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ENVIRONMENTAL EQUITY IN SOUTHEAST LOUISIANA: OIL, PEOPLE, POLICY AND THE GEOGRAPHY OF INDUSTRIAL HAZARDS

A Dissertation

Submitted to the Graduate Faculty of the Louisiana State University and Agricultural and Mechanical College in partial fulfillment of the requirements for the degree of Doctor of Philosophy

in

The Department of Geography and Anthropology

by

Scott Allan Hemmerling
B.S., State University of New York at Buffalo, 1992
M.S., University of New Orleans, 1999
May, 2007
ACKNOWLEDGMENTS

I am grateful to so many people for the help and support they have provided me throughout the duration of this process. First and foremost, I would like to thank my advisor, Dr. Craig Colten. His high standards, eye for detail, and desire to eliminate any “lingering peccadilloes” in my writing have made this dissertation something I can be proud of.

I would like to thank the rest of my committee as well. Each of you has contributed to my education and research in several important ways. Dr. Andrew Curtis provided me, a qualitative researcher possessing a talent for GIS, with the confidence and training to take on this largely quantitative project. Dr. Kent Mathewson’s uncanny ability to see to the heart of a project and suggest previously unknown literature has kick-started this research at times when I was unsure of how to move forward. Dr. John Pine’s enthusiasm and eagerness to discuss this project from the outset encouraged me to move forward with it. I would also like to thank the Dean’s Representative, Dr. Christopher White, for bringing his expertise and practical experience to the table.

My heartfelt thanks go out to my family, especially my wife Nicole and daughter Phoebe. You have been the light at the end of the tunnel throughout the good times and the difficult times. You have been there for me throughout this entire process, and I could never have completed this without you. I would also like to thank my parents, Al and Judy Hemmerling. My father has taught me how to do work that brings me happiness and my mother taught me how to accept responsibility and keep on working, even when the times get rough. It took both of these traits to get me to this point. I
would be remiss if I did not thank my in-laws, May and Fallon Lorenz, for the support, prayers, and encouragement throughout.

Several of my fellow graduate students have come and gone, providing invaluable help along the way. I need to thank three in particular, without whom I could not have finished this work. Meg Streiff, Michelle Fischer, and Trushna Parekh helped keep me on track during the beginning, middle, and end of this project, respectively.

Finally, I am extremely grateful to the United States Minerals Management Service and Dr. Harry Luton for funding this research and providing helpful comments and ideas along the way.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACKNOWLEDGMENTS</td>
<td>ii</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>viii</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>xi</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>xviii</td>
</tr>
<tr>
<td>CHAPTER 1 – INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>1.1 Background to the Research Problem</td>
<td>5</td>
</tr>
<tr>
<td>1.2 Environmental Equity Definition and Methodologies</td>
<td>12</td>
</tr>
<tr>
<td>1.2.1 Proximity- and Risk-Based Analyses</td>
<td>15</td>
</tr>
<tr>
<td>1.2.2 Comparative Risk Analysis</td>
<td>17</td>
</tr>
<tr>
<td>1.2.3 Process- and Outcome-Based Analyses</td>
<td>19</td>
</tr>
<tr>
<td>1.3 Southeast Louisiana People and Places</td>
<td>20</td>
</tr>
<tr>
<td>1.3.1 Lafourche Parish</td>
<td>22</td>
</tr>
<tr>
<td>1.3.2 Jefferson Parish</td>
<td>24</td>
</tr>
<tr>
<td>1.3.3 Saint Bernard Parish</td>
<td>30</td>
</tr>
<tr>
<td>1.4 Racial and Ethnic Communities in Southeast Louisiana</td>
<td>32</td>
</tr>
<tr>
<td>1.4.1 Non-Hispanic White Ethnic Groups</td>
<td>34</td>
</tr>
<tr>
<td>1.4.2 African Americans</td>
<td>35</td>
</tr>
<tr>
<td>1.4.3 Native American</td>
<td>36</td>
</tr>
<tr>
<td>1.4.4 Asians</td>
<td>37</td>
</tr>
<tr>
<td>1.4.5 Hispanics</td>
<td>38</td>
</tr>
<tr>
<td>1.5 Outline of the Study</td>
<td>42</td>
</tr>
<tr>
<td>CHAPTER 2 – LITERATURE REVIEW</td>
<td>44</td>
</tr>
<tr>
<td>2.1 Geographical Hazards Research</td>
<td>44</td>
</tr>
<tr>
<td>2.1.1 Natural Hazards Research</td>
<td>46</td>
</tr>
<tr>
<td>2.1.2 Technological Hazards Research</td>
<td>48</td>
</tr>
<tr>
<td>2.1.3 Integrated Hazards Research</td>
<td>50</td>
</tr>
<tr>
<td>2.2 Environmental Justice and Equity Research</td>
<td>51</td>
</tr>
<tr>
<td>2.2.1 Social Justice</td>
<td>52</td>
</tr>
<tr>
<td>2.2.2 Environmental Justice</td>
<td>53</td>
</tr>
<tr>
<td>2.3 Historical Geography and Environmental Issues</td>
<td>58</td>
</tr>
<tr>
<td>2.3.1 Environmental History Research</td>
<td>59</td>
</tr>
<tr>
<td>2.3.2 Environmental History of the Petroleum Industry</td>
<td>63</td>
</tr>
<tr>
<td>2.4 Federal Authority and Environmental Justice</td>
<td>68</td>
</tr>
<tr>
<td>2.4.1 Federal Civil Rights Laws</td>
<td>69</td>
</tr>
<tr>
<td>2.4.2 Federal Environmental Laws</td>
<td>70</td>
</tr>
<tr>
<td>2.5 Conclusion</td>
<td>72</td>
</tr>
</tbody>
</table>
CHAPTER 3 – MEASURING THE ENVIRONMENTAL AND HUMAN IMPACTS OF THE OIL INDUSTRY IN COASTAL LOUISIANA ............................... 74
3.1 Oil and Gas Related Environmental Hazards ...................................................... 75
  3.1.1 Risk and the Frequency of Oil-Related Hazard Events in Southeast Louisiana.. 75
  3.1.2 Oil-Related Activities .................................................................................. 80
    3.1.2.1 Transportation Corridors......................................................................... 82
    3.1.2.2 Onshore and Offshore Oilfields ............................................................... 86
    3.1.2.3 Refineries and Gas Processing Plants ....................................................... 88
    3.1.2.4 Pipelines, Pumping Stations, and Oil Storage Facilities............................ 93
    3.1.2.5 Shipyards and Shipbuilding Yards.............................................................. 95
3.2 Modeling Cumulative Impact ........................................................................... 99
  3.2.1 Geographical Sources and Databases ............................................................ 100
    3.2.1.1 Louisiana State University ATLAS Website .......................................... 102
    3.2.1.2 U.S. Bureau of Census ........................................................................... 102
    3.2.1.3 U.S. Coast Guard National Response Center ........................................... 104
    3.2.1.4 U.S. Department of Transportation ......................................................... 104
    3.2.1.5 U.S. Environmental Protection Agency .................................................... 105
    3.2.1.6 U.S. Geological Survey .......................................................................... 106
    3.2.1.7 U.S. Minerals Management Service ......................................................... 107
  3.2.2 Integrating and Analyzing Data with GIS ..................................................... 107
    3.2.2.1 Proximity-Based Analyses ...................................................................... 108
    3.2.2.2 Risk-Based Analyses .............................................................................. 112
3.3 Statistical Analysis ............................................................................................ 124
3.4 Summary .......................................................................................................... 127

CHAPTER 4 – PETROLEUM, PEOPLE, EQUITY, AND JUSTICE IN SOUTHEAST LOUISIANA’S COASTAL ZONE ........................................ 128
4.1 Hazardousness of Place Model ........................................................................ 128
  4.1.1 Biophysical Vulnerability ............................................................................ 128
    4.1.1.1 Lafourche Parish ..................................................................................... 129
    4.1.1.2 Jefferson Parish ...................................................................................... 132
    4.1.1.3 Saint Bernard Parish .............................................................................. 138
    4.1.1.4 Three Parish Comparison of Biophysical Vulnerability ......................... 142
  4.1.2 Social Vulnerability ..................................................................................... 143
    4.1.2.1 Lafourche Parish ..................................................................................... 143
    4.1.2.2 Jefferson Parish ...................................................................................... 152
    4.1.2.3 Saint Bernard Parish .............................................................................. 161
  4.1.3 Place Vulnerability ..................................................................................... 166
    4.1.3.1 Lafourche Parish ..................................................................................... 166
    4.1.3.2 Jefferson Parish ...................................................................................... 170
    4.1.3.3 Saint Bernard Parish .............................................................................. 177
    4.1.3.4 Three Parish Comparison of Place Vulnerability ....................................... 181
  4.2 Statistical Analysis ......................................................................................... 183
    4.2.1 Lafourche Parish ......................................................................................... 187
    4.2.2 Jefferson Parish .......................................................................................... 194
    4.2.3 Saint Bernard Parish .................................................................................. 200
  4.3 Summary of Findings ..................................................................................... 210
7.2 Population Geography ........................................................................................................ 354
7.3 Public Policy and the Role of Government ..................................................................... 355
7.4 Towards a New Theoretical Framework......................................................................... 358

CHAPTER 8 – POSTSCRIPT: KATRINA, RITA, AND THE GEOGRAPHY OF
STORM-RELATED HAZARDOUS RELEASES ..................................................................... 363
8.1 Hurricane Katrina and Petroleum-Related Releases ...................................................... 364
  8.1.1 Lafourche Parish ...................................................................................................... 366
  8.1.2 Jefferson Parish ........................................................................................................ 371
  8.1.3 Saint Bernard Parish ............................................................................................... 377
8.2 Environmental Equity and Floodwater Sampling Techniques .................................... 384
8.3 The Need for Further Analysis ..................................................................................... 386

LITERATURE CITED ............................................................................................................. 388

VITA ..................................................................................................................................... 413
1. Racial and Ethnic Characteristics of Selected Communities in Lafourche Parish, Louisiana........................................................................................................................................................................................................ 25
2. Economic Characteristics of Selected Communities in Lafourche Parish, Louisiana........................................................................................................................................................................................................ 25
3. Racial and Ethnic Characteristics of Selected Communities in Jefferson Parish, Louisiana........................................................................................................................................................................................................ 26
4. Economic Characteristics of Selected Communities in Jefferson Parish, Louisiana........................................................................................................................................................................................................ 27
5. Racial and Ethnic Characteristics of Selected Communities in Saint Bernard Parish, Louisiana........................................................................................................................................................................................................ 33
6. Economic Characteristics of Selected Communities in Saint Bernard Parish, Louisiana........................................................................................................................................................................................................ 33
7. Annual Rate of Occurrence of Identified Hazards for Lafourche Parish, Louisiana........................................................................................................................................................................................................ 78
8. Annual Rate of Occurrence of Identified Hazards for Jefferson Parish, Louisiana........................................................................................................................................................................................................ 78
9. Annual Rate of Occurrence of Identified Hazards for Saint Bernard Parish, Louisiana........................................................................................................................................................................................................ 78
10. Total Number of Fixed-Facility Chemical Releases by Location, 1999-2003 .................................................................................................................................................................................................................. 79
11. List of Mobile Source Air Toxics (MSATs)................................................................................................................................................................................................................................................................. 83
12. Produced Water Effluent Concentrations – Gulf of Mexico (Coastal Waters)........................................................................................................................................................................................................ 87
13. Components Found in Natural Gas................................................................................................................................................................................................................................................................................................. 91
14. Material Inputs and Potential Pollutant Outputs for the Shipbuilding and Repair Industry ................................................................................................................................................................................................................................................................. 97
15. Common Refinery Releases and Associated Toxicity Values.............................................................................................................................................................................................................................................. 118
16. Common Shipyard Releases and Associated Toxicity Values .............................................................................................................................................................................................................................................. 119
17. Common Petroleum Bulk Storage Releases and Associated Toxicity Values .............................................................................................................................................................................................................................................. 119
18. Common Natural Gas Liquids Releases and Associated Toxicity Values .............................................................................................................................................................................................................................................. 120
19. Common Oil and Gas Field Air Releases and Associated Toxicity Values .............................................................................................................................................................................................................................................. 120
20. Common Roadway Air Releases and Associated Toxicity Values .............................................................................................................................................................................................................................................. 121
21. Common Oil and Gas Field Waste Pit Releases and Associated Toxicity Values .......... 121
22. Comparison of Population for Selected OCS-Related Infrastructure in Lafourche Parish, Louisiana ................................................................................................................................................................. 189
23. Comparison of Population Proportions for OCS-Related Hazard Deciles in Lafourche Parish, Louisiana ............................................................................................................................................... 192
24. Results of Stepwise Multiple Regression Analysis for Lafourche Parish, Louisiana with the Hazardousness of Place Rating as the Dependant Variable ......................................................................................... 193
25. Comparison of Population Proportions for Onshore Oil-Related Hazard Deciles in Jefferson Parish, Louisiana ........................................................................................................................................ 198
26. Results of Stepwise Multiple Regression Analysis for Jefferson Parish, Louisiana with the Hazardousness of Place Rating as the Dependant Variable .................................................................................. 199
27. Comparison of Population Proportions for Oil Refining-Related Hazard Deciles in Saint Bernard Parish, Louisiana ........................................................................................................................................ 203
28. Comparison of Population for Selected Oil Refining-Related Infrastructure in Saint Bernard Parish, Louisiana ........................................................................................................................................ 205
29. Results of Stepwise Multiple Regression Analysis for Saint Bernard Parish, Louisiana with the Hazardousness of Place Rating as the Dependant Variable ........................................................................ 207
30. Odds Ratio Values of Potentially Impacted Wildlife Habitat in Lafourche Parish, Louisiana with Census Block Race Variables: White, African American, Native American, Asian, and Hispanic ......................................................................................................................... 235
31. Odds Ratio Values of Potentially Impacted Wildlife Habitat in Jefferson Parish, Louisiana with Census Block Race Variables: White, African American, Native American, Asian, and Hispanic ......................................................................................................................... 243
32. Odds Ratio Values of Potentially Impacted Wildlife Habitat in Saint Bernard Parish, Louisiana with Census Block Race Variables: White, African American, Native American, Asian, and Hispanic ......................................................................................................................... 251
33. Results of Stepwise Multiple Regression Analysis for Lafourche, Jefferson, and Saint Bernard Parishes, Louisiana with Census Tract In-Migration as the Dependant Variable .......... 315
34. Results of Stepwise Multiple Regression Analysis for Lafourche Parish, Louisiana with Census Tract In-Migration as the Dependant Variable ......................................................................................................... 320
35. Results of Stepwise Multiple Regression Analysis for Jefferson Parish, Louisiana with Census Tract In-Migration as the Dependant Variable ................................................................. 328

36. Results of Stepwise Multiple Regression Analysis for the East Bank of Jefferson Parish, Louisiana with Census Tract In-Migration as the Dependant Variable .............................................. 336

37. Results of Stepwise Multiple Regression Analysis for the West Bank of Jefferson Parish, Louisiana with Census Tract In-Migration as the Dependant Variable .............................................. 339

38. Results of Stepwise Multiple Regression Analysis for Saint Bernard Parish, Louisiana with Census Tract In-Migration as the Dependant Variable ............................................................... 342
LIST OF FIGURES

1. Study Area ................................................................................................................................... 21
2. Census Designated Places and Other Populated Areas, Lafourche Parish, Louisiana .............. 23
3. Census Designated Places and Other Populated Areas, Jefferson Parish, Louisiana............. 29
4. Census Designated Places and Other Populated Areas, St. Bernard Parish, Louisiana......... 31
5. Proximity-Based Hazardscape of Lafourche Parish, Louisiana ........................................... 130
6. Risk-Based Hazardscape of Lafourche Parish, Louisiana....................................................... 133
7. Proximity-Based Hazardscape of Jefferson Parish, Louisiana................................................. 134
8. Risk-Based Hazardscape of Jefferson Parish, Louisiana.......................................................... 135
9. Proximity-Based Hazardscape of Saint Bernard Parish, Louisiana......................................... 139
10. Risk-Based Hazardscape of Saint Bernard Parish, Louisiana.................................................. 140
11. Distribution of African American Population by Census Block in Lafourche Parish, Louisiana, 2000......................................................................................................................... 144
12. Distribution of Native American Population by Census Block in Lafourche Parish, Louisiana, 2000.......................................................................................................................... 145
13. Distribution of Asian Population by Census Block in Lafourche Parish, Louisiana, 2000 ................................................................................................................................. 146
14. Distribution of Hispanic Population by Census Block in Lafourche Parish, Louisiana, 2000 ................................................................................................................................. 147
15. Per Capita Income by Census Block Group in Lafourche Parish, Louisiana, 2000............. 149
16. Median Contract Rent by Census Block Group in Lafourche Parish, Louisiana, 2000 ...... 150
17. Median House Value by Census Block Group in Lafourche Parish, Louisiana, 2000......... 151
19. Distribution of Native American Population by Census Block in Jefferson Parish, Louisiana, 2000.......................................................................................................................... 154
20. Distribution of Asian Population by Census Block in Jefferson Parish, Louisiana, 2000... 155

