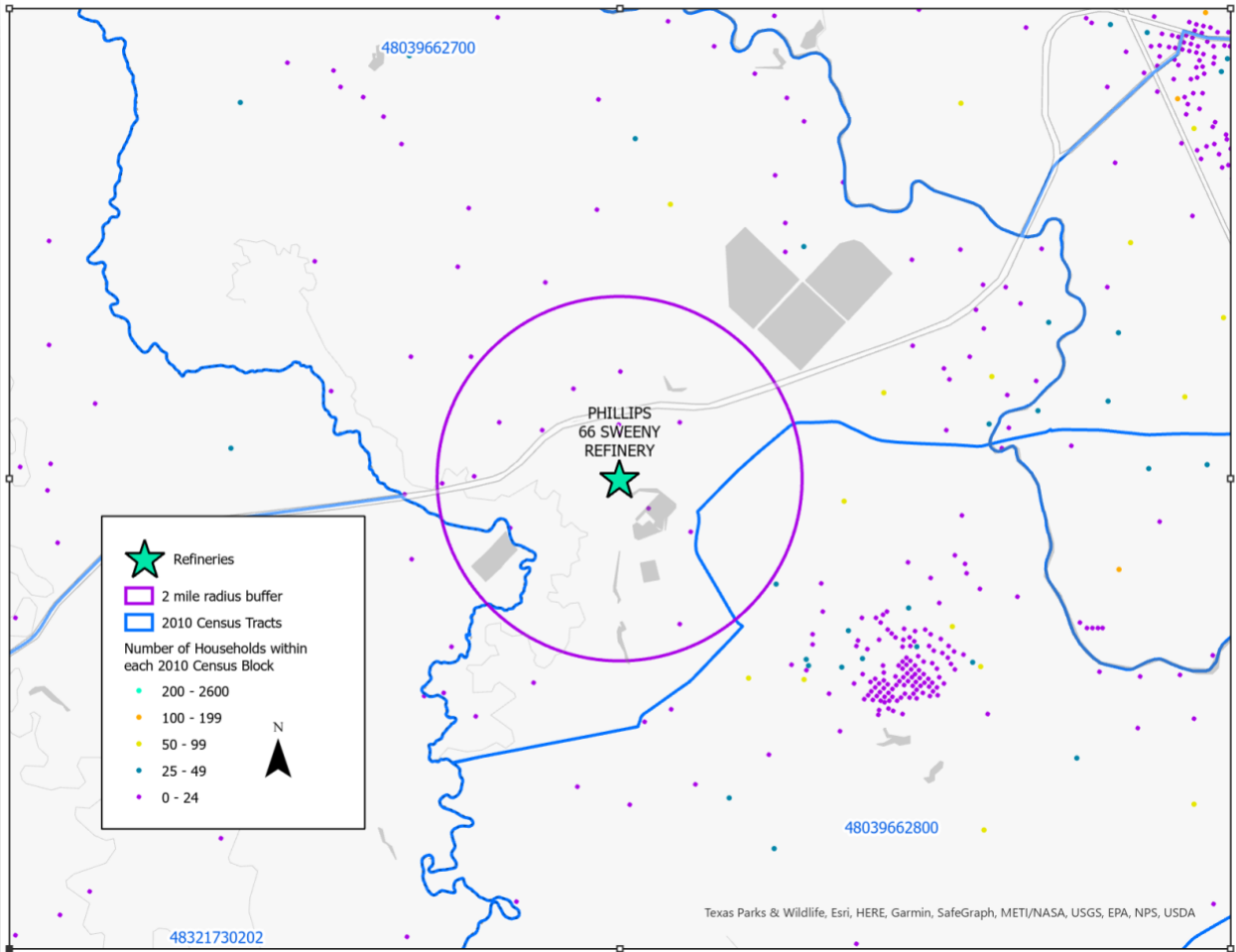


Figure A17. Census Tracts Near Valero Houston Refinery with Two-Mile Radius

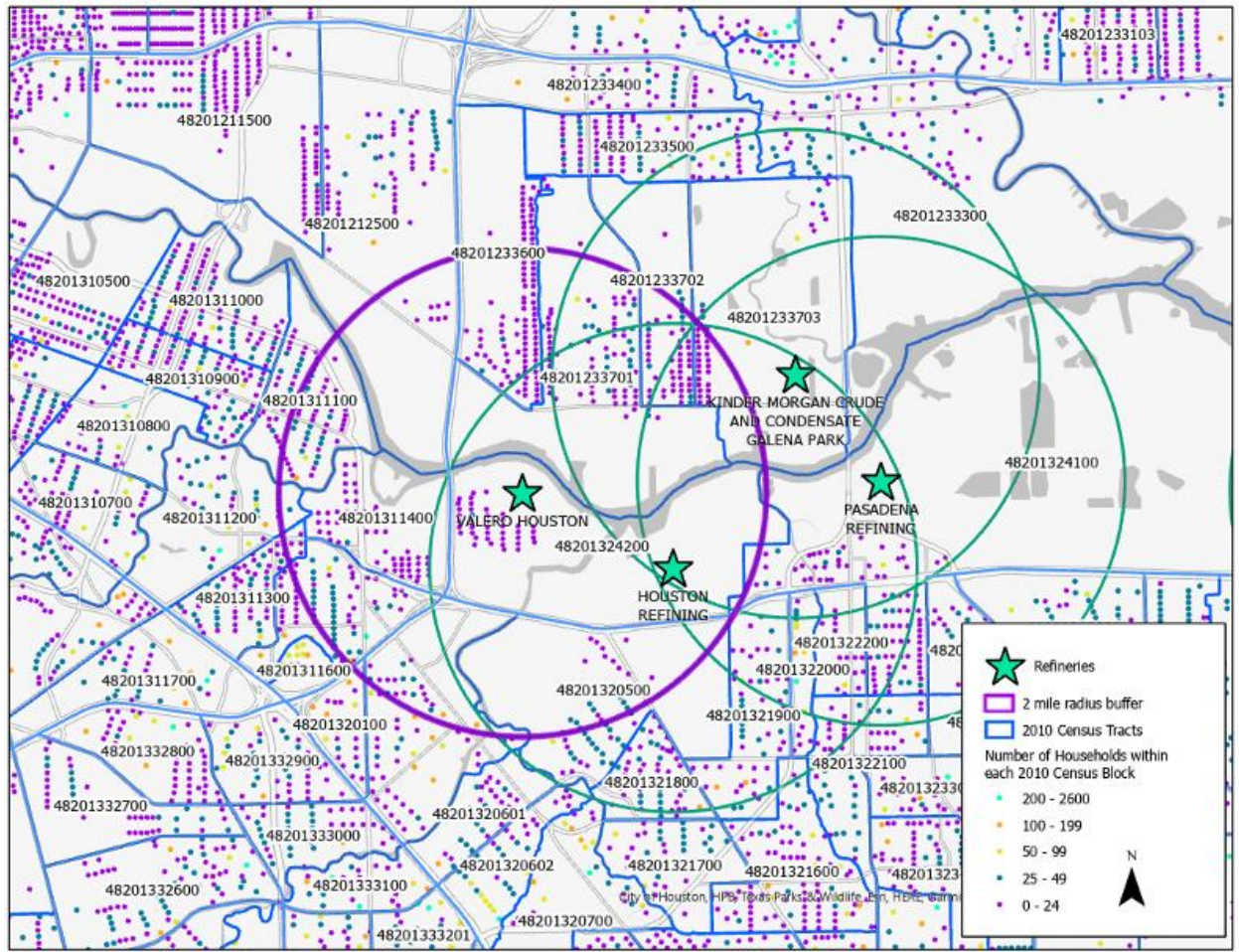


Figure A18. Census Tracts Near CITGO Corpus Christi Refinery East Plant with Two-Mile Radius

