Appendix 8A

Environmental Justice Evaluation Approach

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Population Estimation Technique

A uniform 1,250-ft-wide distance from the pipeline centerline (total corridor width of 2,500 ft) was defined as the area of potential effects on human population. A 1,250-ft distance from the pipeline was selected for analytical purposes based upon reasonable catastrophic dispersion modeling of sudden gasoline releases from the pipeline (Chapter 4). This threshold offers a practical, uniform approach to identifying the communities that would experience the most significant human health impacts and also encompasses areas that could be expected to experience other localized effects such as construction impacts, visual intrusion, and noise impacts.

Aerial photography and ground-based surveys were used to determine the number of housing units per linear mile along the 2,500-ft-wide corridor and to provide the basis for estimating population within 1,250 ft from the pipeline (Chapter 4). Data from the 1990 US Census were used to estimate the minority and low-income population percentages for all potentially affected areas. The demographic characteristics of areas of potential effects were examined at the census block group level (using data provided in the 1990 Census) because this is the smallest geographic unit for which data on ethnicity and income levels is provided. These data are required for the environmental justice evaluation.

The 1990 census data were used to generate estimates of percent minority population and percent low-income population for each census block group that completely or partially falls within a defined area of potential effects. The boundaries of areas of potential effects created as described above will not generally correspond with the boundaries of census block groups. For areas of potential effects falling within more than one census block group, the minority and low-income population percentages were based on the proportion of housing units within each census block group. For example, if 100 housing units exist within an area of potential effects in Harris County (272 persons), and 50 of the housing units (136 persons) are in a block group with 15 percent minority population and 50 housing units (136 persons) are in a block group with 45 percent minority population, the estimated minority population for the area of effects is:

(136 persons X 45 percent minority) + (136 persons X 15 percent minority) = 82 minority persons.
The percent minority population for the same area of potential effects is:
82 minority persons / 272 total persons X 100 = 30 percent minority.

A similar procedure was used to estimate percent low-income for each area of potential effects.

Potential Environmental Justice Index

A ranking scheme developed by EPA Region 6 called the potential environmental justice index (EJI) was used as an environmental justice indicator for the proposed project (EPA Region 6, 1996). The EJI is composed of three factors: the percent minority population factor, the percent low-income population factor, and the population density factor. These factors can be used either individually or in combination to evaluate environmental justice concerns of proposed projects.

The population density factor is the population density score for areas of potential effects. The population density score was determined by estimating the total population for each 1-mile pipeline segment (Chapter 5) and evaluating the population density per square mile for each area. Table 8A-1 provides the population density factor scoring criteria.

Table 8A-1. Population Density Factor (POP) Criteria

Population per Square Mile	**Score**
0	0
> 0 and ≤ 200	1
> 200 and ≤ 1,000	2
> 1,000 ≤ 5,000	3
> 5,000	4

The percent minority population score is based on block group data from Summary Tape File 3A (STF3A) of the 1990 Census. The minority population group, based on US Census Bureau tabulation methods and EPA Region 6 guidelines, includes all persons who are Black (Non-Hispanic), Hispanic, Asian American, American Indian, or Alaskan Native as defined in the 1990 US Census (US Census Bureau, 1990). An equivalent definition of minority population is the total of non-white population plus the white Hispanic-origin population (EPA Region 6, 1996, p. 4). Table 8A-2 provides the percent minority population factor scoring criteria.

Table 8A-2. Percent Minority Population (DVMAV) Criteria

Percent (%) Minority Representation	**Score**
≤ 39.4% (≤ Texas state average)	1
> 39.4% and ≤ 52.4%	2
> 52.4% and ≤ 65.4%	3
> 65.4% and ≤ 78.8%	4
> 78.8%	5

The percent low-income population score is based on block group data from STF3A. The low-income population group includes all persons living in households making less than

$15,000 a year in 1990 (EPA Region 6, 1996, p. 4). Table 8A-3 provides the percent low-income population factor scoring criteria.