21. Distribution of Hispanic Population by Census Block in Jefferson Parish, Louisiana, 2000............................................................................................................................................. 156

22. Per Capita Income by Census Block Group in Jefferson Parish, Louisiana, 2000............ 158

23. Median House Value by Census Block Group in Jefferson Parish, Louisiana, 2000........ 159

24. Median Contract Rent by Census Block Group in Jefferson Parish, Louisiana, 2000 ...... 160

25. Distribution of African American Population by Census Block in Saint Bernard Parish, Louisiana, 2000............................................................................................................................................. 162

26. Distribution of Native American Population by Census Block in Saint Bernard Parish, Louisiana, 2000............................................................................................................................................. 163

27. Distribution of Asian Population by Census Block in Saint Bernard Parish, Louisiana, 2000............................................................................................................................................. 164

28. Distribution of Hispanic Population by Census Block in Saint Bernard Parish, Louisiana, 2000............................................................................................................................................. 165

29. Per Capita Income by Census Block Group in Saint Bernard Parish, Louisiana, 2000 ..... 167

30. Median House Value by Census Block Group in Saint Bernard Parish, Louisiana, 2000 .. 168

31. Median Contract Rent by Census Block Group in Saint Bernard Parish, Louisiana, 2000 169

32. Proportion of the Population Residing in OCS-Related Hazardousness Deciles in Lafourche Parish, Louisiana.......................................................................................................................... 171

33. Minority Population by Census Block and OCS-Related Infrastructure in Larose, Louisiana............................................................................................................................................. 173

34. Minority Population by Census Block and OCS-Related Infrastructure in Golden Meadow, Louisiana............................................................................................................................................. 174

35. Minority Population by Census Block and OCS-Related Infrastructure in Lockport, Louisiana............................................................................................................................................. 175

36. Minority Population by Census Block and OCS-Related Infrastructure in Grandbois, Louisiana............................................................................................................................................. 176
37. Proportion of the Population Residing in Onshore Oil-Related Hazardous Deciles in Jefferson Parish, Louisiana ................................................................. 178

38. Minority Population by Census Block and Oil-Related Infrastructure in Avondale, Louisiana ................................................................. 179

39. Minority Population by Census Block and Oil-Related Infrastructure in Barataria, Louisiana ................................................................. 180

40. Proportion of the Population Residing in Refining-Related Hazardousness Deciles in Saint Bernard Parish, Louisiana .................................................. 182

41. Minority Population by Census Block and Oil Refining Infrastructure in Chalmette, Louisiana ................................................................. 184

42. Minority Population by Census Block and Oil Refining Infrastructure in Toca, Louisiana ................................................................. 185

43. Minority Population by Census Block and Oil Refining Infrastructure in Yscloskey, Louisiana ................................................................. 186

44. Odds Ratios for Lafourche Parish, Louisiana OCS-Related Infrastructure ................................................................. 188

45. Odds Ratios for Lafourche Parish, Louisiana OCS-Related Hazardousness Deciles ................................................................. 191

46. Household Income by Block Group and Proximity to OCS-Related Infrastructure in Lockport, Louisiana ................................................................. 195

47. Household Income by Block Group and Proximity to OCS-Related Infrastructure in Larose, Louisiana ................................................................. 196

48. Odds Ratios for Jefferson Parish, Louisiana Onshore Oil-Related Hazardousness Deciles ...................................................................................... 197

49. Household Income by Block Group and Proximity to Onshore Oil-Related Infrastructure in Avondale, Louisiana ................................................................. 201

50. Odds Ratios for Saint Bernard Parish, Louisiana Oil Refining-Related Hazardousness Deciles ...................................................................................... 202

51. Odds Ratios for Saint Bernard Parish, Louisiana Oil Refining-Related Infrastructure ................................................................. 204

52. Household Income by Block Group and Proximity to Oil Refining-Related Infrastructure in Chalmette, Louisiana ................................................................. 208
53. Household Income by Block Group and Proximity to Oil Refining-Related Infrastructure in Toca, Louisiana

54. Locations of Potentially Impacted Trapping Zones in Lafourche Parish, Louisiana

55. Locations of Potentially Impacted Hunting Zones in Lafourche Parish, Louisiana

56. Locations of Potentially Impacted Fishing Zones in Lafourche Parish, Louisiana

57. Environmental Management Units in Lafourche Parish, Louisiana

58. Locations of Potentially Impacted Hunting Zones in Jefferson Parish, Louisiana

59. Locations of Potentially Impacted Trapping Zones in Jefferson Parish, Louisiana

60. Locations of Potentially Impacted Fishing Zones in Jefferson Parish, Louisiana

61. Environmental Management Units in Jefferson Parish, Louisiana

62. Locations of Potentially Impacted Hunting Zones in Saint Bernard Parish, Louisiana

63. Locations of Potentially Impacted Trapping Zones in Saint Bernard Parish, Louisiana

64. Locations of Potentially Impacted Fishing Zones in Saint Bernard Parish, Louisiana

65. Coast 2050 Region 1 and 2 Mapping Unit Boundaries in Saint Bernard Parish, Louisiana

66. Areas of Historical Refinery Development in Saint Bernard Parish, Louisiana, 1937

67. Wards with Significant African American Population, 1930, St Bernard Parish, Louisiana

68. Wards with Significant African American Population, 1940, Jefferson Parish, Louisiana

69. Areas of Historical Shipping Development in Larose, Lafourche Parish, Louisiana, 1926

70. Areas of Historical Shipping Development in Larose, Lafourche Parish, Louisiana, 1932

71. Wards with Significant Non-African American Population, 1940, Jefferson Parish, Louisiana

72. Historical Development of Onshore Oil Fields, Jefferson Parish, Louisiana
73. Areas of Historical Petroleum Storage Development in Marrero, Jefferson Parish, Louisiana, 1935........................................................................................................................................................................271

74. Areas of Historical Petroleum Storage Development in Westwego, Jefferson Parish, Louisiana, 1939........................................................................................................................................................................272

75. Areas of Historical Petroleum Storage Development in Avondale, Jefferson Parish, Louisiana, 1940........................................................................................................................................................................274

76. Areas of Historical Refinery Development in Saint Bernard Parish, Louisiana, 1951........................................................................................................................................................................277

77. Areas of Historical Petroleum Storage Development in Marrero, Jefferson Parish, Louisiana, 1951........................................................................................................................................................................278

78. Areas of Historical Petroleum Storage Development in Westwego, Jefferson Parish, Louisiana, 1951........................................................................................................................................................................279


80. Areas of Historical Petroleum Storage Development in Avondale, Jefferson Parish, Louisiana, 1951........................................................................................................................................................................282

81. Areas of Historical Shipyard Development in Golden Meadow, Lafourche Parish, Louisiana, 1944........................................................................................................................................................................284

82. Areas of Historical Gas Processing in Toca, Saint Bernard Parish, Louisiana, 1951........................................................................................................................................................................285

83. Areas of Historical Gas Processing in Yscloskey, Saint Bernard Parish, Louisiana, 1957........................................................................................................................................................................286

84. Wards with Significant African American Population, 1940, Lafourche Parish, Louisiana........................................................................................................................................................................287

85. Wards with Significant Non-African American Minority Population, 1940, Lafourche Parish, Louisiana........................................................................................................................................................................289

86. Wards with Significant Non-African American Minority Population, 1960, Lafourche Parish, Louisiana........................................................................................................................................................................290

87. Areas of Historical Shipping Development in Larose, Lafourche Parish, Louisiana, 1963........................................................................................................................................................................291

88. Areas of Historical Shipping Development in Golden Meadow, Lafourche Parish, Louisiana, 1964........................................................................................................................................................................292
89. Areas of Historical Shipping Development in Golden Meadow, Lafourche Parish, Louisiana, 1990 ................................................................. 296

90. Areas of Historical Gas Processing in Toca, Saint Bernard Parish, Louisiana, 1989 ........ 297

91. Areas of Historical Gas Processing in Yscloskey, Saint Bernard Parish, Louisiana, 1989 ................................................................. 298

92. Areas of Historical Refinery Development in Saint Bernard Parish, Louisiana, 1989 .... 299

93. Areas of Historical Petroleum Storage Development in Jefferson Parish, Louisiana, 1990 ................................................................. 300

94. Areas of Historical Petroleum Storage Development in Avondale, Jefferson Parish, Louisiana, 1990 ................................................................. 301


98. Migration Patterns of the Native American Population, 1995-2000, Lafourche Parish, Louisiana ........................................................................ 325


104. Migration Patterns of the Native American Population, 1995-2000, Jefferson Parish, Louisiana ........................................................................ 335


110. Hurricane Katrina Damage Estimates, Port Fourchon, Lafourche Parish, Louisiana

111. Hurricane Katrina Damage Estimates, Golden Meadow, Lafourche Parish, Louisiana

112. Hurricane Katrina Damage Estimates, Avondale, Jefferson Parish, Louisiana

113. Hurricane Katrina Damage Estimates, Barataria, Jefferson Parish, Louisiana

114. Hurricane Katrina Damage Estimates, Grand Isle, Jefferson Parish, Louisiana

115. Hurricane Katrina Damage Estimates, Ysckoskey, Saint Bernard Parish, Louisiana

116. Hurricane Katrina Damage Estimates, Toca, Saint Bernard Parish, Louisiana

117. Hurricane Katrina Damage Estimates, Chalmette, Saint Bernard Parish, Louisiana
ABSTRACT

This dissertation explores issues and concepts underlying the creation of Louisiana’s rural-industrial petrochemical complex as they relate to environmental equity and industrial development’s deleterious consequences. Cumulative hazards models examine the distribution of technological hazards associated with petroleum extraction and processing and explores how this varies among different socioeconomic groups in three coastal Louisiana parishes. Considerable onshore oil extraction occurs in Jefferson Parish. Lafourche Parish is the primary land-based supply center for the majority of the offshore oil activity in the Gulf of Mexico. The refineries of Saint Bernard Parish represent the endpoint of the flow of raw product and the staging point from which the refined product is transported to the wider market. Transportation infrastructure and a web of oil and gas pipelines connect these three parishes to each other and the areas beyond.

The hazards models found a range of potential impacts affecting a wide swath of communities. Chalmette, for example, faces the greatest immediate risk from Saint Bernard Parish’s two large refineries and has the lowest proportion of minority residents within the study area. Conversely, Houma Indians residing on the wetland fringe stand at risk from the petroleum industry, both directly, through potential residential exposure, and indirectly, through potentially impacted hunting and fishing grounds. These results highlight the importance of using a fine grained localized environmental equity model.

Historic process-based analyses examined the development of environmental inequity in communities identified by the hazards models. The historical development of environmental inequity is an extremely dynamic process. Generally, industry arrived first followed by population. After the initial siting, industry and population grew concomitantly. Industry
growth continued even after the communities became predominantly minority or low-income. This research examined regional migration patterns over the last decade to explore why people move into potentially hazardous areas. Statistical analysis reveals that historic segregation patterns are a primary factor in most population movement. Additionally, populations are moving into neighborhoods proximate to their place of employment.

Finally, this dissertation describes how the results achieved compare to those of other environmental equity studies and identifies six tenets of a practical, attainable, place-specific model of environmental equity.
CHAPTER 1 – INTRODUCTION

Environmental equity has become an increasingly important issue in terms of siting industries, hazardous facilities, and other undesirable land uses. On February 11, 1994, President William Clinton issued Executive Order 12898, affirming the importance of the environmental equity issue by directing federal agencies and regulated industries to assess whether their actions have disproportionate environmental effects on minorities or low-income populations. The environmental effects encompassed by the order include human health, social, and economic consequences.

Though environmental equity concerns are not limited to any particular region, the impacts are concentrated in areas that have experienced rapid and largely unregulated industrial growth. Without regulation, the economic incentives for industry to locate on inexpensive land often results in the disproportionate siting of facilities in low-income or minority neighborhoods. In the United States, researchers have documented many cases of environmental inequity in the recently industrialized South, which experienced a period of relative economic expansion well beyond the national average in the years following the Second World War. Many of these formerly rural southern states were determined to draw industry to the region and placed relatively few regulatory controls on growth (Cobb 1984, 1993). This was particularly true in those states lying on the Gulf of Mexico, where the petroleum and petrochemical industries have spearheaded the drive to industrialization, transforming much of the rural landscape into what environmental historian Brian Black calls an industrial “factoriescape of oil” (Black 2000). In Louisiana, with its substantial minority and low-income population, the development of such a petroleum-industrial complex dramatically raises the threat of environmental inequity.
Oil and gas production has dominated the economy of Louisiana throughout the twentieth century. Even as onshore reserves have dwindled, outer continental shelf (OCS) deepwater extraction activities have commenced and developed to the point where coastal Louisiana is the dominant offshore oil producing state in the country. The extraction sites may have shifted offshore, but onshore logistical chains still link and maintain the offshore operations. As a result, an extensive network of petroleum-related industrial facilities has developed within southeast Louisiana’s coastal zone. The infrastructure necessary to extract, transfer, and process petroleum products has come to dominate the landscape of much of southeast Louisiana, with rural communities bearing the brunt of this industrial development. The rural byways of Louisiana have historically been the site of most of the petroleum-related development, but Baton Rouge and New Orleans remain the ghosts in the machine, so to speak. For these large urban centers have “tremendous influence on policy and practice as they relate to environmental change” even beyond their boundaries (Colten 2000: 3). The economic growth of these cities may in fact come at the expense of neighboring smaller communities and the rural dwellers of southeast Louisiana, where many minority and low-income populations live.

This dissertation will examine the potential environmental equity impacts of the petroleum extraction and processing industries in three rural southeast Louisiana parishes: Jefferson, Lafourche, and Saint Bernard. I elected to examine individual parishes rather than the entire region for two primary reasons. The first relates to the distribution of oil- and gas-related infrastructure. The impacts of the petroleum industry are not distributed evenly across the region. Certain locations have, through time, become nodes of activity for specific sectors of the petroleum industry. The onshore extraction industry centers on oil and gas fields. The offshore extraction industry centers on ports and supply bases. The processing industry centers on crude
oil refineries. Potential environmental equity impacts are concentrated around these nodes of activity. This research utilizes individual parishes to more accurately gauge the local, community-level impacts of these industrial concentrations.

The second primary reason to focus on single parishes relates to population distributions. This research uses a relative population threshold to determine minority or low-income population significance (USEPA 1998). Different reference frames can lead to different interpretations. The reference area should reflect the local geography. The impacts of oil and gas extraction and processing takes place in rural locales with a relatively small population density. Using a multi-county area as a reference point would artificially dilute the total population and mask the potential impact of industry on small rural communities. For this reason, I have elected to use parish population as the reference frame.

Each of the three parishes examined in this dissertation possess a specialized industrial geography unique to a specific sector of the petroleum industry. Jefferson Parish contains several large oil fields, including Lafitte Field, the oldest producing field in southeast Louisiana. The urbanized northern portion of the parish developed an extensive petroleum bulk storage industry along the Mississippi River. Lafourche Parish is the primary land-based supply center for the majority of the offshore oil and gas activity occurring in the Gulf of Mexico. Finally, Saint Bernard Parish contains two large oil refineries and two large gas processing plants. Transportation infrastructure and a web of oil and gas pipelines connect these three parishes to each other and areas beyond. The flows and linkages of oil and gas join all these parishes, yet each is unique in how it is impacted by the industry. This study will delve into many of the issues and concepts underlying the creation of Louisiana’s rural-industrial petrochemical landscape, particularly as they relate to environmental equity and industrial development’s deleterious consequences.
The petroleum industry is, as environmental historian Hugh Gorman says, an inherently messy business (Gorman 2001). As a result, the siting of petroleum-related industrial facilities represents one of the most important issues in the environmental history of southeast Louisiana. Historically, public officials and industry have used utilitarian reasoning to justify siting decisions, claiming that their decisions bring the greatest benefit to the greatest number of people. As Christian Hunold and Iris Marion Young state, such straightforward utilitarian arguments are incapable of dealing with the complexity of the issues involved in cases such as hazardous facility siting, because “utilitarianism does not address questions of fairness in the distribution of benefits and burdens” (Hunold and Young 1998: 84). The question of fairness lies at the heart of the environmental justice debate, which argues that minorities and low-income populations face risks that are disproportionate to their numbers in the population, and that these risks are a result of the unequal enforcement of environmental regulations. Accordingly, environmental justice, a subset of environmental equity, can be seen as an issue that exists at the intersection of ecology, economics, public policy, and human society.