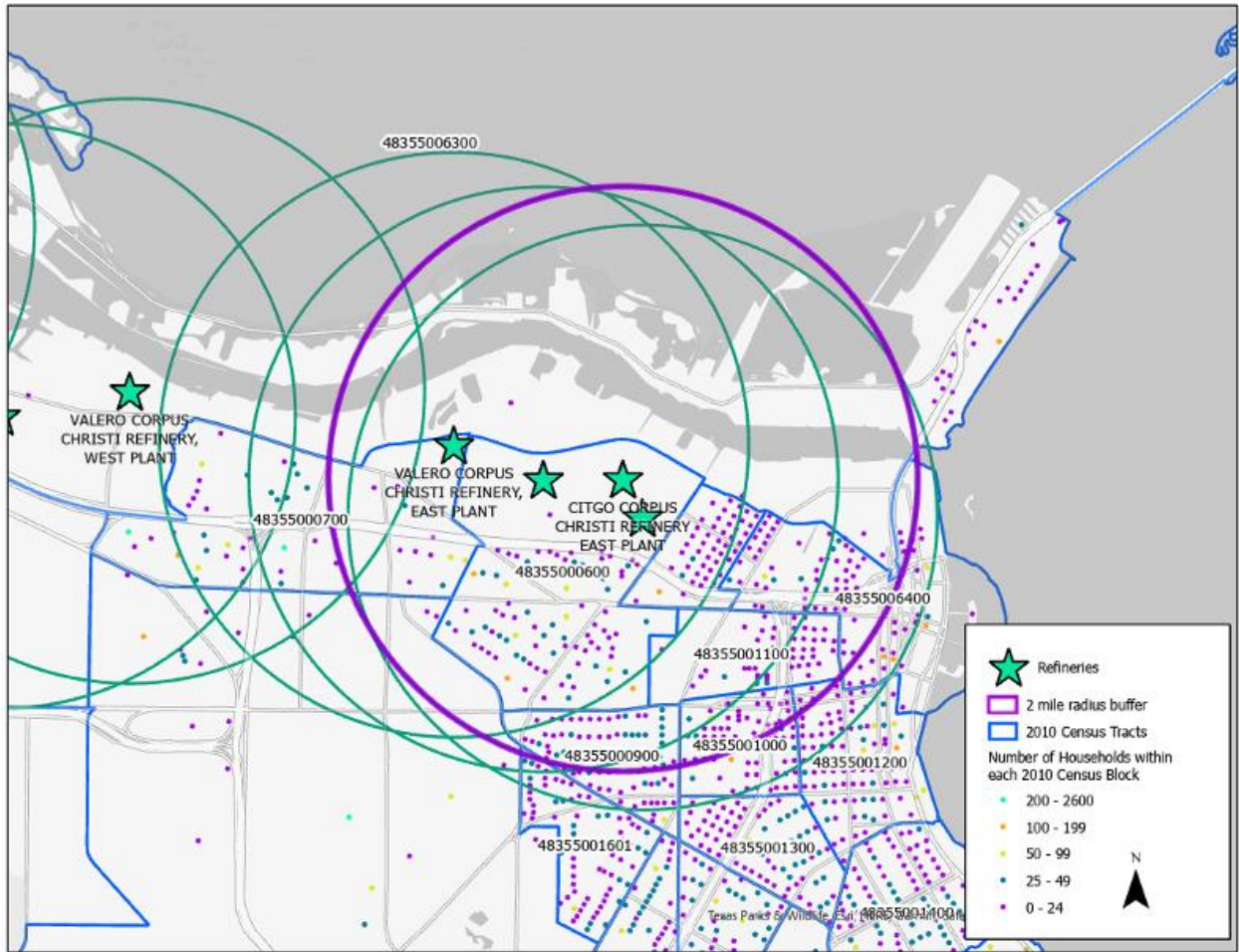


Figure A19. Census Tracts Near CITGO Corpus Christi Refinery West Plant with Two-Mile Radius