Table 8A-3. Percent Low-Income Population (DVECO) Criteria

Percent (%) Households below $15k	Score
≤ 27.6% (≤ Texas state average)	1
> 27.6% and ≤ 36.7%	2
> 36.7% and ≤ 45.8%	3
> 45.8% and ≤ 55.2%	4
> 55.2%	5

Sensitivity of Disproportionate Impact Result to Pre-Mitigation Risk-Cutoff Score

First, a series of plots were constructed for the Harris County data to "picture" any patterns evident in the data. For all areas with EJI population factor greater than zero, the relative risk score was sliced various ways (for example, defining categories from 165-170,170-175, 175-180, etc.; or categories from 160-170,170-180, 180-190, etc.) and then plotted the proportion of EJ areas versus the average relative failure probability score for a given slice. (See Figure 8A-1.) These plots show why the chi-square tests are significant for Harris County and suggest that the results probably would not change much (i.e., would remain statistically significant), unless the definition of "high risk" was increased to a point where fewer than 10 Harris County segments remained in the "low relative risk" category. These plots indicate that there is something "real" going on for Harris County – i.e., we can't really explain away the significance as an artifact of the statistical methodology or small counts.

Next, two charts were produced showing the p-values from chi-square tests using risk-cutoff scores ranging from 170 to 215. In other words, for each point on the graph, a chi-square test of independence was performed (as previously described) using the relative failure probability score on the horizontal axis as the cutoff for High/Medium and Low Relative Risk. Figure 8A-2 shows these confidence levels for the entire pipeline and Figure 8-1 shows the confidence levels for only Harris County. A confidence level of 50 percent or higher indicates a statistically significant disproportionality, as defined in the environmental justice evaluation approach in Chapter 8. The charts of the confidence levels combined with the plots of proportion of EJ areas indicate that, for Harris County, risk-cutoff scores between 184 and 189 lead to statistically significant chi-square results as typically defined in scholarly texts (a confidence level of 90 percent or greater). Risk cutoff scores between 181 and 192 lead to statistically significant chi-square results using the conservative 50 percent confidence level defined in Chapter 8.

Within Harris County, the proportion of "EJ" segments that are "high" risk (index less than or equal to 185) is twice as high as for "non-EJ" segments. For EJ segments, the proportion of high risk segments is 61 percent, while for non-EJ segments, the proportion of high risk segments is only 30 percent. When all other counties besides Harris County are considered, the proportion of high risk segments for EJ areas is 39 percent, while the proportion of high risk segments for non-EJ areas is 31 percent.

From another perspective, the *odds* that a segment in Harris County is classified as high risk are almost four times higher for EJ segments than for non-EJ segments. For EJ segments in Harris County, the odds are 1.57 to 1 that the segment is high risk (61 percent high risk relative to a 39 percent low risk). For non-EJ segments in Harris County, the odds are 0.42 to 1 that the segment is high risk (30 percent high risk, relative to 70 percent low risk). The ratio of the odds for the EJ segments to the odds for the non-EJ segment is one way to quantify the difference between EJ populations and non-EJ populations. For Harris County, the odds ratio is 3.67, meaning that the EJ odds are 3.67 times higher than the non-EJ odds. For all other counties besides Harris County, the EJ odds are 0.63 and the non-EJ odds are 0.44, yielding an odds ratio of 1.42.

These odds ratios provide further indication that the data in Harris County may be driving the pipeline-wide disproportionality.

Discussion for Use of Chi-Square as a Screening-level Test of Disproportionality

Most inferential statistical tests are based on samples from a population. In most hypothesis testing situations, conclusions about a population are desired, but because the entire population cannot be evaluated, inferences are made based on a sample. A (null) hypothesis about the population is formulated and a hypothesis test is conducted. The hypothesis test essentially amounts to asking “how consistent are these data with the hypothesis?” or “how likely is it that we would have obtained a sample that looks like this *just due to chance alone* if the hypothesis were really true?” If the entire population could be evaluated, then there would be no need to ask such questions and therefore, no need to perform the hypothesis test. In that case, the population itself could be compared to the hypothesis and the hypothesis could be judged to be true or not true.

With respect to the chi-square test of independence for this EJ study, the point could be raised that we have population data and therefore, the application of hypothesis tests has no meaning. Any observed differences between EJ areas and non-EJ areas are “real” and there is nothing to test statistically. While this is a legitimate point that should be kept in mind when evaluating the results, there is another perspective from which the statistical hypothesis test of independence does have merit: given the number of segments that are EJ or not and the number of segments that the area is high risk or not, we can test whether the breakdown of high risk and low risk by EJ versus non-EJ could have happened just due to chance alone. This is explained in more specific detail below.