The remainder of the present chapter will identify the major concepts that will frame this study. In order to understand the interaction between socioeconomic status and environmental degradation in Louisiana, it is necessary to review the background of the relationship between industry, government, and local communities. This will help to establish the role that public policy plays in environmental equity formation. It is also important to establish a working definition of environmental justice, environmental equity, and environmental racism, three concepts that describe the complex interaction of socioeconomic status and environmental quality. Whereas many researchers use these terms interchangeably, there are nuanced differences among them. Similarly, there are several contemporary approaches to the study of
environmental justice, any of which could alter the outcome of the analysis. Finally, this chapter will provide a brief introduction to each of the case study parishes as well as the minority populations that reside there.

1.1 Background to the Research Problem

For more than three decades, the United States has worked to develop one of the most advanced systems of environmental protection in the world. Spearheaded by the National Environmental Policy Act of 1969 (NEPA), this system seeks to assure that the federal government, in cooperation with state and local governments, use all practicable means to create and maintain conditions that meet the social and economic needs of all citizens and to assure that all Americans live in “safe, healthful, productive, and esthetically and culturally pleasing surroundings” (42 U.S.C. 4331).

Despite the tremendous progress made, many communities across the nation continue to struggle with disproportionately high levels of environmental contamination. Two out of five Americans, for example, lived in cities where the air does not meet public health standards and one in four Americans live within four miles of a toxic waste site (USEPA 1995). Recent evidence suggests that these environmental hazards may not be evenly distributed, with minority and low-income populations bearing a greater risk than the overall population.

Glaring examples of such environmental inequities abound in southeast Louisiana, with minority residents constituting over two-thirds of the population. In fact, the state has the third highest proportion of minority residents in the nation, behind only Mississippi and California. For the purpose of this research, “minority” refers to all racial categories utilized by the U.S. Census Bureau exclusive of the white population, including African American, Native American,
and Asian populations. In addition, this research identifies persons of Spanish or Hispanic origin, regardless of their race, as minority.

Critics charge that U.S. environmental policy is highly fragmented because it focuses on specific environmental media, such as air, water, and waste. This fragmentation prevents government and industry from achieving the best overall environmental and economic results for each facility or industrial sector (Fiorino 1996). This is especially apparent in environmental equity research. Current trends in environmental equity are largely facility-oriented, essentially privileging the facility over the community (Flanagan 2005). This dissertation uses an industry sector approach to environmental equity as an alternative to a facility-oriented approach.

A sector approach to environmental equity focuses on one industrial sector as the basic analytical unit for identifying cost-effective ways to reduce industrial contributions to environmental problems (USEPA 2000c). This method essentially ignores other potential sources of environmental inequity in exchange for improved efficiency. A sector approach improves the efficiency and effectiveness of federal environmental justice guidelines and other regulatory programs, using a bottom up approach to determine which factors impede and which promote sound environmental performance (Fiorino 1996). For example, a sector-based approach enables analysts to address environmental problems from industrial sources that are not currently subject to regulation. For example, USEPA exempts onshore oil production from reporting its releases. As a result, few environmental equity researchers have examined this important industry. Similarly, industry sector analysis includes small and medium-sized businesses generally not required to report to the Toxic Release Inventory due to insufficient toxic releases. The ship building industry that supports offshore oil production, for example,
consists of several medium-sized facilities not listed on the TRI. Such facilities are generally ignored in facility-based environmental equity studies.

This research utilizes an industry sector approach to environmental equity to accurately gauge the level of environmental equity in a way that is responsive to the community, business, and government. Focusing on one specific industry, a sector approach enables policy makers to develop environmental strategies customized to the characteristics and needs of a sector (USEPA 2000c). The petroleum-based industry is the primary economic force in Louisiana and thus provides an ideal case study to apply the industry sector approach to environmental equity.

Louisiana, typically thought of as a “Sportsman’s Paradise,” is home to one of the country’s largest oil, gas, and petrochemical complexes. During the latter half of the twentieth century, this petroleum-based economy rapidly developed, replacing agriculture and fishing as the primary economic force in the state. In 2005, Louisiana was the nation’s number five producer of natural gas and number four in crude oil. In addition, the state ranked second in terms of total refining capacity (U.S. Department of Energy 2005). Critics have charged that lax enforcement of environmental regulations has left the state’s air, water, and land among the most polluted in the country (Wright et al. 1994). Indeed, Louisiana currently ranks second in the total amount of recognized carcinogens released to both air and water as well as in the amount of toxic chemicals injected into subsurface wells (Environmental Defense Fund 2004).

Furthermore, according to the U.S. Coast Guard (USCG), Louisiana has had more oil spills in its waters than any other state and trails only Texas in the number of chemical spills in state waters (USCG 2005). All of these factors, combined with the fact that Louisiana is one of the smallest states in terms of total land mass, has resulted in a situation with tremendous potential for the development of environmental inequities.
This research asserts that the development of the oil and gas industry in southeast Louisiana has tremendous potential for creating disproportionately high and adverse human health and environmental effects, particularly in minority and low-income communities. Much of the petroleum-related industry, as well as its support infrastructure, is located in small rural communities in Louisiana’s coastal zone, stretching out along the Mississippi River and numerous other bayous and waterways. Likewise, low-income and minority populations often reside in these same areas, resulting in a geography of disparate impact. The most widely publicized example of this is the petrochemical refining district stretching along the Mississippi River between the cities of New Orleans and Baton Rouge. Since the 1980s, residents and community activists have leveled accusations of “environmental racism,” accusing industry of deliberately targeting minority communities for toxic and hazardous waste facilities. Some have gone even further, charging the government itself with racial discrimination in its environmental policy making and in the enforcement of regulations and laws. Evidence does seem to suggest that the proximity of numerous impoverished minority clusters to large petrochemical plants has led to an undue toxic burden upon residents, lending some credence to their claims (Wright et al. 1994, Burby 1995, Allen 2001, Markowitz and Rosner 2002, Allen 2003, Flanagan 2005, Lerner 2005). Existing data and research suggests that similar distributional and procedural inequities exist in other sectors of the vertically integrated petroleum industry as well, including onshore and offshore extraction (Hemmerling and Colten 2003, Hemmerling and Colten 2004).

Industry, for its part, does not seem to dispute the fact that minority residents are sometimes disproportionately impacted by its activities. A typical argument, however, is that in no case has industry specifically targeted a minority or low-income community for facility siting because of socioeconomic status. Rather, according to industry representatives, facility planners
make siting decisions based on a number of geographical and economic factors, including the availability of abundant land, the proximity to water and rail transportation, and the presence of neighboring plants to provide chemical feedstocks (Louisiana Chemical Association 1992).

From a purely legal standpoint, unless there is a “clear pattern, unexplainable on grounds other than race,” there is no discriminatory intent, and thus, no violation of federal law, regardless of discriminatory impact (429 U.S. 452). This places local communities at a distinct disadvantage, in that proving the presence of environmental inequity is, in and of itself, not enough to hold industry liable for violating a person’s rights under either the Equal Protection Clause of the U.S. Constitution or Section 601 of the 1964 Civil Rights Act.

Note that federal regulations require the identification of a clear pattern of inequity. The United States Environmental Protection Agency (USEPA) reinforces this notion in its Revised Guidance for Investigating Title VI Administrative Complaints Challenging Permits when it states that a single action is rarely the sole cause of a disparate adverse impact (65 F.R. 39649). This finding would appear to have a twofold effect on environmental inequity cases. To begin, the regulations effectively shield a great many individual facilities from liability, particularly if they do not exceed de minimis risk levels. This would lead to a greater emphasis on the role of state and federal authorities, which provide oversight and issue permits to industry. In most cases, a permit issued to a single facility would not authorize the release of significant amounts of pollutants to the environment, particularly at levels considered harmful to human health. However, when agencies allow multiple permitted activities to take place in a concentrated geographical area, the cumulative effects may in fact be harmful to local residents (Flanagan 2005). As one industry representative notes, more emphasis needs to be placed on “identifying patterns of discrimination in permitting processes and assisting state and local permitting
agencies to improve their processes so that, ultimately, these patterns of discrimination do not continue” (American Petroleum Institute 2000). Industry, perhaps rightfully, makes the claim that they need only operate within the parameters of the permits issued to them. The implication is that industry has no legal obligation to consider the total cumulative impacts on the community. This has been borne out by the courts, which have tended to consider a defendant’s action standing alone rather than in the context of other decisions by the defendants or decisions by other local agencies (Perry 2003).

If multiple potentially hazardous sources significantly impact low-income or minority communities, then one can make a case that governmental actions may have contributed to the development of environmental inequity in the community, particularly if the individual facilities operate under government-issued permits. One aim of this research is to analyze how the oil and gas industry in southeast Louisiana has developed and the role that multiple permitted activities have played in the development of petroleum-related environmental inequities. In Louisiana, as in many other states, the agency that is charged with environmental protection is also charged with raising revenue through permit issuance, creating a situation whereby the state must make a trade-off between environmental protection and economic growth. Clearly, the issuance of numerous permits to several different facilities, none of which operate above threshold release levels, would, on the surface, protect the environment while maximizing profit for the state. When USEPA stepped in to require these agencies to examine the impacts of a wide universe of sources on surrounding communities, the state needed to reassess its permitting methods. In a carefully worded critique of USEPA’s Section VI Guidance, the Louisiana Department of Environmental Quality (LDEQ), notes that “the only reason for considering other sources that are not covered by the permit(s) in question should be to provide the ambient background levels for
assessing whether the permit(s) in question will result in a significant increase in disparity above what currently exists” (LDEQ 2000). This statement appears to suggest that the state concurs with the assessment that multiple permitted actions can raise ambient risk levels in particular communities to unsafe levels. However, LDEQ would apparently allow for the permitting of additional facilities in communities where environmental inequities currently exist, provided that these permits do not significantly increase the disparity. From a statistical standpoint, as background levels increase, it takes a greater level of risk to achieve significance. Using this standard, and provided that the permits are issued at sufficiently spaced intervals, communities would be allowed to become increasingly hazardous over time.

In cases where state and local authorities fail to effectively address cumulative environmental hazards, particularly in minority and low-income communities, federal agencies may be forced to step in and take more aggressive action. These agencies can use several broadly worded clauses in federal environmental statutes such as the Clean Air Act (CAA), Clean Water Act (CWA), and the Resource Conservation and Recovery Act (RCRA) to condition or deny permits on environmental justice grounds (Lazarus and Tai 1999; Rechtschaffen and Gauna 2002). In order to prompt federal agencies to use these authorities to address distributional inequities, President Clinton issued Executive Order 12898 (EO 12898), *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, which requires federal agencies to “make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations” (59 F.R. 32). EO 12898 essentially recognizes that environmental justice protections are inherent in existing environmental assessment strategies.
established by NEPA. As the President’s Council on Environmental Quality (CEQ) notes, environmental justice issues may arise at any step of the NEPA process. In order to comply with E.O. 12898 then, agencies should consider these issues at each and every step of the NEPA process. One of the most important principles established by the Executive Order is the recognition that federal agencies need to consider the cumulative effects of its actions, even if these effects are not within the control or subject to the discretion of the agency proposing the action (CEQ 1997). So, while the EO 12898 does not change the existing legal thresholds and statutory interpretations under NEPA, it may, by focusing additional federal attention on low-income and minority communities, lead to the identification of disproportionately high and adverse human health or environmental effects that are significant and that otherwise would have been overlooked (CEQ 1997).

Building on principles established by the CEQ, this research will demonstrate that a number of cultural, social, occupational, historical, and economic factors may amplify the environmental impacts of the oil industry, creating a landscape of risk unique to the petroleum industry in coastal Louisiana.

1.2 Environmental Equity Definition and Methodologies

In southeast Louisiana, where oil and gas-related industries dominate the economy, researchers have paid substantial attention to environmental justice concerns in New Orleans (Colten 2001, Colten 2002, Colten 2005) and along the industrial corridor of the Mississippi River (Louisiana Advisory Committee 1993, Wright et al. 1994, Burby 1995, Allen 2001, Pine et al. 2002, Markowitz and Rosner 2002, Allen 2003, Lerner 2005). Several of these studies indicate that minority and low-income populations face a disproportionately greater risk than do higher income and non-minority residents due in part to public policy and its enforcement. Very
little attention, however, has been paid to minority and low-income populations in the coastal parishes where much of the state’s oil and gas is either brought ashore or produced. Studies that have examined these areas have found that minority residents residing on the wetland fringe, such as the Houma Indians, tend to face disproportionately greater risks than do non-minority residents (Roberts and Toffolon-Weiss 2001, Hemmerling and Colten 2003, Hemmerling and Colten 2004).

This relationship between race and class and environmental burdens form the framework of environmental equity as well as the associated issues of environmental justice and environmental racism. All three terms refer to the same basic issues, but there are nuanced differences among them. The basis of the debate is one of equity. Environmental equity refers to whether or not the distribution of environmental hazards is equitable across the population with regard to race, ethnicity, or income and implies no bias or presumptions (Burke 1993). Despite the claim that environmental equity studies are bias-free, in actuality, there are two different approaches to evaluating the distribution of environmental hazards. One view is akin to the relative deprivation hypothesis and would suggest that people are concerned about their standing in a community relative to their neighbors rather than about their absolute standard of living (Helfand and Peyton 1999). The second vision of environmental equity implies the achievement of safe minimum standards everywhere but does not require the same environmental quality in all communities. According to Cutter (1995), environmental equity involves an equal sharing of risk burdens, not an overall reduction in the burdens themselves.

Environmental justice focuses the notion of environmental equity within the realm of public policy and environmental protection. As used by government agencies, environmental justice functions as an accounting system whereby agency personnel seek to identify minority
and low-income populations and determine if an agency’s actions have a disproportionate impact (Colten 2007). Outside of government, researchers often view environmental justice as a socio-political movement aimed at achieving environmental equity, by addressing environmental enforcement, compliance, policy formation, and decision making (Bullard 1994). Viewed in this way, environmental justice connotes “some remedial action to correct an injustice imposed on a specific group of people” (Cutter 1995: 112). In the broadest view, this would require that everyone, through the equitable implementation and enforcement of public policy, have access to safe, clean neighborhoods, adequate jobs, quality schools, and sustainable communities (Helfand and Peyton 1999).

The third related term, environmental racism, is based upon the premise that environmental inequities do in fact exist and that institutional racism has created these patterns of disproportionate exposure. In general, the causes may include overt racial intent in environmental decision making, racial discrimination in housing and labor markets, racial bias in education systems, and unintentionally discriminatory operation of social institutions. White privilege, a newer term, refers to the range of social institutions that enable the dominant white population to impose undesirable land uses on minorities without taking explicitly discriminatory actions (Pulido 2000).

In this dissertation, I analyze the relationship between environmental risk and population distribution. I do not specifically analyze the role of public policy in environmental inequity formation. This research would therefore fall under the broader term, environmental equity. Funded by the Minerals Management Service, a federal agency located within the U.S. Department of the Interior (USDOI), the research design determines if that agency’s actions have a disproportionate impact on low-income or minority populations (Hemmerling and Colten
2003). MMS has cited portions of this research in several recent impact assessments submitted to the USEPA (USDOI 2004, USDOI 2005a, USDOI 2005b, USDOI 2006). In some respects then, this research adheres to the broader governmental description of environmental justice. However, because I do not deal specifically with regulatory or legal actions, and to avoid confusion with the socio-political movement, I use the term environmental equity in place of environmental justice.

The initial portion of this study will focus on environmental equity from both a proximity- and risk-based perspective. Using a cumulative hazards model, the research will provide a snapshot in time of the oil industry in southeast Louisiana with a focus on environmental equity and the overall distribution of hazards. It is important to note, however, that the development of the oil and gas industry in Louisiana, as well as its continued expansion, is overseen by numerous governmental agencies, squarely placing the impacts of the industry within the realm of environmental justice as well as environmental equity. The focus on activities influenced by these agencies situates this research under the rubric of Executive Order 12898.