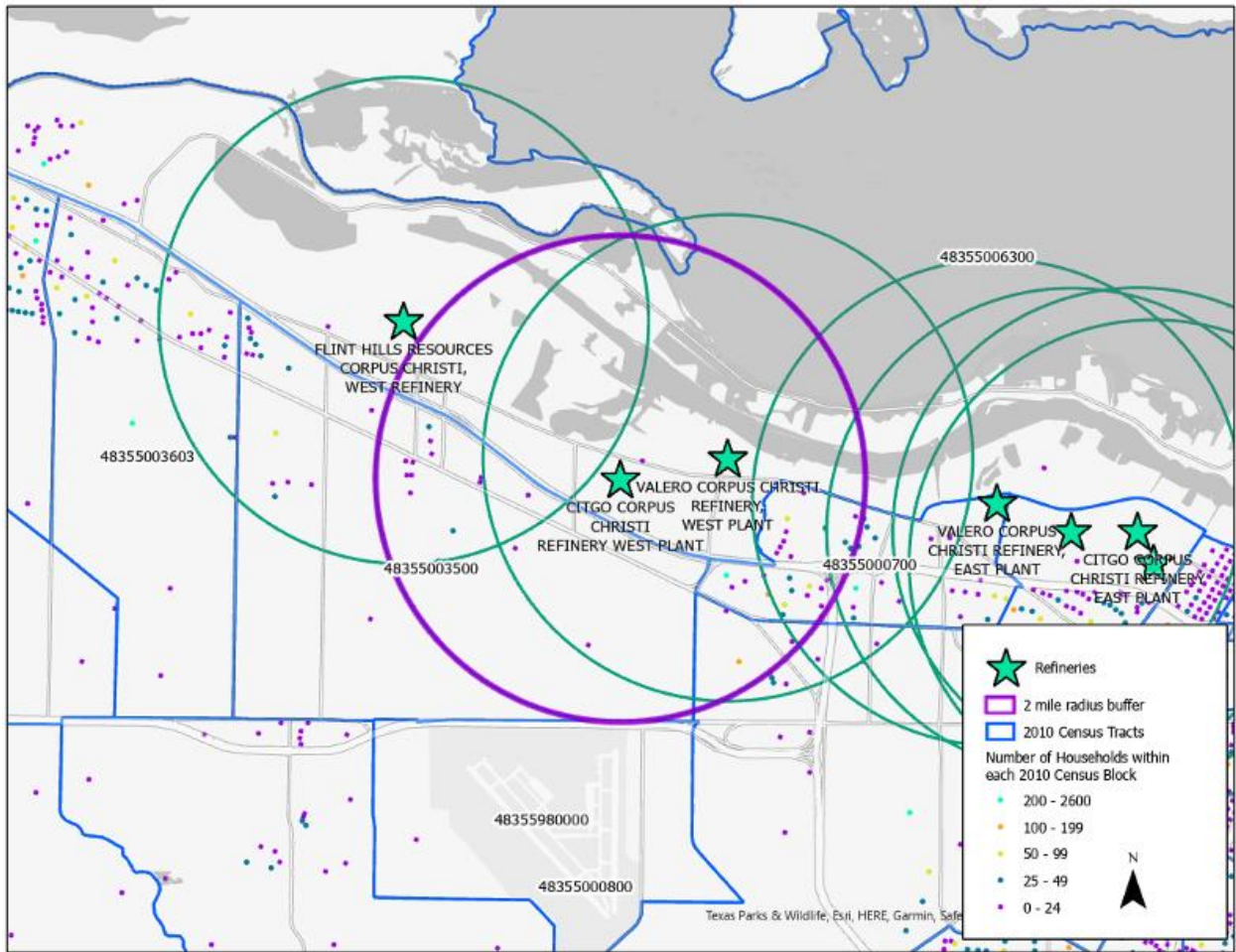


Figure A20. Census Tracts Near Flint Hills Resources Corpus Christi, East Refinery with Two-Mile Radius