A discrepancy is defined as a difference between the proportion of EJ segments that are high risk and the proportion of non-EJ segments that are high risk. A statistically significant difference can be said to exist if the observed difference could not be explained by chance alone. That is, given a fixed number of EJ segments and non-EJ segments and a fixed number of high risk and low risk segments, the statistical test of significance considers all of the ways that segments could have been independently and randomly assigned to be high or low risk. If a discrepancy as large as that observed is unlikely under the hypothesis of random and independent assignment, then the discrepancy is statistically significant.

The argument above explains why it is legitimate to apply the test of independence even to “population” data. However, the test should still be interpreted cautiously, because segments are not independent of each other. In other words, there is spatial autocorrelation in that “nearby” segments have a tendency to be “like their neighbors.” Therefore, if one segment is randomly assigned a risk value (as the null hypothesis presumes is possible), nearby segments are more likely to have similar risk values. This spatial dependence is not taken into account in the chi-square test of independence (whether the data are “population” data or “sample” data). Nonetheless, this kind of evaluation serves as a useful starting point for assessing disparities, and when accompanied by spatial evaluations of the data, can provide useful information to decision makers.

Alternative EJ Evaluation Methods

The purpose of Chapter 8 was to evaluate the potential for disproportionately high and adverse effects of the proposed project. There are two basic approaches for conducting such an evaluation. The approaches differ in assumptions made regarding how effects are distributed among the population in the affected area.

The first approach, called a proximity-based analysis, assumes that effects are equally distributed within the affected area (i.e., the 1,250-ft pipeline buffer). Using this approach, a determination that high and adverse effects disproportionately effect EJ populations is made by comparing the demographic characteristics of the potentially affected population to the demographic characteristics of a suitable reference population, such as the population within a county or state. The finding that the potentially affected population has a significantly higher minority percentage compared to the reference population is consistent with the finding in Section 8.3.4.2, and indicates there is potential for EJ populations to experience disproportionate effects.

The second approach does not assume that effects are equally distributed within the affected area. Instead, geographic data describing the distribution of effects is combined with population and demographic data to determine if effects are unequally distributed among the potentially affected population. This approach analyzes disparity by comparing the potential effects on EJ populations in the affected area to potential effects on non-EJ populations in the affected area. This was the approach taken in Chapter 8, with relative pipeline failure probability scores as the effects. The finding, based on the system-wide analysis, was that areas of EJ concern experience a somewhat higher average relative failure probability than areas of low EJ concern. This finding is consistent with the implied conclusion of the finding that 54 percent of the potentially affected population is minority, in comparison to a Texas average of 39.4 percent.

Regardless of the approach taken, the finding that there is potential for disproportionate impacts to occur requires a more detailed analysis to characterize the geographic extent and degree of those impacts. Determining the geographic extent of potential disproportionate impacts is important because it allows development of specific, targeted mitigation measures. Determining the degree of potential disproportionate impacts is important because the statistical methods applied in Chapter 8 address the statistical significance of results, not whether those results are meaningful (or practically significant). In Chapter 8, the county-level analyses were performed to determine the geographic extent of potential disproportionately high and adverse effects (Section 8.3.4.4), and the Harris County Pre-Mitigation Comparison Analysis was performed to characterize the degree, or amount, of potential disproportionately high and adverse effects (Section 8.3.4.6).

As with the detailed analyses performed in Chapter 8, detailed research using the proximity based approach would lead analysts to identify populated segments in Harris County as the section of the proposed project where disproportionately high and adverse effects are most likely to occur. The approach used in Chapter 8 is preferred over the proximity-based approach, however, because it is based on both demographic patterns and risk distributions, thus allowing analysts to assess whether the extent of potential disproportionately high and adverse effects is meaningful.