1.2.1 Proximity- and Risk-Based Analyses

Most equity and justice analyses are distributive in nature, using either proximity-based or risk-based methods. Proximity-based analysis refers to the question of whether the distance-related impacts of one or more facilities are distributed evenly among the social groups in the local population (Glickman and Hersh 1995). These impacts are not only health or safety related, but may also include immeasurable effects that may have negative impacts on the overall quality of life, including unsightliness, noise, and odor. If these impacts are strong enough, they will diminish the collective self-esteem and reputation of a community and the property values
within it (Glickman and Hersh 1995). In conducting a proximity-based analysis, the geographical unit of analysis is a uniform buffer created around each facility or structure in question. These buffers are not modeled on any specific release, therefore weather conditions and wind direction are not included in the model, resulting in the buffers being uniform in all directions.

Risk-based analysis refers more specifically to the health and safety-related factors associated with particular facilities. Often, this may involve complex modeling of hazardous releases dependant upon environmental factors such as weather conditions and prevailing winds. Generally, mathematical processes modeling the distribution of contaminants in the environment estimate the potential environmental effects (Batterman and Huang 1996). In this type of analysis, the magnitude of the hazards and the size, shape, and orientation of the associated impact areas constitute risk (Glickman and Hersh 1995). Risk assessments combine exposure assessment information with chemical toxicity and demographic information to estimate the potential health threats from the manufacture, use, and disposal of chemicals and have been extensively employed in the last decade, especially at toxic waste sites, due to United States Environmental Protection Agency (USEPA) requirements (Batterman and Huang 1996). Risk-based evaluations can often lead to different conclusions about environmental equity than proximity-based evaluations. The differences can be attributed to the fact that the size of the impact areas in risk-based evaluations vary and are generally much larger than the circles used in proximity-based evaluations (Maantay 2002).

Proximity- and risk-based analyses are both valuable tools used to evaluate environmental equity. While risk-based estimates tend to take much more information into account than proximity-based measures, the amount of information available to researchers is
limited to specific recorded releases, presenting an incomplete view of the potential hazardousness to the community as a whole. An earlier study prepared for MMS developed a methodology that was largely proximity-based, although modified to include some risk-based elements (Hemmerling and Colten 2003, Hemmerling and Colten 2004). This study uses proximity-based buffers that are dependent on the specific potential hazard associated with each activity. In other words, the hazardousness of the industrial processes was taken into account, although environmental conditions and diffusion were not (Hemmerling and Colten 2004).

1.2.2 Comparative Risk Analysis

Comparative risk analysis is a subtopic of environmental risk that compares different environmental problems to determine their relative risk to human health and quality of life, as well as risks to the natural environment (Jones 1997). Analysts use this type of risk assessment to rank environmental problems by their seriousness or relative risk, as opposed to quantitative risk assessment, which merely quantifies any given risk (Rechtschaffen and Gauna 2002).

The question of comparative risk analysis came to the fore in 1987 when the USEPA published *Unfinished Business: A Comparative Assessment of Environmental Problems* (USEPA 1987). This project, which arose out of a concern that the agency was not allocating resources to areas with the greatest environmental problems, was the first to directly address the question of relative risk and resource allocation. Indeed, the results of that project showed that the highest ranked risks were not the focus of the greatest agency expenditures (Jones and Klein 1999). In 1989, the USEPA commissioned its Scientific Advisory Board (SAB) to review the findings of the report. The resultant report, *Relative Risk: Setting Priorities and Strategies for Environmental Protection*, concluded that, although the data used to measure risk was often of poor quality and that qualitative factors are not easily indexed for comparison, comparative risk
analysis represents an important development in national environmental policy (Hornstein 1992). USEPA also noted that any comparative risk assessment must take into account ecological risk and the protection of natural resources, noting the strong linkages between human health and the health of wetlands, forests, oceans, and estuaries (USEPA 1990).

Neither of these early USEPA reports discussed the importance of gauging comparative risk levels to minority or low-income individuals, though it noted that the agency must be attuned to the concerns of people who are closest to the real-world health, ecological, and welfare risks posed by different environmental problems (USEPA 1990). It was not until 1993, months before the issuance of EO 12898, that federal comparative risk guidelines included environmental equity consideration. In these guidelines, USEPA notes that low-income and minority groups often live in polluted industrial areas where they may be exposed to multiple sources of risk, resulting in dramatic differences in the death rates, life expectancy, and disease rates of African Americans, Asians, and Native Americans compared to rates for Caucasian Americans (USEPA 1993). According to USEPA guidelines, analysts should address these issues in all phases of the comparative risk analysis.

In theory, comparative risk analysis allows federal agencies to evaluate two or more risks simultaneously and juxtapose the results for the purpose of examining whether the relative effort devoted to each risk should be changed (Cura et al. 2004). However, in examining present-day risks, comparative risk analysis tends to establish a baseline among existing risks, and so may accept rather than eliminate economically inefficient risks (Hornstein 1992). The ultimate goal of comparative risk analysis is to reduce the fragmentary nature of U.S. environmental policy and foster the evolution of an integrated and targeted national policy (USEPA 1990). Despite the overall importance USEPA has placed on comparative risk analysis, caution must be exercised
when interpreting the results. Analysts should not interpret baseline levels of risk as being acceptable, given the ultimate goals of the USEPA.

1.2.3 Process- and Outcome-Based Analyses

Two other distinctive fields of inquiry have developed in environmental justice research. The first seeks to determine present day levels of environmental inequity in low-income and minority communities. Many empirical environmental equity studies have demonstrated, for example, that minorities bear a disproportionate share of the burden from the effects of hazardous facilities. I refer to studies that seek to determine whether there is an association between racial demographics and the location of environmentally undesirable sites as outcome-based equity analyses (Talih and Fricker 2002). The proximity-based and risk-based models described in the previous section are outcome-based. Process-based equity studies are those that attempt to determine how such an association may have developed.

Outcome-based analysis may result in a determination of environmental inequity but not environmental racism, which is a conclusion of causation and not simply association (Talih and Fricker 2002). In other words, these studies present a “snapshot in time” of potential residential exposure levels. Recognizing where hazards are and whom they might affect is of immediate concern to federal agencies seeking to estimate the potential impacts of their activities, as well as to those public officials calculating health risks, planning emergency measures, or seeking to redevelop contaminated land (Pastor et al. 2001).

A process-based analysis is the natural extension of finding inequity in an outcome-based analysis (Talih and Fricker 2002). If, for instance, an outcome-based analysis finds existing inequities, a process-based analysis could determine whether industry disproportionately sited in minority communities or whether minority residents moved in after the potentially hazardous
facilities arrived. This determination is of central concern to policy makers and analysts. If the observed inequity is due to disproportionate siting, then it would be appropriate for planners and policy makers to revise permitting procedures to eliminate any elements of discrimination (Pastor et al. 2001). If, on the other hand, market responses to the facilities led the neighborhood to become disproportionately populated by low-income and minority residents through time, then policy makers would need a different set of tools with which to approach the problem. In these cases, the role of policy might be confined to ensuring that residents have access to data about neighborhood health risks so that individuals who choose to trade risk for affordable housing are not acting on incomplete data. In addition, policy makers would need to enforce existing statutes that limit the steering of minority house-seekers to particular neighborhoods (Pastor et al. 2001).

The final portion of this research consists of an equity analysis that explores the historical processes occurring within communities identified by the outcome-based analyses. The most common process-based methodology involves examining the demographic makeup of the community at the time of the facility’s siting. This methodology allows researchers to determine whether the facility was initially sited in a low-income or minority community or if low-income and minority populations came to live around the facility over time (Mitchell et al. 1999). This approach fails, however, to examine the population changes that had been occurring in the community prior to the facility siting. Without examining these preconditions and controlling for other confounding factors, it remains difficult for researchers to identify any type of process-based causal relationship (Liu 1997).

1.3 Southeast Louisiana People and Places

The current research explores the environmental equity implications in three individual case study parishes, each focusing on a particular aspect of the petrochemical industry (Figure 1).
Figure 1 Study Area
The intent is to compare the potential environmental impacts of extensive onshore and offshore oil and gas development in three Louisiana coastal parishes and to examine any socioeconomic inequality patterns in their distributions. The chosen parishes all represent different stages of historical petroleum development in Louisiana.

1.3.1 Lafourche Parish

Lafourche Parish is a coastal Louisiana parish that serves as the primary land-based supply center for the majority of the offshore oil activity in the Gulf of Mexico. Largely located in Louisiana’s coastal zone, some 50 miles south-southwest of New Orleans, Lafourche Parish is accessible by few large roadways. U.S. Highway 90 traverses the parish from east to west. Louisiana Highways 1 and 308 provide the only major north-south motor routes. Bayou Lafourche provides north-south waterway transportation to the Gulf of Mexico, while the Intracoastal Waterway serves Lafourche Parish as an east-west waterway and is accessible from Bayou Lafourche. The largest volume of shipping traffic occurs in the portion of Bayou Lafourche between the Gulf of Mexico and the Intracoastal Waterway in Larose. Principal goods shipped items include shells, sulfur, water, drilling mud, crude oil, cement, and steel. Shrimp and oyster tonnage is smaller but has a higher value.

There are three incorporated towns located in Lafourche Parish, Thibodaux, Lockport, and Golden Meadow. Thibodaux is Lafourche Parish’s largest town as well as the parish seat. Other communities within the study area include the unincorporated towns of Raceland, Larose, Cut Off, and Galliano (Figure 2). Port Fourchon, a deep-draft port at the mouth of Bayou Lafourche on the Gulf of Mexico, is a major onshore staging area for OCS oil and gas activities in the central and western Gulf of Mexico and the land fall for the Louisiana Offshore Oil Port (LOOP). Currently, the South Lafourche Airport in Galliano serves the southern portion of the
Figure 2 Census Designated Places and Other Populated Areas, Lafourche Parish, Louisiana
parish while the Thibodaux Municipal Airport in Thibodaux provides similar service to the north.

Nearly 90,000 residents live in Lafourche Parish; the majority reside along the Bayou Lafourche natural levee. Because of limited high ground, much of the offshore oil industry’s support infrastructure is proximate to the parish’s population centers. The parish is home to a sizable Native American population (2.3 percent) as well as African American population (12.6 percent) and a small Asian-American population (0.7 percent). In total, nearly 15 percent of the parish population is minority. Furthermore, for the parish as a whole, 14.7 percent of the population is below the U.S. Census Bureau’s definition of poverty and 19.7 percent of the children in the parish live below the poverty level. While these figures are below the state average, they are significant nonetheless. Table 1 and Table 2 introduce general racial and economic characteristics of the Lafourche Parish study area in 2000. Communities with large numbers of low-income and minority residents are more susceptible to environmental inequity given the clustering of facilities and population along the Bayou Lafourche natural levee.

1.3.2 Jefferson Parish

Jefferson Parish is a highly urbanized parish with over 455,000 residents. Studies have shown a greater concentration of environmental inequity in urban locations (Stockwell et al. 1993, Cutter 1995, Harner et al. 2002) and it is essential to consider one such parish in coastal Louisiana for comparative purposes. Jefferson Parish’s total minority population of 152,636 (33.5 percent) closely mirrors the state proportion (35 percent; Table 3). Its population living in poverty in 2001 (18.9 percent) was nearly the same as the state’s percentage (18.2; Table 4). With a total of 236 active wells in 2002, there is considerable on-shore activity in Jefferson Parish. This is a parish with a much larger population that might be susceptible to exposure to
Table 1  Racial and Ethnic Characteristics of Selected Communities in Lafourche Parish, Louisiana

<table>
<thead>
<tr>
<th>Area</th>
<th>Total Pop</th>
<th>White</th>
<th>African American</th>
<th>American Indian</th>
<th>Asian</th>
<th>Hispanic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lafourche Parish</td>
<td>89,974</td>
<td>82.90%</td>
<td>12.60%</td>
<td>2.30%</td>
<td>0.70%</td>
<td>1.40%</td>
</tr>
<tr>
<td>Chackbay</td>
<td>4,018</td>
<td>94.50%</td>
<td>4.00%</td>
<td>0.70%</td>
<td>0.30%</td>
<td>0.70%</td>
</tr>
<tr>
<td>Cut Off</td>
<td>5,635</td>
<td>91.40%</td>
<td>1.10%</td>
<td>3.80%</td>
<td>1.30%</td>
<td>2.10%</td>
</tr>
<tr>
<td>Galliano</td>
<td>7,356</td>
<td>92.30%</td>
<td>0.70%</td>
<td>4.50%</td>
<td>0.80%</td>
<td>1.70%</td>
</tr>
<tr>
<td>Golden Meadow</td>
<td>2,193</td>
<td>92.50%</td>
<td>0.50%</td>
<td>4.80%</td>
<td>0.40%</td>
<td>1.50%</td>
</tr>
<tr>
<td>Larose</td>
<td>7,306</td>
<td>85.60%</td>
<td>5.70%</td>
<td>3.90%</td>
<td>2.40%</td>
<td>2.50%</td>
</tr>
<tr>
<td>Lockport</td>
<td>2,624</td>
<td>95.70%</td>
<td>1.00%</td>
<td>1.60%</td>
<td>0.40%</td>
<td>1.20%</td>
</tr>
<tr>
<td>Mathews</td>
<td>2,003</td>
<td>96.60%</td>
<td>1.50%</td>
<td>0.80%</td>
<td>0.30%</td>
<td>0.50%</td>
</tr>
<tr>
<td>Raceland</td>
<td>10,224</td>
<td>71.20%</td>
<td>26.20%</td>
<td>1.00%</td>
<td>0.30%</td>
<td>1.50%</td>
</tr>
<tr>
<td>Thibodaux</td>
<td>14,431</td>
<td>64.00%</td>
<td>33.80%</td>
<td>0.40%</td>
<td>0.60%</td>
<td>1.00%</td>
</tr>
</tbody>
</table>

Source: U.S. Census Bureau, 2000

Table 2  Economic Characteristics of Selected Communities in Lafourche Parish, Louisiana

<table>
<thead>
<tr>
<th>Area</th>
<th>Annual Median Family Income ($)</th>
<th>Annual Per Capita Income ($)</th>
<th>Median House Value ($)</th>
<th>Median Monthly Contract Rent ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lafourche Parish</td>
<td>40,504</td>
<td>15,809</td>
<td>78,900</td>
<td>310</td>
</tr>
<tr>
<td>Chackbay</td>
<td>41,934</td>
<td>15,389</td>
<td>87,800</td>
<td>175</td>
</tr>
<tr>
<td>Cut Off</td>
<td>42,986</td>
<td>16,353</td>
<td>79,500</td>
<td>343</td>
</tr>
<tr>
<td>Galliano</td>
<td>36,136</td>
<td>13,910</td>
<td>71,000</td>
<td>325</td>
</tr>
<tr>
<td>Golden Meadow</td>
<td>36,944</td>
<td>13,122</td>
<td>57,600</td>
<td>243</td>
</tr>
<tr>
<td>Larose</td>
<td>45,126</td>
<td>15,541</td>
<td>82,200</td>
<td>269</td>
</tr>
<tr>
<td>Lockport</td>
<td>40,288</td>
<td>15,769</td>
<td>65,500</td>
<td>306</td>
</tr>
<tr>
<td>Mathews</td>
<td>41,683</td>
<td>19,336</td>
<td>90,600</td>
<td>335</td>
</tr>
<tr>
<td>Raceland</td>
<td>35,460</td>
<td>15,539</td>
<td>73,800</td>
<td>266</td>
</tr>
<tr>
<td>Thibodaux</td>
<td>36,551</td>
<td>16,966</td>
<td>72,000</td>
<td>309</td>
</tr>
</tbody>
</table>

Source: U.S. Census Bureau, 2000
Table 3  Racial and Ethnic Characteristics of Selected Communities in Jefferson Parish, Louisiana