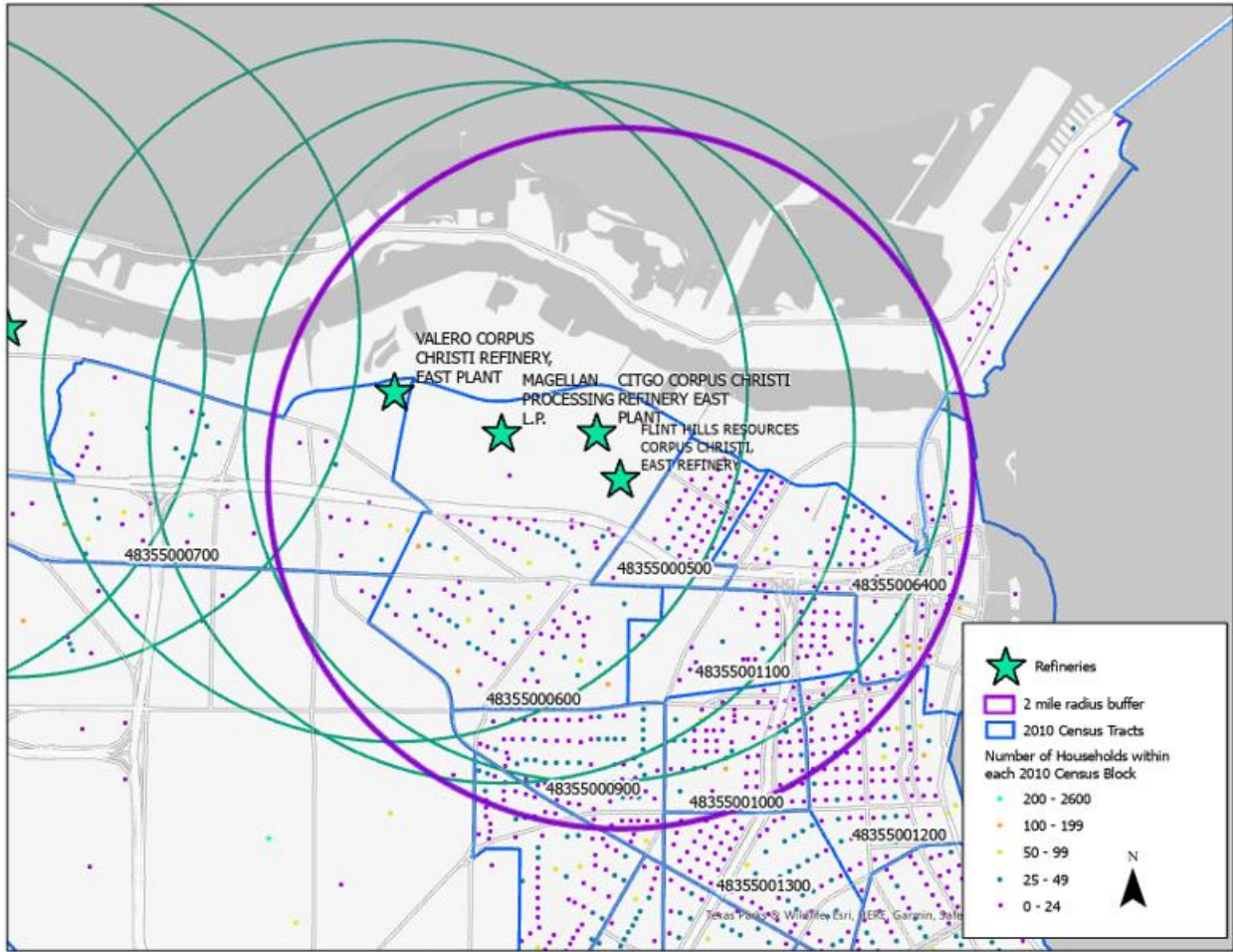


Figure A21. Census Tracts Near Flint Hills Resources Corpus Christi, West Refinery with Two-Mile Radius