Note on Reference Populations

Comparison of minority and low-income population statistics in Section 8.3.1.1 to US averages and statistics in 8.3.1.2 to Texas State average may, at first glance, seem inconsistent. However, EPA EJ guidance suggests comparison of minority and low-income characteristics of potentially affected populations to an appropriate reference population, which is the population for a geographic area of resolution larger than the area of potential effects. In the case of the existing pipeline, the State of Texas provides an appropriate reference population since the pipeline transcends multiple counties, all within Texas. In Section 8.3.1.1, the area of potential effects for socioeconomic impacts includes large areas in the states of Texas, Arizona, and New Mexico and using the State of Texas as a reference population is therefore inappropriate.

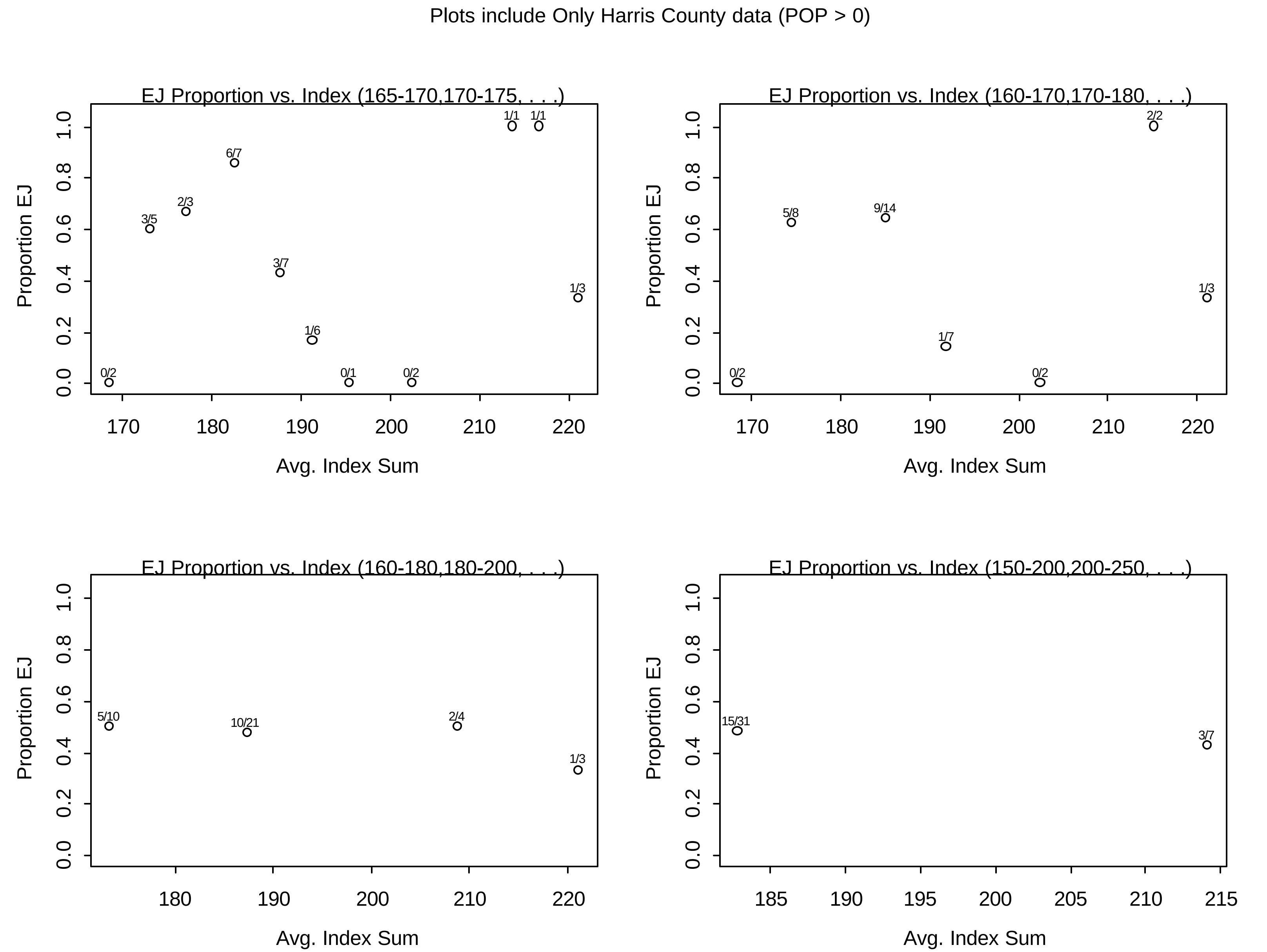

Figure 8A-1. Proportion of Medium to High Environmental Justice Concern Mile Segments by Index Sum Category in Harris County