<table>
<thead>
<tr>
<th>Area</th>
<th>Total Pop</th>
<th>White</th>
<th>African American</th>
<th>American Indian</th>
<th>Asian</th>
<th>Hispanic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jefferson Parish</td>
<td>455,466</td>
<td>69.80%</td>
<td>22.90%</td>
<td>0.40%</td>
<td>3.10%</td>
<td>7.10%</td>
</tr>
<tr>
<td>Avondale</td>
<td>5,442</td>
<td>64.90%</td>
<td>19.00%</td>
<td>0.80%</td>
<td>11.30%</td>
<td>4.80%</td>
</tr>
<tr>
<td>Barataria</td>
<td>1,390</td>
<td>85.30%</td>
<td>11.60%</td>
<td>1.00%</td>
<td>0.00%</td>
<td>1.40%</td>
</tr>
<tr>
<td>Bridge City</td>
<td>8,270</td>
<td>42.60%</td>
<td>49.80%</td>
<td>0.30%</td>
<td>4.30%</td>
<td>4.00%</td>
</tr>
<tr>
<td>Elmwood</td>
<td>4,432</td>
<td>80.40%</td>
<td>12.10%</td>
<td>0.00%</td>
<td>4.20%</td>
<td>4.90%</td>
</tr>
<tr>
<td>Estelle</td>
<td>15,983</td>
<td>75.50%</td>
<td>16.10%</td>
<td>0.80%</td>
<td>2.80%</td>
<td>7.70%</td>
</tr>
<tr>
<td>Grand Isle</td>
<td>1,541</td>
<td>96.70%</td>
<td>0.20%</td>
<td>1.90%</td>
<td>0.00%</td>
<td>1.20%</td>
</tr>
<tr>
<td>Gretna</td>
<td>17,338</td>
<td>56.70%</td>
<td>35.20%</td>
<td>0.50%</td>
<td>3.70%</td>
<td>6.10%</td>
</tr>
<tr>
<td>Harahan</td>
<td>9,861</td>
<td>97.50%</td>
<td>0.70%</td>
<td>0.20%</td>
<td>0.60%</td>
<td>2.00%</td>
</tr>
<tr>
<td>Harvey</td>
<td>22,259</td>
<td>49.10%</td>
<td>41.30%</td>
<td>0.50%</td>
<td>5.20%</td>
<td>5.50%</td>
</tr>
<tr>
<td>Jean Lafitte</td>
<td>2,136</td>
<td>94.20%</td>
<td>0.20%</td>
<td>2.70%</td>
<td>1.60%</td>
<td>1.10%</td>
</tr>
<tr>
<td>Jefferson</td>
<td>11,873</td>
<td>71.70%</td>
<td>24.60%</td>
<td>0.30%</td>
<td>0.70%</td>
<td>4.80%</td>
</tr>
<tr>
<td>Kenner</td>
<td>70,517</td>
<td>67.90%</td>
<td>22.90%</td>
<td>0.20%</td>
<td>2.60%</td>
<td>13.80%</td>
</tr>
<tr>
<td>Lafitte</td>
<td>1,650</td>
<td>96.20%</td>
<td>0.00%</td>
<td>1.90%</td>
<td>0.50%</td>
<td>2.00%</td>
</tr>
<tr>
<td>Marrero</td>
<td>36,073</td>
<td>47.40%</td>
<td>47.70%</td>
<td>0.50%</td>
<td>2.80%</td>
<td>2.50%</td>
</tr>
<tr>
<td>Metairie</td>
<td>145,852</td>
<td>86.60%</td>
<td>6.60%</td>
<td>0.30%</td>
<td>2.80%</td>
<td>7.20%</td>
</tr>
<tr>
<td>River Ridge</td>
<td>14,601</td>
<td>85.60%</td>
<td>10.90%</td>
<td>0.30%</td>
<td>0.70%</td>
<td>3.50%</td>
</tr>
<tr>
<td>Terrytown</td>
<td>25,397</td>
<td>56.70%</td>
<td>35.70%</td>
<td>0.30%</td>
<td>2.70%</td>
<td>8.70%</td>
</tr>
<tr>
<td>Timberlane</td>
<td>11,460</td>
<td>65.00%</td>
<td>23.30%</td>
<td>0.50%</td>
<td>5.60%</td>
<td>7.20%</td>
</tr>
<tr>
<td>Waggaman</td>
<td>9,403</td>
<td>41.70%</td>
<td>54.50%</td>
<td>0.60%</td>
<td>1.20%</td>
<td>4.10%</td>
</tr>
<tr>
<td>Westwego</td>
<td>10,841</td>
<td>76.70%</td>
<td>18.50%</td>
<td>1.10%</td>
<td>1.40%</td>
<td>3.30%</td>
</tr>
<tr>
<td>Woodmere</td>
<td>13,102</td>
<td>24.80%</td>
<td>64.80%</td>
<td>0.70%</td>
<td>5.40%</td>
<td>5.90%</td>
</tr>
</tbody>
</table>

Source: U.S. Census Bureau, 2000
Table 4  Economic Characteristics of Selected Communities in Jefferson Parish, Louisiana

<table>
<thead>
<tr>
<th>Area</th>
<th>Annual Median Family Income ($)</th>
<th>Annual Per Capita Income ($)</th>
<th>Median House Value ($)</th>
<th>Median Monthly Contract Rent ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jefferson Parish</td>
<td>45,834</td>
<td>19,953</td>
<td>105,300</td>
<td>455</td>
</tr>
<tr>
<td>Avondale</td>
<td>37,250</td>
<td>13,518</td>
<td>58,600</td>
<td>436</td>
</tr>
<tr>
<td>Barataria</td>
<td>29,913</td>
<td>12,890</td>
<td>104,700</td>
<td>247</td>
</tr>
<tr>
<td>Bridge City</td>
<td>25,620</td>
<td>10,333</td>
<td>58,800</td>
<td>289</td>
</tr>
<tr>
<td>Elmwood</td>
<td>61,176</td>
<td>34,329</td>
<td>120,000</td>
<td>706</td>
</tr>
<tr>
<td>Estelle</td>
<td>47,500</td>
<td>16,586</td>
<td>82,000</td>
<td>396</td>
</tr>
<tr>
<td>Grand Isle</td>
<td>35,517</td>
<td>18,330</td>
<td>69,500</td>
<td>316</td>
</tr>
<tr>
<td>Gretna</td>
<td>31,881</td>
<td>15,735</td>
<td>75,400</td>
<td>362</td>
</tr>
<tr>
<td>Harahan</td>
<td>55,319</td>
<td>23,448</td>
<td>135,200</td>
<td>474</td>
</tr>
<tr>
<td>Harvey</td>
<td>34,221</td>
<td>14,885</td>
<td>86,500</td>
<td>396</td>
</tr>
<tr>
<td>Jean Lafitte</td>
<td>40,163</td>
<td>14,209</td>
<td>102,800</td>
<td>338</td>
</tr>
<tr>
<td>Jefferson</td>
<td>40,408</td>
<td>19,245</td>
<td>98,100</td>
<td>407</td>
</tr>
<tr>
<td>Kenner</td>
<td>45,866</td>
<td>19,615</td>
<td>111,900</td>
<td>476</td>
</tr>
<tr>
<td>Lafitte</td>
<td>43,816</td>
<td>14,839</td>
<td>103,900</td>
<td>283</td>
</tr>
<tr>
<td>Marrero</td>
<td>37,287</td>
<td>13,933</td>
<td>73,900</td>
<td>336</td>
</tr>
<tr>
<td>Metairie</td>
<td>52,555</td>
<td>24,771</td>
<td>139,100</td>
<td>482</td>
</tr>
<tr>
<td>River Ridge</td>
<td>58,139</td>
<td>27,088</td>
<td>153,100</td>
<td>450</td>
</tr>
<tr>
<td>Terrytown</td>
<td>41,963</td>
<td>16,725</td>
<td>93,600</td>
<td>445</td>
</tr>
<tr>
<td>Timberlane</td>
<td>55,573</td>
<td>20,674</td>
<td>95,300</td>
<td>530</td>
</tr>
<tr>
<td>Waggaman</td>
<td>34,639</td>
<td>12,078</td>
<td>64,100</td>
<td>440</td>
</tr>
<tr>
<td>Westwego</td>
<td>31,187</td>
<td>13,160</td>
<td>68,400</td>
<td>335</td>
</tr>
<tr>
<td>Woodmere</td>
<td>45,378</td>
<td>14,494</td>
<td>85,400</td>
<td>471</td>
</tr>
</tbody>
</table>

Source: U.S. Census Bureau, 2000
impacts from the highly dispersed activity of oil extraction and the distribution of minorities and low-income residents is much higher.

Jefferson Parish is west of and adjacent to New Orleans. The Mississippi River separates the parish into a northern portion (the East Bank) and a southern portion (the West Bank). While the East Bank is home for many commuters that work in New Orleans’ Central Business District (CBD), the northern portion of the West Bank is much more industrial. The southern portion of the West Bank is home to several fishing communities that rely on Barataria Bay and the Gulf of Mexico for their livelihoods. Several large roadways service the northern portion of the parish. Interstate 10 is the primary east-west transportation route in and out of the parish, while U.S. Highways 61 and 90 serve as alternate routes. Louisiana Highway 45 is the primary roadway servicing the southern fishing communities and the rural oilfields. The Louis Armstrong International Airport, an important regional aviation hub, is in the western portion of the East Bank.

Harahan and Kenner, on the East Bank, as well as Gretna, the parish seat, Grand Isle, Jean Lafitte, and Westwego, on the West Bank are the six incorporated communities in Jefferson Parish (Figure 3). In total, the U.S. Census Bureau recognizes some twenty-one incorporated and unincorporated places in Jefferson Parish. Two important unincorporated communities are Metairie and Harvey. With a 2000 population of over 146,000, Metairie is a densely populated residential community containing a number of commercial industries. Harvey, on the other hand is a densely populated industrialized community located on the West Bank. Other unincorporated communities of interest include Avondale, Barataria, Lafitte, Marrero, and Waggaman. Several of these communities are impacted by the onshore oil extraction industry. Some are home to large oilfields while others are bisected by pipelines or house large petroleum
Figure 3 Census Designated Places and Other Populated Areas, Jefferson Parish, Louisiana
storage sites. Those with large minority or low-income populations are therefore at greater risk of environmental inequity.

1.3.3 Saint Bernard Parish

Like the other two parishes, Saint Bernard is a coastal parish. With two refining operations, employing over 500 workers, Saint Bernard provides a good site for examining refining activity. Located east of and adjacent to New Orleans, the parish is accessible via a number of transportation routes. Two primary east-west transportation arteries are Louisiana State Highways 39 and 46. Another important road is Louisiana State Highway 47, which connects to Interstate Highway 10 to the north. I-510, as this connection is designated, provides a north-south route in and out of Saint Bernard Parish for industrial and residential transportation. The Mississippi River borders the parish on the west and the Mississippi River Gulf Outlet, which provides a short water route between the Mississippi River and the Gulf of Mexico, bisects it.

No incorporated communities are located within Saint Bernard Parish, although the U.S. Census Bureau has identified six communities that contain a mixture of residential, commercial, and retail areas similar to those found in incorporated places of similar size (U.S. Census Bureau 2000). These include Chalmette, the parish seat, as well as Arabi, Meraux, Poydras, and Violet (Figure 4). These census designated places (CDPs) all occupy sites on the Mississippi River. Other smaller communities, such as Delacroix, Reggio, Saint Bernard, Toca, and Yscloskey, are spread throughout the rural portion of the parish.

Saint Bernard Parish’s population is distributed along the Mississippi River and Bayous La Loutre and Terre Aux Boeufs. Among its 67,000 residents, 14.5 percent represent a minority population and 13.2 percent live in poverty according to the Census Bureau’s 2001 estimates.
Figure 4 Census Designated Places and Other Populated Areas, St. Bernard Parish, Louisiana
(Table 5 and Table 6). The minority and impoverished population for St. Bernard is similar to Lafourche and will enable a reasonable cross-sector comparison. The susceptible populations are concentrated in the areas along the natural levee near several refining operations so risk is ever present in the relatively small territory occupied by human settlements.

1.4 Racial and Ethnic Communities in Southeast Louisiana

Any examination of environmental equity should begin with an analysis of the population of the potentially impacted area. It is important to recognize that, as Susan Cutter notes, a hazard is a threat to people and the things they value. Furthermore, hazards can be thought of as arising from the interaction between social, technological, and natural systems (Cutter 2001). Studies of environmental justice and equity expand this notion of environmental hazards from an examination of social systems in general to a more specific examination minority and/or low-income populations. USEPA defines an environmental justice community as a location where residents are predominantly minorities or low-income; where residents have been excluded from the environmental policy setting or decision making process; where they are subject to a disproportionate impact from one or more environmental hazards; and where residents experience disparate implementation of environmental regulations, requirements, practices, and activities in their communities (USEPA 1999b).

The first step in identifying an environmental justice community is to examine the spatial distribution of underrepresented populations, be they low income or minority. To this end, I begin this analysis with a description of ethnic and racial groups found to some extent within southeast Louisiana, regardless of whether or not these groups are impacted by oil-related industries or activities.
Table 5  Racial and Ethnic Characteristics of Selected Communities in Saint Bernard Parish, Louisiana

<table>
<thead>
<tr>
<th>Area</th>
<th>Total Pop</th>
<th>White</th>
<th>African American</th>
<th>American Indian</th>
<th>Asian</th>
<th>Hispanic</th>
</tr>
</thead>
<tbody>
<tr>
<td>St. Bernard Parish</td>
<td>67,229</td>
<td>88.30%</td>
<td>7.60%</td>
<td>0.50%</td>
<td>1.30%</td>
<td>5.10%</td>
</tr>
<tr>
<td>Arabi</td>
<td>8,103</td>
<td>95.70%</td>
<td>1.00%</td>
<td>0.10%</td>
<td>1.10%</td>
<td>6.30%</td>
</tr>
<tr>
<td>Chalmette</td>
<td>32,080</td>
<td>93.20%</td>
<td>2.00%</td>
<td>0.30%</td>
<td>1.50%</td>
<td>4.90%</td>
</tr>
<tr>
<td>Meraux</td>
<td>10,264</td>
<td>92.10%</td>
<td>2.80%</td>
<td>0.50%</td>
<td>2.90%</td>
<td>3.70%</td>
</tr>
<tr>
<td>Poydras</td>
<td>3,672</td>
<td>84.40%</td>
<td>11.50%</td>
<td>1.70%</td>
<td>1.70%</td>
<td>3.50%</td>
</tr>
<tr>
<td>Violet</td>
<td>8,627</td>
<td>60.50%</td>
<td>34.60%</td>
<td>0.70%</td>
<td>1.80%</td>
<td>4.80%</td>
</tr>
</tbody>
</table>

Source: U.S. Census Bureau, 2000

Table 6  Economic Characteristics of Selected Communities in Saint Bernard Parish, Louisiana

<table>
<thead>
<tr>
<th>Area</th>
<th>Annual Median Family Income ($)</th>
<th>Annual Per Capita Income ($)</th>
<th>Median House Value ($)</th>
<th>Median Monthly Contract Rent ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>St. Bernard Parish</td>
<td>42,785</td>
<td>16,718</td>
<td>85,200</td>
<td>374</td>
</tr>
<tr>
<td>Arabi</td>
<td>42,526</td>
<td>19,038</td>
<td>77,900</td>
<td>373</td>
</tr>
<tr>
<td>Chalmette</td>
<td>43,804</td>
<td>17,408</td>
<td>89,600</td>
<td>393</td>
</tr>
<tr>
<td>Meraux</td>
<td>52,408</td>
<td>17,951</td>
<td>93,100</td>
<td>311</td>
</tr>
<tr>
<td>Poydras</td>
<td>33,036</td>
<td>12,874</td>
<td>61,100</td>
<td>284</td>
</tr>
<tr>
<td>Violet</td>
<td>36,616</td>
<td>13,894</td>
<td>76,000</td>
<td>352</td>
</tr>
</tbody>
</table>

Source: U.S. Census Bureau, 2000
1.4.1 Non-Hispanic White Ethnic Groups

The largest racial group in southeast Louisiana is the Caucasian, largely of French and French Canadian descent known as Acadians. The U.S. census data is generally unreliable in differentiating Acadians from members of other Francophone groups, which may include white French Creoles, Creoles of Color, or more recent Francophone immigrants from Europe, French Canada, or the Caribbean (Brassieur et al. 2000).

During the late nineteenth century and into the twentieth century, the latest technological innovations began to diffuse throughout the towns and villages of the Acadian homeland of south Louisiana. Innovations such as mechanized agriculture, automobiles, electricity, and telephones began to affect Cajun culture (Estaville 2001). Still, many Acadians continue to spend their lives trapping animals for fur, dredging oysters, trawling for shrimp, or pursuing other forms of aquatic and marine life that thrive in the marshlands of southeast Louisiana, selling much of their harvest for cash. In this way, they have moved closer to the mainstream of American economic life while still clinging to their traditional lifeways (Hallowell 2003).