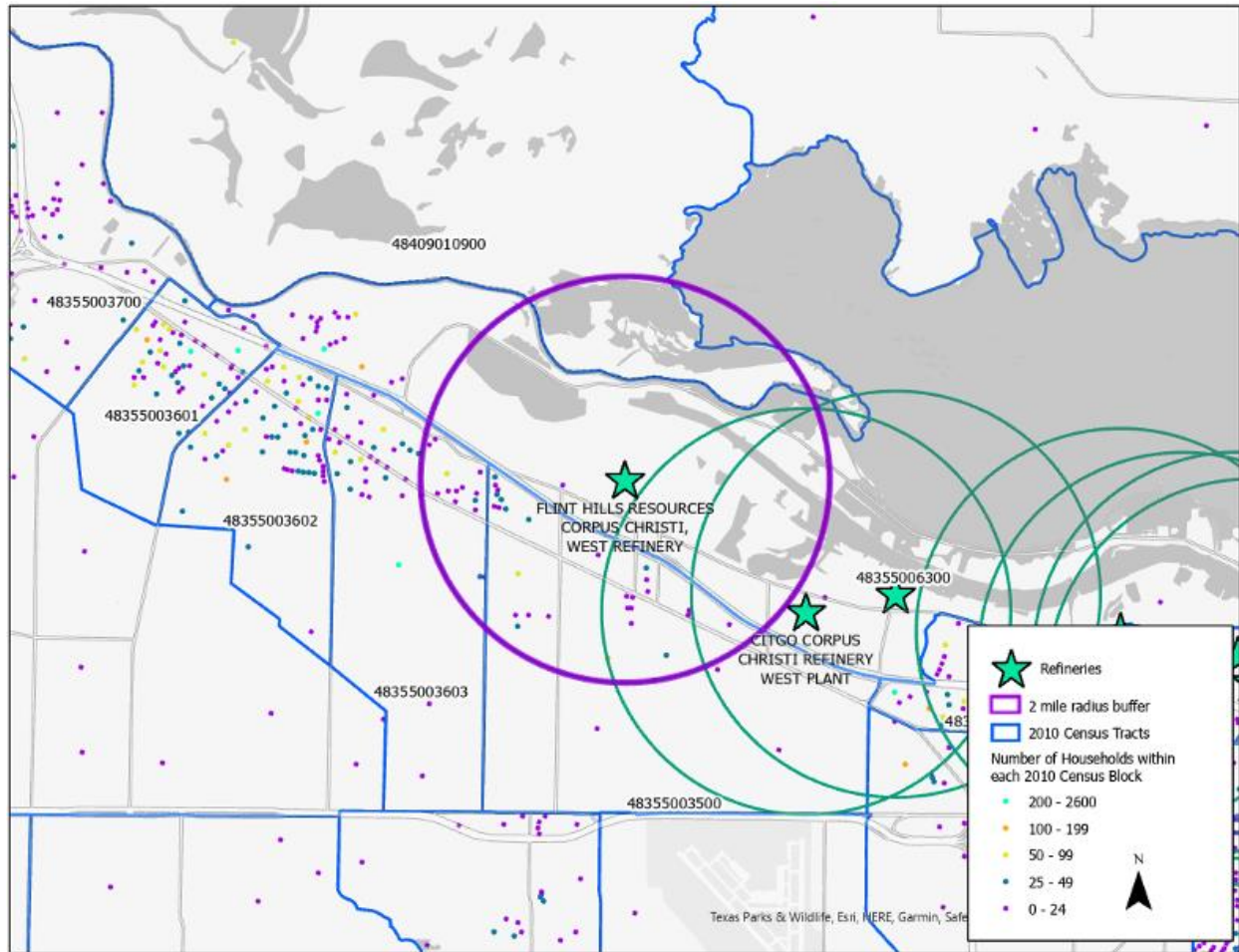


Figure A22. Census Tracts Near Magellan Processing L.P. with Two-Mile Radius

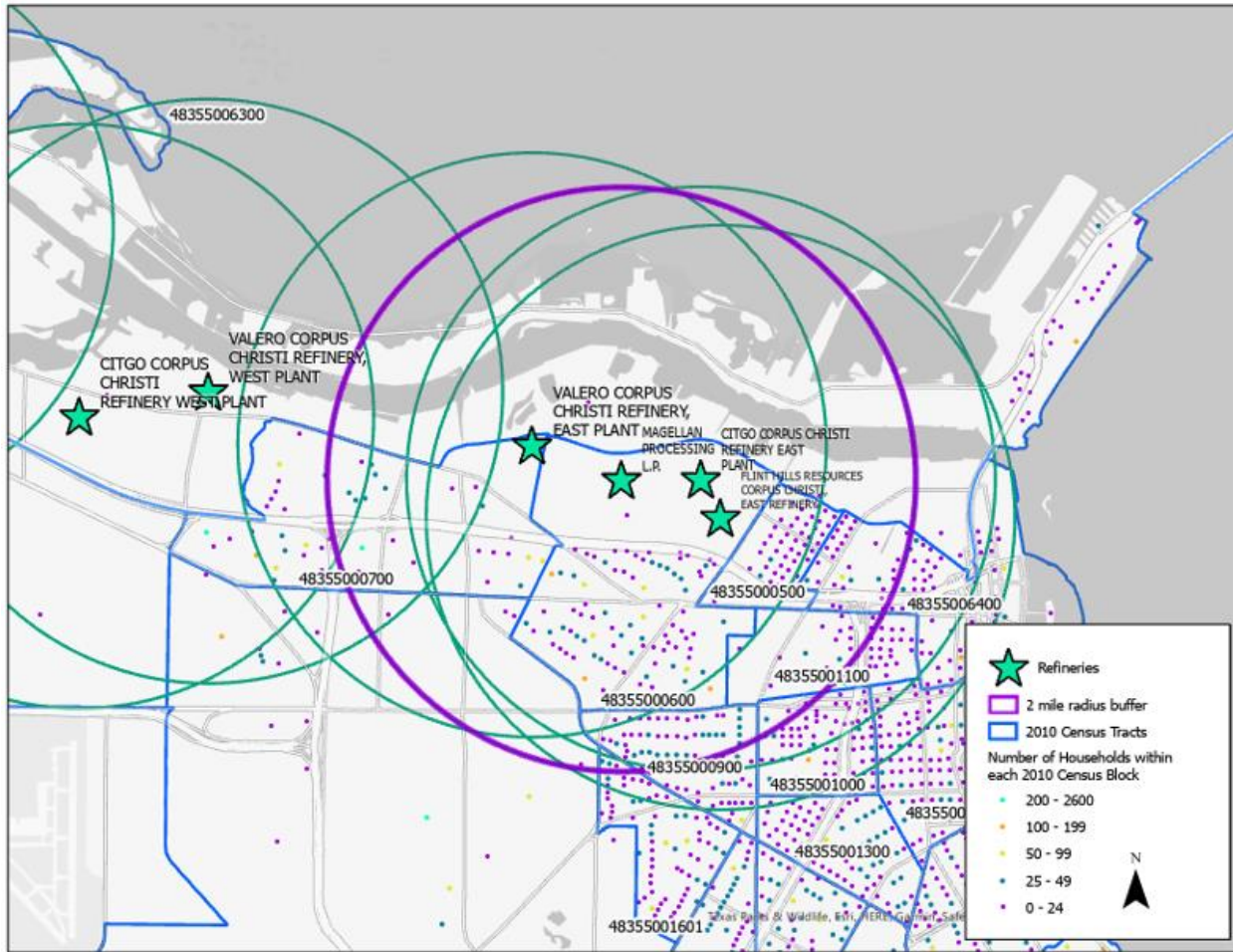


Figure A23. Census Tracts Near Valero Corpus Christi Refinery, East Plant with Two-Mile Radius