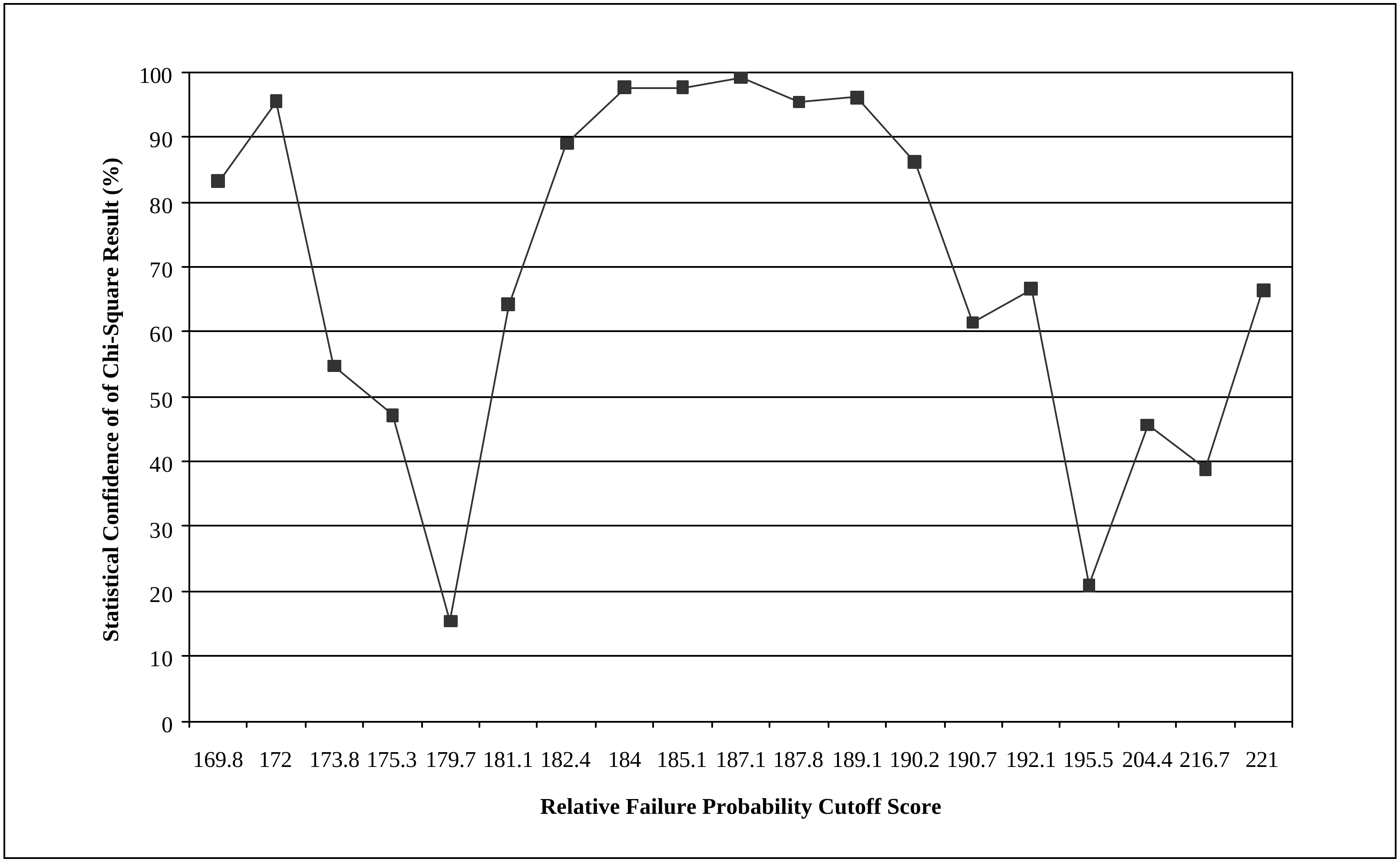

Figure 8A-2. Statistical Significance of Chi-Square Result by Cutoff Score, Longhorn Pipeline System