More than any other force, the discovery of oil in Louisiana would dramatically change the face of Acadian culture in south Louisiana. To begin, a number of hydrologic disruptions have occurred due to the oil industry’s canal dredging projects in the coastal wetlands of southeast Louisiana, used for transportation into the marshland and for pipeline laying. Saltwater intrusion not only killed off valuable aquatic plant life vital to the perpetuation of numerous animal species, but also introduced predatory saltwater fish species from the Gulf of Mexico that would kill off much of the oyster harvest (Hallowell 2003). These changes in the natural ecology of the marshlands of southeast Louisiana have led many Acadians seek more secure work with the oil industry, leading, in some cases to a less cohesive Cajun community.
In addition to the indirect effects of the oil industry on traditional livelihoods, the Acadian community has also been tremendously impacted by population migration, both into and out of traditional communities. First, thousands of Anglos moved into Acadian south Louisiana to work in the oil fields. Conversely, the construction of many large petroleum refineries in Baton Rouge and Lake Charles drew a great many Acadian plant workers out of southeast Louisiana. The diffusion of the Acadian population and the intrusion of the Anglo population have resulted in a situation where, today, many Cajuns have developed lifestyles similar to mainstream urban Americans (Estaville 2001). This situation combined with the unreliability of census data in identifying Cajun persons has resulted in the Cajun being largely invisible as far as environmental justice and equity studies are concerned.

1.4.2 African Americans

For most of their history in North America, African Americans were a rural people largely confined to the southern plantation regions, where, historically, they were sold into the plantations as slaves. Lafourche Parish was one of these major historic plantation regions (Aiken 2001). A number of sugar plantations grew up alongside Lower Bayou Lafourche in the late 1820s and the 1830s. In the antebellum period, dwellings of various sizes housed the planter’s family, his overseers, and his slaves. The latter were housed on the premises in the “agglomerated village settlement” called the “quarters” (Rehder 1999). The compact settlement pattern of the sugar plantations continued in the post-Civil War period because sugar cane required teams of men working and housed together as wage-earning residential laborers (Rehder 1999). Lane villages are residuals of the slave quarters lanes of the former sugar plantations. In the 1970s, many quarters settlements were aggressively removed from the landscape (Rehder 1999). By the 1990s, the remaining sugar plantations have fewer quarter houses, fewer workers
of both races, and many fewer if any whites living on plantation premises. Today, the former overseers house, almost all of the sugar factory workers’ houses, and the storekeepers’ houses are almost entirely inhabited by African Americans (Rehder 1999).

Other changes also occurred during the latter part of the twentieth century that began to affect African American settlement patterns in the rural South. African Americans who remained in the plantation areas have begun to make significant social and economic advances, as a result of their severance from the plantation system as well as the civil rights movement. In 1960, farming was the leading occupation of African Americans in the plantation regions. However, by 1990, manufacturing and professional services were the two primary occupations. African Americans have not, for the most part, entered the fishing, trapping, and gathering economy. These occupations have been kept mostly white through racial barriers (Brassieur et al. 2000). In addition to occupational changes, there has been a substantial increase in home ownership for African American during the latter half of the twentieth century (Aiken 2001). Today, the great majority of African Americans reside in urbanized areas of southeast Louisiana.

### 1.4.3 Native American

Native American tribes like the Houma Indians, the namesake for the southeast Louisiana city of Houma, migrated to the marshlands of south Louisiana because of the area’s remoteness (Wallace et al. 2001). The Houma and remnants of other tribes that they absorbed moved into the marshes and bayous of Terrebonne Parish when the white settlers came to south Louisiana nearly 300 years ago, after the Tunica Indian tribe had already driven them out of central Louisiana (Kniffen 1994). Since then, the Houma developed a number of small communities along the bayous of south Lafourche and Terrebonne parishes. Many of these settlements were the offspring of Indian and non-Indian unions, where the residents retained Indian identity. The
Houma’s ready acceptance of not only members of other Native American tribes, but many non-Indians as well, exacerbated their separation from white society (Austin 2001).

Today, the Houma are the largest Native American tribe in Louisiana, although they are not a federally recognized tribe. Recent attempts to register all descendants of historical Houma people have swelled the current tribal rolls to around 17,000 members. The majority of the Houma reside along Highway 1 in south Lafourche, between Larose and Golden Meadow, and in the area around Houma, in neighboring Terrebonne Parish. Considered by some to be “the most conservative of all Louisiana French speakers,” many Houma retained their traditional attitudes and practices at a time when many of their neighbors left fishing and trapping to work in the oilfields (Austin 2001). Many of the Houma who live along Bayou Lafourche continue to make a living from shrimping, continuing to supplement their subsistence by hunting, fishing, and gathering wild resources. Recent encroachment of salt water and loss of coastal marsh presently threatens to displace many Houma communities as the water’s edge has moved further and further inland.

1.4.4 Asians

Some of the most recent immigrants to south Louisiana and Lafourche Parish are the southeast Asians, particularly the Vietnamese. In the 1970s, following the American withdrawal from Vietnam, a number of Vietnamese immigrants fled to the United States. The primary volunteer agency in charge of resettling southeast Asian refugees was the Catholic Church. The involvement of the Catholic Church in resettlement has led southeast Asians to locate disproportionately in predominantly Catholic areas. The Louisiana dioceses were particularly active in resettling refugees, especially the Houma/Thibodaux Diocese, which sought housing and sponsors in St. Mary, Terrebonne, and Lafourche parishes (Bankston 1996)
Eighty-six percent of Louisiana Vietnamese reside in just seven parishes, each of which had around 500 or more Vietnamese residents: Orleans, Jefferson, East Baton Rouge, St. Mary, Vermillion, Terrebonne, and Lafourche (Bankston 1996). There were a number of institutional and economic forces that drew the Vietnamese to rural parishes in south Louisiana. The oil boom, together with federal funding for job training at oil-related skills, created job opportunities in south Louisiana. Furthermore, fishing in the Gulf of Mexico, an occupation appealing to many Vietnamese because it did not require advanced English-language skills, began drawing Asians in the 1970s.

The number of southeast Asians employed in both shrimping and fishing expanded greatly in the 1980s as the oil industry in Louisiana contracted (Bankston 1996). Since many of the immigrants come from fishing families, many southeast Asians have specialized in the seafood industry. By 1990, more than one in every twenty Louisiana fishers and shrimpers had roots in southeast Asia, even though the southeast Asians made up less than half a percent of the state’s workforce (Bankston 1996). They have progressively dominated the shrimping industry, running large, modern steel-hulled shrimp boats along the Gulf Coast. In many cases, they have displaced Cajun workers in the crawfish industry as well (Brassieur et al. 2000). Many southeast Asians have begun to achieve upward mobility, operating a number of small businesses (Donato et al. 2001).

1.4.5 Hispanics

Since the 1980s, the United States has experienced rising levels of new immigrants in rural areas. Especially in the southern United States, the single largest group of new immigrants is Mexican. Mexican immigrants are drawn to areas with a growing economy dependent on abundant, inexpensive labor that require a population willing to fill such positions (Duchon and
Murphy 2001). This is especially true in the coastal parishes of southern Louisiana, where many Hispanic migrants are now working in the shipbuilding and fabrication yards in the coastal areas of the state (Donato et al. 2001).

After the drop in oil prices and the resultant economic downturn in the 1980s, many highly skilled workers moved away from Louisiana in search of new job markets, leaving many unskilled workers. When the offshore oil industry expanded in the 1990s, some employers began to import skilled Mexican labor from the Rio Grande Valley (Donato et al. 2001). Even though Hispanic welders, fitters, and carpenters were relatively well paid, they performed some of the dirtiest jobs possible (Donato et al. 2001). Hispanic workers are especially conspicuous as welders and fitters in the ship repair industry. Large employers that have the financial and organizational resources tend to be the biggest employers of Hispanic workers.

Researchers have suggested that, although becoming a major part of the labor force, Mexican migrant workers in the Louisiana oil industry are geographically, linguistically, and socially isolated, seldom mingling with others and sending much of their earnings home to Mexico or Texas (Donato et al. 2001). The migrant Hispanic population for the most part have come to settle in residential niches and, besides patronizing small stores and food establishments, are peripheral to the social life of the area (Donato et al. 2001).

In addition to recent Latin American immigrants, there is another group of native-born Spanish speaking residents residing in southeast Louisiana, the Isleños, descendants of Canary Islanders brought to Spanish-controlled Louisiana in the late eighteenth century. Though the descendants of the original Isleño population have been in large part assimilated into the general population, an intact Isleño community still exists in Saint Bernard Parish, and its members
continue to earn a living fishing and trapping the surrounding waterways and wetlands (Wilds et al. 1996).

The ancestors of today’s Isleño population were colonists placed in settlements around New Orleans along major waterways in an effort to safeguard routes that an invading force might use to penetrate southeast Louisiana (Din 1986). The Isleños settled in Valenzuela on northern Bayou Lafourche, Barataria along Bayou des Families in Jefferson Parish, and San Bernardo in Saint Bernard Parish (Garvey and Widmer 2001). Two of these settlements were relatively successful, one in the area around the junction of Bayou Lafourche and the Mississippi River and the other in lower Saint Bernard Parish.

By the early nineteenth century, most of the Isleño population in Saint Bernard Parish lived at a subsistence level in relative poverty. The majority engaged in agriculture and sold their produce to New Orleans markets. Still others began to gather fish, shrimp, oysters, and crabs from the local waters for a livelihood (Din 1986). Later in the century, as sugar became the Louisiana’s leading cash crop, sugar planters began buying up much of the Isleño land in Saint Bernard Parish. After selling their land, many of the Isleños worked on the sugar plantations. Others resettled in eastern Saint Bernard Parish, where fishing and the trapping of fur-bearing mammals became an important livelihood for Isleños in the late nineteenth century (Garvey and Widmer 2001). The settlements of Delacroix Island, Yscloskey, and Shell Beach survive today as Isleño fishing communities.

Unlike in Saint Bernard Parish, where residents continue to preserve the word Isleño, the term Isleño disappeared from usage along Bayou Lafourche in the nineteenth century, where the descendants of the Canary Islanders referred to themselves as Spaniards or Spanish (Din 1988). In communities in Assumption and Ascension parishes, the Isleños adopted French material
traits, particularly house types, settlement patterns, recreation, and cuisine. They also learned the French as well as English leading some outsiders to believe that there were no Isleños in this area. Until recent times, however, a number of Spanish enclaves still existed along the brulees of Ascension and Assumption parishes. The recent encroachment of sugarcane plantations on the brulees, however, have driven many of the descendants of the Canary Islanders to the towns or the to bayou front (Din 1988).

Similarly, in Saint Bernard Parish, the mechanization of agriculture has served to drive Isleños as well as others from agriculture into the towns and cities. Though agriculture still enjoys importance in the state’s economy, fewer hands are now needed. The surplus labor has found employment in petroleum, natural gas, lumbering, manufacturing, salt, and sulphur industries (Din 1988). This has had a profound impact on the Isleño community, particularly in Saint Bernard Parish. Despite the fact that many of the original Canary Island settlers were farmers, some Isleños believe that the fishermen, hunters, and trappers residing around Delacroix, Shell Beach, and Delacroix are genuine Isleños, while those that have farmed or taken up other occupations are not (Din 1988).

Today, many Isleños see the encroachment of oil and gas as a threat to their community and its lifeways. While the oil and gas industry has provided a number of economic opportunities to the Isleño population, these activities have had a negative impact on traditional occupations, such as trapping, fishing, and oystering, and significantly reduced income from these occupations. This has been particularly true in lower Saint Bernard Parish, where marsh buggies used in oil and gas exploration have helped to destroy the marshes and kill off much of the muskrat population. The construction of the Mississippi River Gulf Outlet and other smaller
channels have destroyed thousands of acres of wetlands and facilitated salt-water intrusion, accelerating the loss of additional marshland (Din 1988).

1.5 Outline of the Study

In this chapter, I have identified the major concepts that will frame the remainder of the study. I have introduced each of the three case study parishes as well as the minority populations that reside therein. The remainder of the report is divided into six chapters. Chapter 2 presents an overview of the literature related to hazards and environmental justice, including both legal and academic works.

Chapter 3 establishes the methodology used in conducting the environmental equity analysis. Two separate yet related methodologies are discussed, one for proximity-based analyses and another for risk-based analyses.

Chapter 4 uses the risk- and proximity-based analyses to determine whether the distance-related impacts of one or more types of oil-related facilities are distributed evenly among the socioeconomic groups in the local population. This enables a comparison of the environmental equity impacts of three sectors of the vertically integrated petroleum industry: onshore production, offshore production, and petroleum refining. Quantitative measures allow for a direct comparison among the different sectors.

Chapter 5 explores the issue of environmental equity as it relates to hunting, fishing, and trapping in southeast Louisiana. According to the President’s Council on Environmental Quality, where an agency action may affect fish, vegetation, or wildlife, that agency action may also affect subsistence patterns of consumption and indicate the potential for environmental injustice. In this chapter, I provide a quantitative assessment of the potential impacts of oil-
related development on commonly hunted, trapped, and fished species in each of three southeast Louisiana case study parishes.

Chapter 6 explores the historical processes involved in the development of environmental inequity. In this chapter, I will analyze how the demographics of the case study parishes have shifted in response to historical developments in each sector of the oil industry. I then use statistical analysis to determine some of the factors that are driving the migration of minority residents into potentially hazardous areas of the region.

Chapter 7 concludes this dissertation with a re-examination of the notions of environmental justice and environmental equity as they relate to oil-related development in the coastal zone of southeast Louisiana. As the research suggests, no one notion of environmental equity can account for all of the variability and demographic shifts in this region. For this reason, it is necessary to rethink many of our notions of what environmental equity is and is not. This chapter concludes by suggesting a new theoretical framework for conducting environmental justice and equity research, one that acknowledges and embraces geographical and social variability.

Finally, in light of the turmoil and devastation left in the wake of Hurricane Katrina, and to a lesser extent Hurricane Rita, I have included a postscript that highlights just a few of the impacts these storms had on the case study parishes examined in this dissertation. While Hurricane Katrina brought the issues of race and poverty to the forefront of the national dialog, it is important to acknowledge that the environmental impacts of these storms are to large degree still unknown. From fears of a biological and chemical “toxic gumbo” to questions of the post-hurricane habitability of certain neighborhoods, questions of environmental health and safety have been and continue to be an important part of the hurricane-related discourse in Louisiana.
CHAPTER 2 – LITERATURE REVIEW

The research presented in this dissertation draws from a wide range of literatures and a broad selection of theories. This chapter reviews and summarizes these literatures, which include geographical hazards research, social and environmental justice research, and the historical geography of the environment and technology. Finally, a brief discussion of the principal federal statutes governing environmental quality and issues of social justice follows.

2.1 Geographical Hazards Research

At its most basic, a hazard can be thought of as a threat to human life and property. Put another way, there is no hazard unless humans, their possessions, and their activities are involved. As Susan Cutter (2001) notes, hazards arise from the interaction between social, technological, and natural systems. Early hazards research dealt primarily with human modification of nature, a view later summarized by Ian Burton, Robert W. Kates, and Gilbert White (1993), who state that the interaction of nature and human creates both useful resources and negative resources or hazards. It is humans that transform the environment into resources and hazards, by using natural features for economic, social, and aesthetic purposes.

Risk, on the other hand, represents the quantitative likelihood of a hazard event occurring (Kates and Kasperson 1983). This notion of risk is generally used by scientists and planners as bases for prescribing societal response to hazard events (Hohenemser et al. 1982). Risk can thus be seen as a component of hazards research.

The third related term, disaster, refers to a singular event that results in widespread loss to people, infrastructure, or the environment (Cutter 2001). A disaster is a human-centric appraisal
of a hazards event that may arise from any number of sources, including natural systems, social systems, and technology failures.

To summarize, a hazard is a threat to human life and property, while risk represents the mathematical probability of such an event occurring. Finally, a disaster is single large-scale occurrence of a hazard event resulting in a tremendous loss of life, property, or environmental quality. As Cutter (2001) notes, the natures of hazards, risks, and disasters are becoming much more complex and intertwined, as the fields of hazards research and management become more integrated. Thus, the distinctions between these three elements of hazards research are becoming much more blurred. This proposed research, by focusing on the extraction, transportation, and processing of petroleum simultaneously, will allow one to study the complexity of all three elements of hazards, to show how, in the flow of a single commodity, the degree of hazard, risk, and disaster are all intertwined.

Similarly, other long-held distinctions in hazards research, such as the division of the field into natural and technological hazards, are being called into question. Traditionally, hazards have been defined by their origins, natural/environmental or technological/anthropogenic. According to Doorkamp (1989), however, the “concept of a natural hazard is an ambiguous one, for many catastrophic events within the environment are man induced, or at least made worse by the interaction of man.” Similarly, natural forces may induce many catastrophic events originating in the technological sphere (Showalter and Myers 1992). These “natech” hazards are especially important in coastal Louisiana, which is often subjected to hurricane winds, storm surges and flooding. For example, hurricanes in the Gulf of Mexico present great risk to offshore oil platforms which in turn present risk to both ecological and human health and safety. Onshore, hurricane-related storm surges, high winds, and flying
debris can threaten chemical storage tanks or pipelines (Pine 1999; Colten 2006). As McCall et al. (1992) states, natural and human-made hazards are so intricately linked that they must be considered together. Work in the United States on hazards and disasters, however, did not begin with this integrated approach. Originally, researchers exclusively studying natural hazards dominated hazards research.