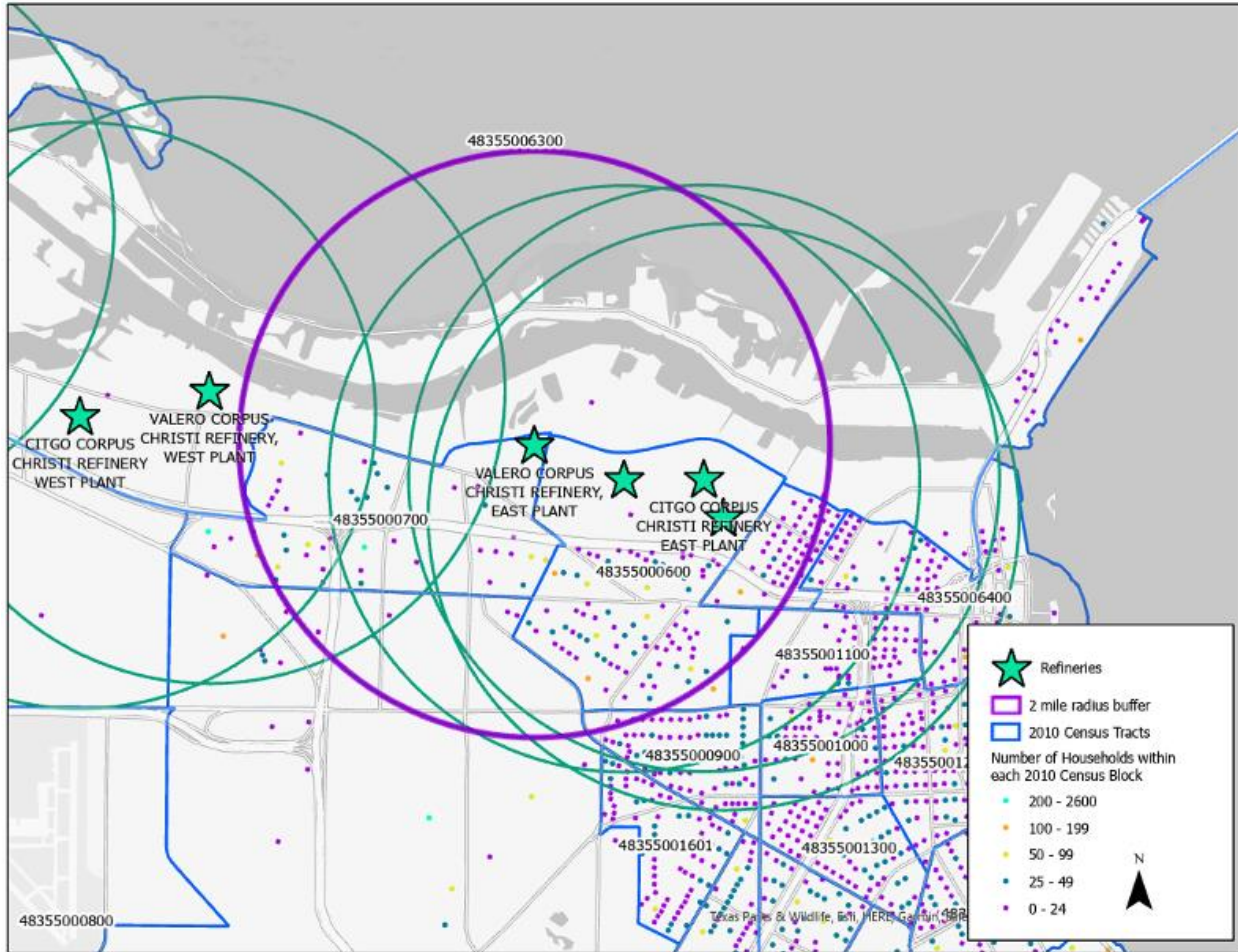


Figure A24. Census Tracts Near Valero McKee Refinery with Two-Mile Radius

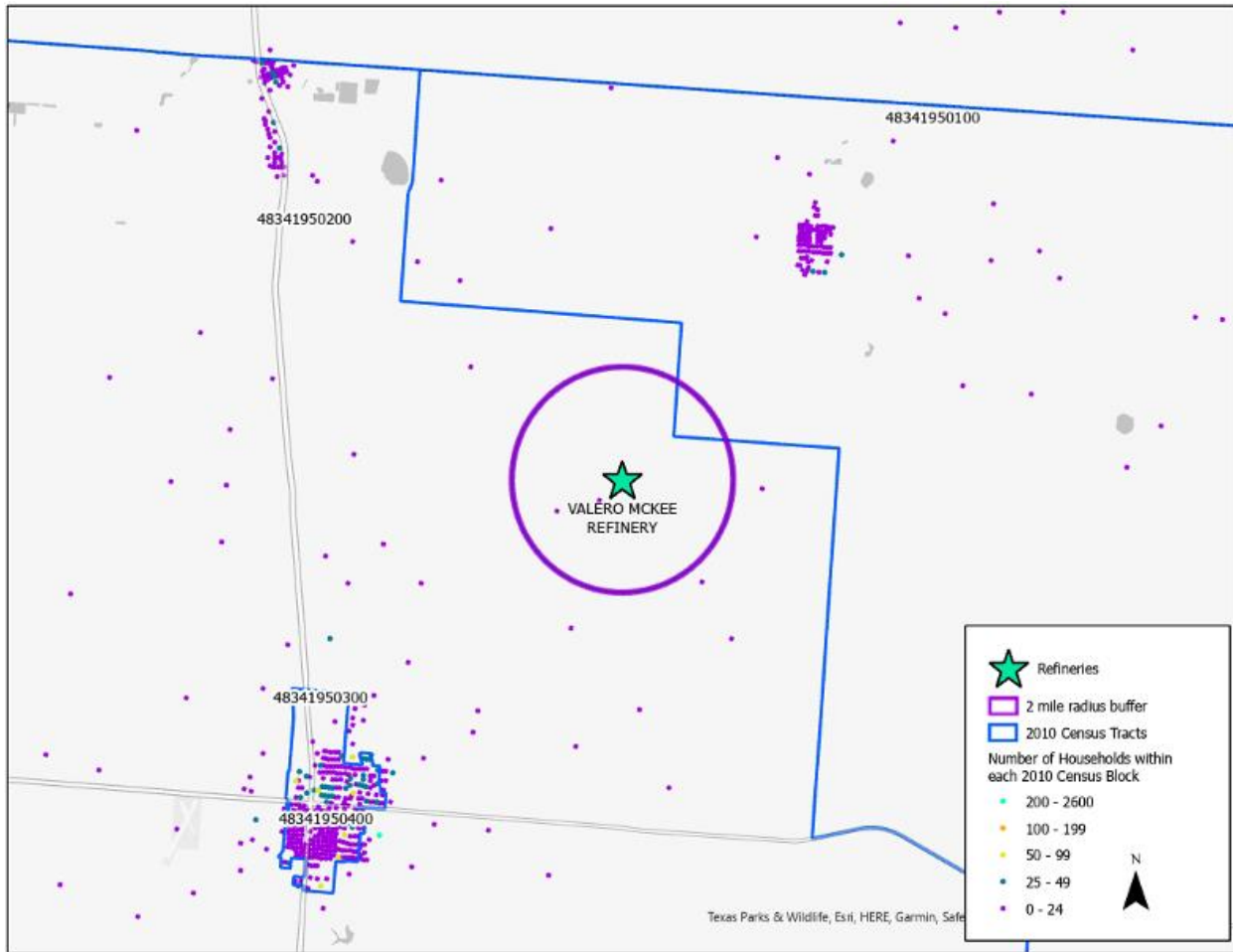


Figure A25. Census Tracts Near Valero Texas City Refinery with Two-Mile Radius

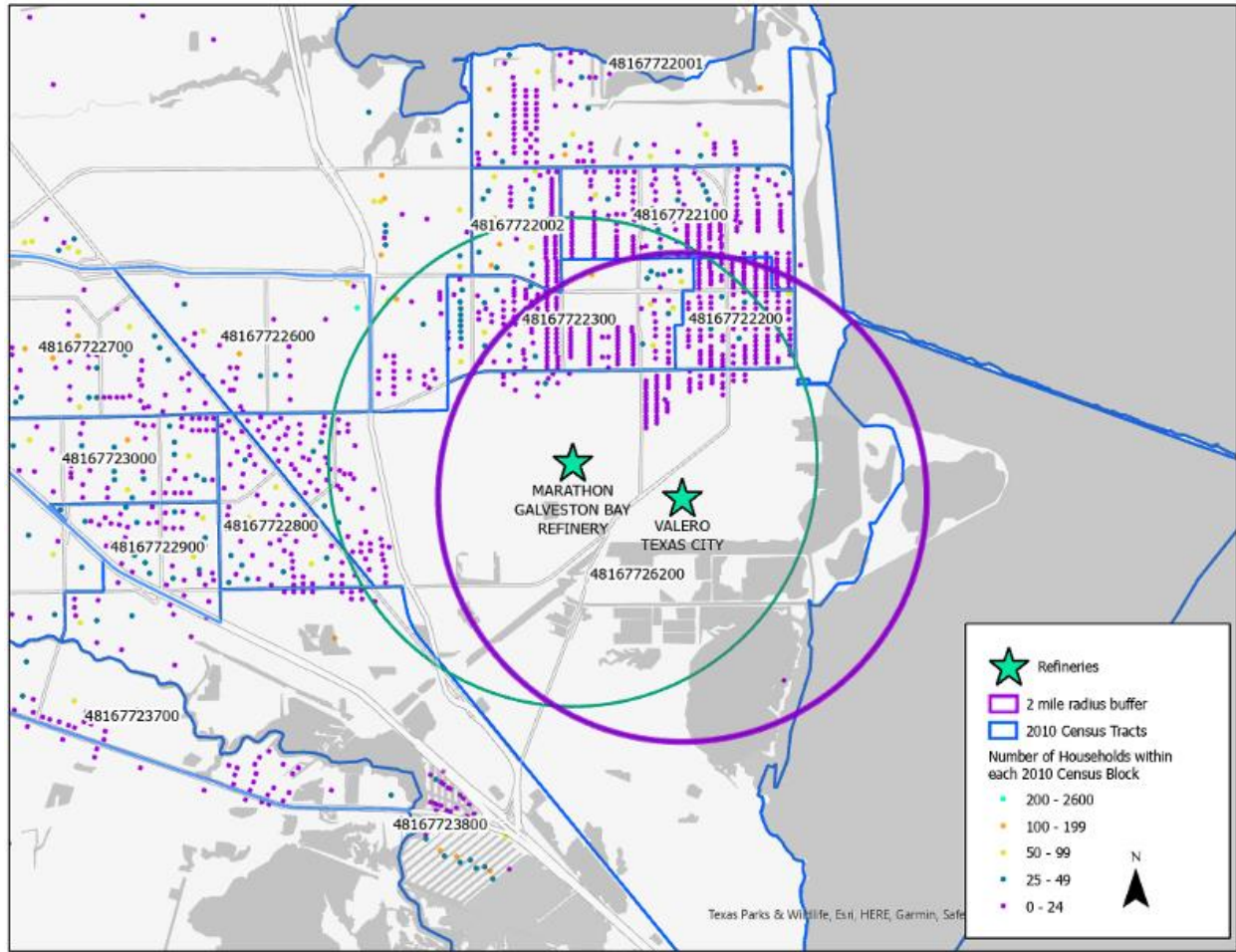
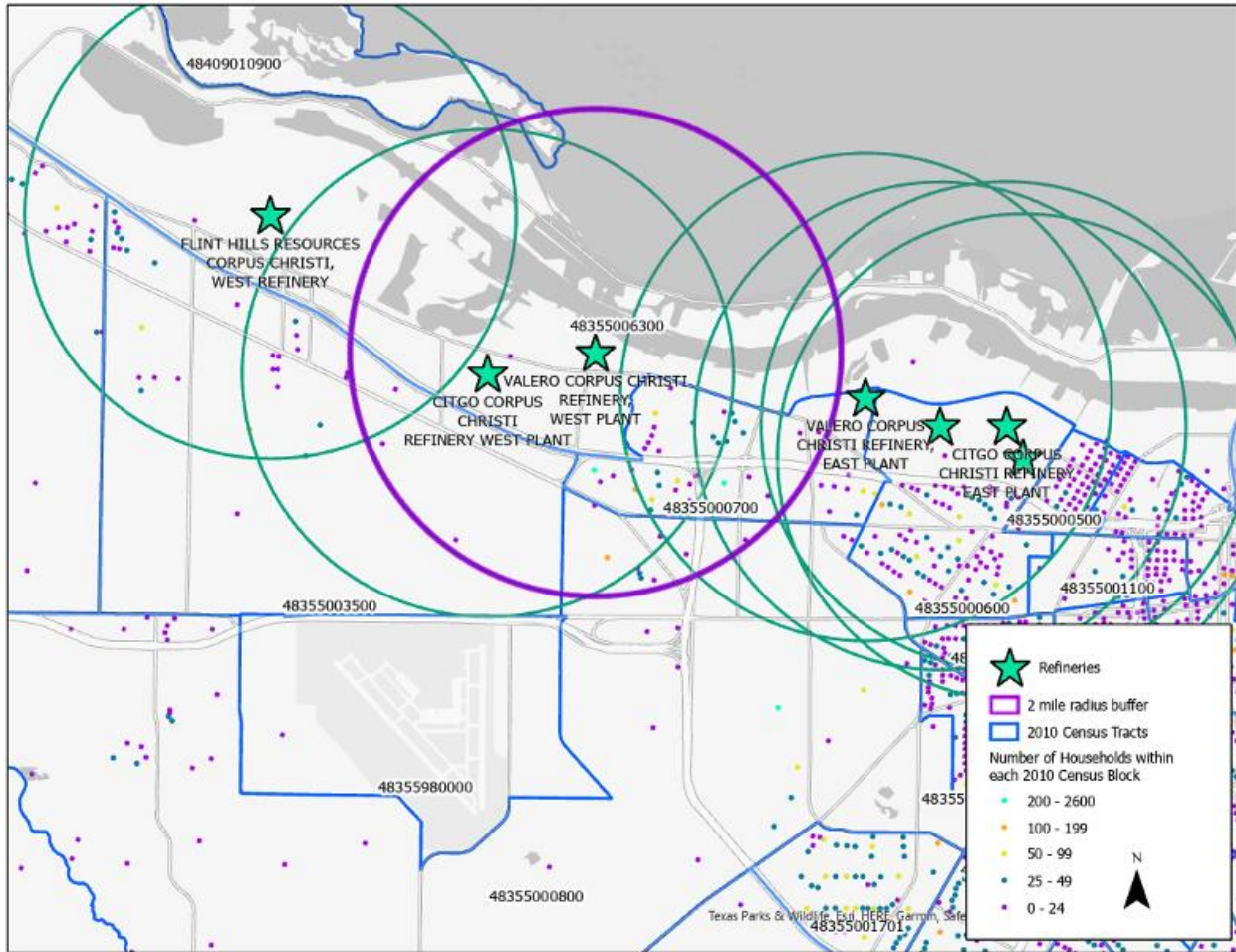


Figure A26. Census Tracts Near Valero Corpus Christi Refinery, West Plant with Two-Mile Radius



Supplemental Tables

ATTACHMENT C

Sensitivity Analyses