2.1.1 Natural Hazards Research

The basis of all hazards literature lies in the natural hazards field. From the inception of Gilbert White’s work in the 1940s until the publication of Chauncey Starr’s 1969 article on technological hazards, natural hazards dominated geographical research on hazards. Natural hazards researchers developed many of the methods that would become part and parcel of all hazards research, both natural and technological, during this time. Notions of magnitude, frequency, duration, areal extent, speed of onset, spatial dispersion, and temporal spacing are all common measures of hazardous events developed by early natural hazards researchers (Burton, Kates, and White 1993).

For the sake of simplicity, natural hazards are those elements of the physical environment that are harmful to humans and caused by forces extraneous to society (Burton and Kates 1964). The term generally refers to geophysical events such as floods, drought, wildfires, and earthquakes, to name a few. Although these events are often “beyond the control of human activity” (Palm 1990), this differentiation is difficult to maintain, for even the earliest geographical research into natural hazards had a human ecological slant to it, focusing on how humans can alter the benefits and risks presented by the environment.

The first hazards researcher to effectively associate natural hazards with human modification, particularly as this related to policy and land use issues, was Gilbert F. White of
the University of Chicago. White’s 1945 dissertation, *On Human Adjustment to Floods, A Geographical Approach to the Flood Problem in the United States*, was sharply critical of public policies that subsidize heavy spending on protection and abatement measures on floodplains, while at the same time encouraging encroachment and development of the same areas (White 1945). This innovative study, with its theme of human adjustment to, and management of, environmental risks, would influence the shape and direction of hazards research for years to come.

Subsequent works by White (1958, 1964, 1975) and others (Kates 1962, Hewitt and Burton 1971) would continue to advance the human ecological approach to hazards research, with a primary focus on how individuals and social groups respond to extreme events in nature (Burton, Kates, and White 1993). While much of this research continued to focus on issues of coastal flooding and floodplain adjustments (White 1945, White 1958, White 1975, Platt 1986, Pitlick 1997), other researchers began to examine natural events such as droughts (Henkins 1974), severe storms (Chu 1973, Islam 1974, Davis and Rogers 1992, Paulson 1993, Engstrom 1994, Faiers et al. 1994, Meentemeyer 1994), and avalanches (Butler and Walsh 1990, Mock and Kay 1992) from a natural hazards context.

Traditionally, natural hazards researchers have viewed hazard events in terms of the direct effects they have on the human population, such as immediate loss of life and property. Viewed in this way, these events appear to be singular occurrences that provide an immediate shock to the human environment from which the population recovers and adapts. In many cases, however, the situation is much more complex than the literature would seem to indicate. In the coastal zone of southeast Louisiana, for example, extreme weather events represent a constant threat to the industrial infrastructure of the onshore and offshore oil industries. Hurricane and
flood events have the potential to release and transport industrial toxins well beyond the immediate point of release, where impacts may not even be noticed for some time after the extreme event has subsided. Though not the explicit focus of this research, natural hazard events and the risks they pose to coastal Louisiana do have the potential in increase the probability of high-risk industrial failures. In order to understand the mechanisms of industrial failure in coastal Louisiana, it is vital to understand the role of the region’s physical geography and associated hazards.

Furthermore, natural hazards researchers have defined a number of human responses to extreme hazard events, ranging from immediate actions in the face of hazard events to long-term actions designed to reduce vulnerability to hazards. As Ian Burton, Robert W. Kates, and Gilbert F. White point out, other responses to hazards include the long-run adaptation of a culture to the extremes of its environment, as in building villages on natural levees (Burton, Kates, and White 1993). This pattern of developing the levees and high ground is especially prevalent in coastal wetlands, such as those found throughout southeast Louisiana. Flood control devices such as artificial levees also tend to further concentrate people in areas protected from flooding. One unintended consequence of this is that flood control devices also encourage industry to build within the protected zone, often in close proximity to residential development. Thus, human adaptation to natural hazards events may potentially heighten the populations vulnerability to technological hazards.

2.1.2 Technological Hazards Research

The focus of this dissertation is on technological hazards. Technological hazards differ from natural hazards by the direct level of human involvement in their causation. The emphasis
here is placed on the word direct because, as previously stated, all hazard events may be induced or intensified by human intervention but only technological hazards require a technological or industrial component. As Hohenemser et al. (1982) point out, some of these technological threats occur at the macroscopic scale of oil spills, gas explosions, dam breaks, and air crashes, for example, while others appear at the microscopic level of pesticides, food additives, and drugs. The most dramatic type of technological hazards are those that combine macroscopic and microscopic elements. Large-scale industrial failures such as nuclear power plant accidents or industrial accidents involving the release of toxic chemical to the environment represent this type of low probability/high risk event that produce the greatest amount of public trepidation.

This proposed research will examine technological threats at various scales. Clearly, macroscopic events such as gas explosions and oil spills present a constant threat to the Louisiana coastal zone, while oilfield wastes and other toxic byproducts of extraction present a potentially microscopic-scale risk to human health and welfare. Oil refineries represent the most technologically complex apparatus in the petroleum industry and present the greatest threat of combined macroscopic and microscopic risk.

Much of the initial research on technological hazards followed the human ecological methods and techniques established by natural hazards researchers. Cited as a milestone in stimulating modern research on technological hazards (Cutter 1993), Chauncey Starr’s 1969 article “Social benefit versus technological risk: What is our society willing to pay for safety” was actually adapted from a paper presented earlier at a symposium on human ecology. In the article, Starr examines the social cost of various technologies to determine the level of technological risk deemed acceptable by society. Social costs are defined as negative indicators of society, such as urban and environmental problems, technological unemployment, and poor
physical or mental health (Starr 1969). Finding that the population as a whole tended to see this matter from a different perspective from those directly impacted, Starr’s analysis called for a much more rigorous approach to societal decision making. More importantly, this article represents the beginning of both the risk paradigm and quantitative risk analysis.

Geographical researchers have expanded upon this quantitative notion of risk by focusing primarily on the temporal and spatial aspects of technological hazards, defining the hazardousness of places and regions. In this research, along with many other environmental justice studies, quantitative methods associate technological hazards with hazard zones, regions defined according to the risk level to which the public is subjected given the proximity to specific technological activity. GIS techniques, such as those I use in this research, represent the latest development in quantitative risk analysis, allowing for a much more comprehensive spatial analysis of technological hazards and risk.

2.1.3 Integrated Hazards Research

Hazards arise from the interaction between social, technological, and natural systems. It is this interaction that forms the basis of a more integrative approach to hazards research, one that focuses on the entire mosaic of risks and hazards that impact an area. When technological hazard zones are combined with other technological and natural hazard zones, it becomes possible to define localized regions of higher and lower risk. Hewitt and Burton (1971) first conceptualized this idea with their “all hazards in one place” model, which stressed the need to enumerate, map, and define the relationships and management possibilities for all hazards that a place is exposed to. Similarly, Foster (1980) described a hazard microzoning method, where large scale maps depict localized areas of high and low risk are produced, creating a mosaic of risks and hazards. Ziegler et al. (1983) used this notion of risk mosaics to show how hazards are
unevenly distributed in both space and time, using the distribution of hazardous waste incidents and waste dumps in the Los Angeles area as a case study. Finally, Cutter and Solecki (1989) examined the pattern of airborne toxic releases in the United States to identify a national risk mosaic. The resultant “hazards of place” model describes hazards not only in terms of technological and natural risks, but also of local mitigation efforts. The mosaic of risks, or hazardscape, can be a landscape of many hazards within a region, or it may consist of comparisons of one type of hazard between regions (Cutter 1993).

Many researchers have used the hazards of place model to study the impacts of multiple hazards on specific places. Cutter and Solecki (1996), for example, examined the differential toxic releases of the southeastern United States, while Tiefenbacher and Hagelman (1999) examined the distribution of toxic air releases in urban Texas counties. One of the most recent publications utilizing the hazard of place model is Bolin et al. (2002), who examined the spatial distribution of four types of technological hazards in Phoenix, Arizona, including toxic release inventory sites, large quantity hazardous waste generators, treatment, storage and disposal facilities, and federally identified contamination sites. What all of these studies have in common is that they disclose patterns of social inequalities in the distribution of hazards. As this research will show, the interaction between nature, society, and technology has become more integrated. In this research, the hazardscape model will be used to examine not just the impacts of the petroleum industry, but distributional inequalities and the social processes that gave rise to them, both questions of environmental justice and equity.

2.2 Environmental Justice and Equity Research

The notion that the human and natural realms, traditionally viewed as separate entities in hazards research, can be unified without becoming identical offers a superior framework from
which to view hazards research, for it emphasizes not nature or society, but the relationship between the two. This notion represents a shift in focus from the hazard to vulnerable populations and represents the inclusion of social theory in hazards research. Vulnerability is defined as the likelihood that an individual or group will be exposed to and adversely affected by a hazard (Cutter 1993). The environmental justice paradigm views vulnerability to hazards as primarily a class relation. Access to both useful and negative resources (i.e. hazards) is far from uniform. As Cutter (1993) notes, there is no such thing as a risk-free or hazard-free environment and societies have always had to make implicit and explicit choices between risk to a few and society’s betterment. As O’Riordan (1986) says, risk has a socially moral element to it. Environmental justice represents the joining of hazards research with this moral element.

2.2.1 Social Justice

A recent series of articles in the journal Progress in Human Geography suggests that the field of geography is undergoing a “moral turn,” that social justice has returned to the geographic agenda (Smith 1997, Smith 1999, Smith 2000, Cutchin 2002). According to David M. Smith (2000), the geographical engagement with social justice goes back three decades, when David Harvey (1972) published a “Social justice and spatial systems” and his book-length exploration Social Justice and the City (1973). Drawing largely on the work of Rawls (1999), Harvey prioritizes the prospects of society’s least advantaged members. This notion of justice states that all “essential public goods” of society should be distributed equitably, unless an unequal distribution is to the advantage of “the least favored” of society (Rawls 1999: 267). In other words, inequality can be justified, provided that the least advantaged members of society benefit from this. This early work in geography and social justice was revolutionary, for it went beyond the mere spatial distribution of phenomena to develop “a sense of ‘territorial justice’ that also
attempted to resolve claims” about inequality and unequal treatment (Kobayashi and Ray 2000: 403). This form of social justice, sometimes called distributional justice, allows us to say whether an institution is just or unjust, and whether some alternative may exist that may be more just. As Brian Barry says in the first volume of his *Treatise on Social Justice*, the currency of distributional justice is “one of rights and disabilities, privileges and disadvantages, equal or unequal opportunities, power and dependency, wealth and poverty” (Barry 1989: 355).

The notion of social justice as distributional justice has dominated discourse until fairly recently. Research in social justice has begun to move beyond the notion of spatial distribution and distributive justice, however, exploring production of social conditions that result in social injustices (Young 1990, Harvey 1992). This represents a movement towards a more historical-geographical view of social justice, one that recognizes that every social process, including those that generate inequality and increase risk, is geographically situated. According to Iris Marion Young, there are structural phenomena within society that immobilize or diminish particular groups (Young 1990: 42). These structures are not generally written in law or policies. Rather, they are enacted historical processes of everyday interaction and evaluation. This notion of difference and informal group oppression marks a move in social justice from universal theories to actual social contexts.

2.2.2 Environmental Justice

The incorporation of particular institutional situations and marginalized groups into social justice studies represents a movement into more applied arenas of study. More recently, David Harvey and others have begun to incorporate notions of nature and political ecology into the social justice dialogue (Harvey 1996, Low and Gleeson 1998). This reflects an emerging interest in environmental justice, a socio-political movement that applies social justice concepts to
environmental issues. Broadly, the environmental justice dialogue concerns the uneven
distribution of hazards generated by waste disposal, industrial plants, and other noxious facilities
or activities due to governmental actions and decisions.

Distributive equity must certainly be a consideration in environmental justice studies.
Both race and class are important elements in the spatial distribution of environmental hazards,
particularly as they relate to whether or not minority and/or low-income communities bear a
disproportionate share of exposure to environmental pollution and technological risk. Historian
Ted Steinberg (2000) has argued that minority and low-income populations have been subjected
to higher risk from natural hazards due to the implementation of public policy. Others have
argued that minority populations endure greater exposure to technological hazards (Cutter 1995).
Mere proximity to hazards does not explain vulnerability. On a general level, social
vulnerability describes the demographic characteristics of social groups that make them more or
less susceptible to the adverse impacts of hazards, as well as the potential impacts of these
hazards. As Susan Cutter has argued for a rural county in South Carolina, lack of financial
resources, for example, can contribute to higher vulnerability to subpopulations (Cutter 2000).
Some key social and demographic characteristics influencing social vulnerability include
socioeconomic status, age, experience, gender, race/ethnicity, wealth, duration of residency,
language capacities, and permanency of residence (Hill and Cutter 2001: 15).

Although some early hazards studies had included localized distributions in their
analyses, few explicitly examined race or class issues. One of those that did (Freeman 1972)
used 1960 census tract level data to examine three metropolitan areas and found that the average
black family has a higher exposure to air pollutants than the average poor family. In addition,
this study found that the rich have the opportunity and the means to protect themselves and/or
avoid environmental insults to a much greater extent than the poor. Similarly, Jeffrey M. Zupan (1973) found a statistically significant correlation between four air quality indicators (sulfur dioxide, smokeshade, settleable particulates, and suspended particulates) and the percent of the population of low-income households in New York City. In these and other early equity studies, economic conditions were examined far more than race as a social indicator.

In 1979, an African American community in Houston, Texas filed a lawsuit against Browning-Ferris Industries charging environmental discrimination when the industry attempted to locate a solid waste disposal facility in their neighborhood (Bullard 1994). Though the plaintiffs lost, this lawsuit can be seen as the start of the environmental justice movement. Following protests in Warren County, North Carolina, in which African Americans demonstrated against the selection of their community for a highly toxic polychlorinated biphenyl (PCB) landfill, the U.S. General Accounting Office conducted a study of hazardous waste landfill siting patterns in eight southern states. This study (U.S. General Accounting Office 1983) found a strong relationship between the location of hazardous waste landfills and the race and socioeconomic status of the surrounding communities. The first nation-wide study of the problems of hazardous wastes on minority communities, *Toxic Wastes and Race in the United States*, conducted by the United Church of Christ Commission for Racial Justice, found that race was the single most important factor in the location of abandoned hazardous waste sites (United Church of Christ 1987).

Since the 1980s when these landmark studies leveled charges of “environmental racism” the terminology and understanding of the relationship between undesirable land uses and minority and/or low-income populations has become more sophisticated. The pioneering works claimed a correlation between people of color and solid waste facilities (Bullard 1983) and
hazardous waste disposal sites (United Church of Christ 1987). The term “environmental racism” emerged to identify the siting of all undesirable land uses in the vicinity of neighborhoods composed primarily of African Americans. While some researchers continue to use the term “environmental racism” to describe institutional causes of disproportionate facility siting, most use “environmental equity” or “environmental justice” to encompass race and class issues (Kuehn 200). Susan Cutter (1995) compared the terms environmental justice and environmental equity. According to Cutter, environmental justice is concerned with the differential enforcement of environmental protection statutes while environmental equity implies an equal sharing of risk burdens, not an overall reduction in the burdens themselves (Cutter 1995). As Colten (2007) notes, however, the terms are sometimes used incorrectly and often interchangeably. As used by government agencies, environmental justice functions as an accounting system whereby agency personnel seek to identify minority and low-income populations and determine if an agency’s actions have a disproportionate impact (Colten 2007). Outside of government, researchers often view environmental justice as a socio-political movement aimed at achieving environmental equity, by addressing environmental enforcement, compliance, policy formation, and decision making (Bullard 1994).

As researchers looked beneath the obvious spatial relationships, they found many nuances. It became obvious that in some cases, market forces had a greater impact on both the residential pattern of minorities and waste sites than racism (Been 1994) or that the offensive land uses were in place before the minority community arrived (Hurley 1997 and Pulido et al. 1996). Others found that there were stronger relationships between low income and hazardous waste releases than between minorities and environmental disamenities (Bowen et al. 1995 and Cutter 1995). Other investigations found either no relationship between race and unwanted land
uses or correlations between white populations and the same type of land uses (Gould et al. 1986, U.S. General Accounting Office 1995, and Liu 1997). Each of these studies has methodological differences in the hazards examined, units of analysis, geographic scale, temporal period, and conception of inequality/injustice (Turner and Wu 2002). Differences in methodology could explain, in part, why there are so many wildly divergent findings in environmental justice and equity studies.


All of these concepts will be explored to some extent in this research. Quantitative risk analysis and GIS techniques will be used to evaluate the degree of present-day environmental
inequity in southeast Louisiana. This data will be combined with historical data to establish the roles that both environmental justice and environmental racism may have played in the creation of present day inequities. Perhaps the most difficult concept to explore will be that of environmental racism. This research may be able to establish that industry developed in minority neighborhoods, but proving that any explicit targeting of minority or low-income populations occurred will be difficult. Without an explicit admission from industry representatives, research can only imply that these communities may have been targeted.

2.3 Historical Geography and Environmental Issues

One goal of this research is to reveal the historical sources of present-day land uses and show how past residential patterns and pollution sources have contributed to present-day conditions. According to Laura Pulido (2000), in addition to enhancing our understanding of environmental inequities, historical research has also problematized racism by asking whether the people or the hazardous facilities came first. In asking this question, Pulido says, researchers do not acknowledge the fundamental relationships between racism and the production of industrial zones, pollution, and residential areas. Other researchers, however, reveal how a retrospective viewpoint is essential to explain current conditions and to develop agendas for future resource management (Colten and Dilsaver 1992). As Andrew Hurley (1997) notes, an environmental historical approach allows researchers to “recast the environmental justice discourse by highlighting the role of demographic change in creating and sustaining patterns of environmental inequity.” Like Pulido, Hurley found that while policies may not be overtly racist, at the very least, the role of race in skewing environmental experience is far more complicated than is usually acknowledged in the environmental justice literature.
2.3.1 Environmental History Research

The principal goal of environmental history as a field is to broaden our understanding of “how humans have been affected by their natural environment though time and, conversely, how they have affected that environment and with what results” (Worster 1988). The field, according to Kellogg (2002), draws on the disciplines of history, ecology, geography, climatology, and epidemiology. Much of environmental history is concerned with the human interaction with nature, particularly agriculture and natural resource collection. While the focus of this research is largely on technology and the built environment, it is in no way limited to those fields. In areas of southeast Louisiana, where the oil industry has not yet extended an urbanizing influence, where natural resource collection is still the dominant economic activity, despite the presence of oil-related activities, rural impacts of industry will be examined. This perspective will be especially important when the full temporal spectrum is examined. When the petroleum industry first arrived in southeast Louisiana, rural Cajuns and Houma Indians dominated the region. The intensification of transportation networks, especially roads, canals, and railways is a major factor in industrial growth, as is the presence of raw materials and energy resources (Butlin 1993). Southeast Louisiana had all of this, and as a result, especially in the years following the Second World War, the region began to undergo industrialization and urbanization.

As a result, although the region being study is not considered entirely urban, the limited availability of land on the high levees has resulted in a situation where the density of development approaches that of urban row housing (Davis and Place 1983). As geographer Robin Butlin notes, the term “urban” connotes a concentration of population (many of whom are not primary producers), a built environment, systems of administration and exchange, and links with proximate and more distant rural hinterlands, and related regional hierarchical urban
systems. Similarly, the term “rural” indicates a type of economy utilizing the land and natural resources of the habitat (Butlin 1993). Most of the land in southeast Louisiana is indeed rural, with the preponderance being coastal wetlands. Much of the industrial land use, however, is concentrated in the developed areas along major transportation routes. Similarly, while many of the activities and infrastructure associated with the petroleum industry are in rural areas, such as the pipelines that cross the coastal wetlands, it is anticipated that those areas with the greatest total number of facilities, will be in the urbanized built environment. For this reason, this study will utilize, in part, many of the same methods used in urban environmental studies.

Urban environmental history (Rosen and Tarr 1994) and the history of technology (Stine and Tarr 1998), particularly as these relate to issues of societal response to environmental degradation, provide of wealth of literature that informs this study. Four dimensions of study can be used to demarcate the field of urban environmental history: the impact of cities on the natural environment, the impact of the natural environment on cities, the urban perspective on the built environment in environmental history, and the response to urban environmental change and environmental problems (Rosen and Tarr 1994). This study will focus on the latter two dimensions.

The natural world influences the technologies, materials, and locations chosen to construct the built form, often shaping a city or town’s particular form. This perspective on the built environment questions how changing technologies affect natural resource utilization and examines environmental hazard distributions created out of socioeconomic conflict and neighborhood level change (Kellogg 2002). Colten (1994) examined the environmental legacy of refuse disposal in the development of Chicago’s urban form. Similarly, Rome (1994) examined the environmental history of residential development in American cities and suburbs.
Though not focusing specifically on the petroleum industry, each of these studies is indicative of how past residential patterns and pollution sources have shaped present-day conditions and development. From a purely methodological standpoint, these studies are illustrative of the ways that the technological landscape evolves in time along with changing residential patterns. This research will expand upon these methodologies to include an explicit environmental justice component.

The issue of environmental justice is relatively new to environmental history, but the ethical cornerstone of the field has always been the issue of environmental degradation and human response to environmental change over time. This view of environmental history deals with value systems and concerns both the human manipulation of the natural world and the distributional equity of environmental hazards. Environmental historians working within this paradigm examine issues of natural resource use, and how this is altered by changes in the neighborhood’s economy, government institutions, politics, technology, and culture, for example (Kellogg 2002). A special issue of *Environmental History* focused on many of these issues with emphasis on city processes (Flanagan 2000, Greenberg 2000, Gugliotta 2000). Joel Tarr’s *The Search for the Ultimate Sink: Urban Pollution in Historical Perspective*, for example, reveals how environmental problem solving, usually involving technological fixes or policy implementation, often produce unpredicted or unanticipated negative effects in other domains or locations (Tarr 1996). Particularly relevant to this study is Hurley (1994), who examined the public response to surface water degradation by the oil industry in nineteenth century New York. Similarly Colten (1997) examined public response to industry and found that, prior to 1950, local opinion held manufacturers accountable for toxic releases and did not consider the costs of pollution control excessive. Issues of regulation and legal responses to pollution have also
proven to be important areas of historical significance. Colten and Skinner (1996), for example, found that inadequate engineering of waste disposal sites, despite the availability of significant knowledge and ability, resulted in long-term contamination of water supplies and repeated failures of burial sites. Markowitz and Rosner (2002) examined internal corporate documents and discovered that some companies used trade associations to influence governmental agencies and even withheld evidence of environmental risks.

Though none of this literature focuses specifically on the oil industry or Louisiana, it does provide a framework from which to view issues of public response and government regulation. It is important to note here that much of the literature dealing with the environmental impacts of industrial activities have tended to focus on the urban setting. One aspect of this research will show how the impacts of industrial activities differ when industrialization occurs in the rural countryside.

As previously stated, an environmental history approach allows researchers to highlight the role that changing demographic patterns play in creating and sustaining patterns of environmental inequity. The result of this approach may be to show how processes of urban development create instances of environmental racism (Pulido 2000, Pulido et al. 1996) and how these processes give rise to barriers to social and geographic mobility (Hersh 1995). In some cases, real estate dynamics were responsible for bringing minority populations into communities that already harbored hazardous waste, as racially segregated housing markets enabled realtors to steer African Americans into polluted neighborhoods with a deteriorating housing stock (Hurley 1997).

In other cases, discriminatory action was not as clear cut. Burke (1993), for example, found that the growth of both industry and residential use in Los Angeles consumed open space,
thereby reducing the buffering between these conflicting land uses. She also notes that because toxic release inventory sites are industrial facilities, they often offer jobs for the surrounding communities and therefore have little need to target minority communities. In contrast, the promise of jobs was the main selling point for industries built along the industrial corridor between New Orleans and Baton Rouge in Louisiana, however, only a few jobs were offered to African Americans, and these were usually the lowest paying jobs (Wright et al. 1994). These last two case studies reveal that geography is a powerful force in terms of developing and maintaining patterns of inequity in facility siting.

A regional perspective is lacking in much of the literature here. By focusing on individual small-scale case studies, many of these studies are unable to determine whether the results represent isolated incidents or larger systematic problems within society. This research will attempt to remedy this shortcoming by examining the petroleum industry within a large geographical region. From a regional perspective, this research will establish the role of geography in developing patterns of inequity.

2.3.2 Environmental History of the Petroleum Industry

The historical analysis of technology and industry represents a logical subset of the environmental history literature. Basically, this is a field of study that assesses the interplay of historical environments and the development of industry and technology. One of the first works to expressly examine the environmental implications of technology was Henry Nash Smith’s landmark 1950 book *Virgin Land*, with its central theme of “technology in the garden.” Marx (1964), Fisher (1967), and Kasson (1976) in one way or another all expanded upon this central theme. These four works helped to develop the framework that would allow subsequent researchers to examine the history of technology and the environment (Stine and Tarr 1998).
the case of southeast Louisiana, it can be argued that prior to the arrival of the petroleum industry, the close-knit Cajun and Houma communities living along the bayous represented life in the “garden,” living off of the land in a subsistence fashion, as they had for generations. As oil companies brought industry and technology into the bayous, however, the garden would be forever altered.

In terms of this research, a number of historical aspects of the petroleum and petrochemical industries will be explored. In addition to general industrial histories, literatures relating industrial siting to environmental regulation will be explored, as will political struggles related to the oil and gas development. Each of these aspects of the historical geography of oil and gas helped to shape the modern landscapes seen in the oil and gas regions of southeast Louisiana.

When exploring the history of the petroleum industry in Louisiana, it is important to view this in the overall context of industrialization in the American South. Economics professor Gavin Wright, for example, shows how New Deal policies undermined the plantation system and transformed the region into what would become known as the Sunbelt (Wright 1986). Others, such as historian James C. Cobb, found that the development of the Sunbelt was founded on creating and maintaining a cooperative relationship with industry by creating a business environment with few controls on growth (Cobb 1984, 1993). Louisiana, like other southern states, used its abundant natural resources and low wages to draw industrialists, including petrochemical makers into the state.

Although Louisiana is currently one of the top petroleum producers in the United States, due largely to the extraction of outer continental shelf oil and gas, historically Louisiana lagged behind much of the nation in production. By the time oil companies struck oil in Jennings in
1901, the technology to handle massive amounts of crude had already been devised in areas such as Oil Creek, Pennsylvania (Black 2000). As Martin Melosi states, however, despite years of experience drilling for oil, patterns of waste and the disregard for conservation measures in the future Sunbelt states were remarkably similar to those in the northern states (Melosi 1985).

Historical research into the industrialization of the South has revealed two distinctive time periods: prior to World War II and post-World War II. The literature exploring the oil and gas industries in the south clearly defined these periods. For example, Roger and Diana Olien (2000) use archival records and oral histories to explore how the discovery of oil in Texas provided a tremendous economic boon to the state and how, following a period of exploitation, the state had to impose restrictions on the industry. Other books examined the early industry in Louisiana (Lambert and Franks 1982) and those southern states east of the Mississippi River (Hughes 1993). World War II provided a tremendous impetus to growth for the petroleum industry, both through fueling the war effort and the resultant growth of the petrochemical industry.

The petrochemical industry grew out of the chemical industry in Germany during the early 1900s (Spitz 1988). Following World War II, a tremendous market for a variety of plastic and rubber products spurred the industry into a period of tremendous growth. Keith Chapman has been one of the preeminent geographers to deal with issues related to the oil and gas, as well as the petrochemical, industries. His book The International Petrochemical Industry: Evolution and Location provides an expansive view of how political, economic, and technological forces have helped to shape the growth of the industry (Chapman 1991). On a more local level, Chapman has examined the impacts of oil and gas in England (Chapman 1976) and petrochemicals in Texas and Louisiana (Chapman 1980). In this last study, Chapman examines issues such as pollution control and environmental quality, issues that would come to the fore as
the location of petroleum-related industries began to move further and further afield of the location of petroleum extraction.

In the case of the offshore oil industry, the processing of oil and gas had to, necessarily, take place away from the site of extraction. Sociologists Robert Gramling and William R. Freudenburg examined the perceptions and politics involved in offshore oil development. The authors found a combination of historical, social, and environmental factors that combined in Louisiana to create a welcoming environment unlikely to be found anywhere else in the coastal United States (Gramling and Freudenburg 1994). Robert Gramling has continued this research, exploring how the expansive growth of the offshore oil industry in Louisiana produced tremendous alterations in the coastal environment, the infrastructure, and human capital in Louisiana (Gramling 1996). Robert Sollen explores many of these same issues in California, finding, as Freudenburg and Gramling did, that there are few financial benefits to local communities in offshore oil development, while there are considerable local costs. For this reason, the offshore oil industry has historically had many confrontations with coastal communities (Freudenburg and Gramling 1994, Sollen 1998). This research will test Freudenburg and Gramling’s findings on a much smaller, localized scale, exploring whether or not these “considerable local costs” are distributed equitably across all socio-economic groups.

As a recent review of the contributions of industrial geography to the environmental debate found, human geographers traditionally have viewed environmental issues as natural science concerns and best left to physical geographers (Gibbs and Healey 1997). However, the authors point out, environmental problems are largely the product of industrial activity. One of the earlier articles explicitly dealing with the chemical industry and the regulatory environment examined the siting of Dow chemical (Walker et al. 1979). Another early study examines the
environmental impacts of industrial agglomeration related to the petrochemical industry in Texas and Louisiana (Chapman 1983), finding that agglomerations of polluting industries are, from an environmental perspective, intrinsically undesirable. However, the economics of pollution control tend to reinforce the competitive advantage of agglomeration. One early study from political geography found that corporate interests tend to use the concept of non-decision-making to keep environmental issues off of the political agenda. This study examines four case studies in England and the United States: a steel mill, a brick company, a mining company, and coal-fired power plants, finding that spatial variations in pollution control are producing ‘pollution havens’ attractive to industry and, conversely, areas industry will seek to avoid (Blowers 1984). Conversely, Howard Stafford found that environmental regulations would not lead to major shifts in the location of industry and that the traditional location factors, such as labor costs, access to markets and materials, and transportation availability, remain predominant (Stafford 1985). Interestingly, however, this study also indicated that environmental regulations are more likely to have had an impact on the selection of a specific site within a region. This last finding confirms the important role that geographic scale will play in this research.

An historical perspective would perhaps better serve to highlight the impact of regulatory mechanisms on industrial siting. According to Hugh Gorman, during the first half of the twentieth century, most firms sought to reduce emissions, effluents, and other pollution-causing discharges primarily when it resulted in the recovery of valuable material or decreased the amount of money spent on damage or nuisance suits (Gorman 1999). While this study focused on oil field brines, Gorman’s *Redefining Efficiency: Pollution Concerns, Regulatory Mechanisms, and Technological Change in the U.S. Petroleum Industry* expanded this research to include the total petroleum industry (Gorman 2001). In this study, he found that the former
ethic of reducing emissions is replaced in the latter half of the twentieth century with a new ethic, one that required society to define its environmental objectives, and then institute policies to meet these objectives. How does this “new ethic” play out in southeast Louisiana, where as Gramling and Freudenburg state, a number of factors have converged to create an environment extremely welcoming to industry? Do these societal objectives include protections for minority and low-income residents?

2.4 Federal Authority and Environmental Justice

The movement for environmental justice represents the confluence of two of the most dominant social issues of the 1960s and 1970s – civil rights and environmentalism. Legislative and legal issues represent an important aspect of this movement. To a large extent, obtaining redress for environmental inequities and presenting such inequities in the future requires knowledge of existing environmental and civil rights laws (Newton 1996). The most important of these is Executive Order 12898 – Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations. In order to comply with Executive Order 12898, government agencies must identify and address disproportionately high and adverse human health and environmental effects on minority and low-income populations. Prior to the signing of this executive order, a number of other laws and statutes were available for those who believed that they were victims of environmental injustice. As Newton (1996) points out, these laws fell into two large categories, which were later drawn together by the executive order, those dealing with civil rights and those dealing with environmental quality.

For this research, familiarity with federal statutes is important from a methodological standpoint. As Colten (1993) states, familiarity with environmental policy provides a foundation for investigating choices available to those handling hazardous substances and wastes. Similarly,
familiarity with both environmental policy and civil rights legislation is vital when exploring environmental justice concerns. Prior to the enactment of Executive Order 12898, environmental justice claims were often made under the guise of civil rights violations. Thus, it is vital to have a working knowledge of federal civil rights laws if one is to conduct any type of historical research into environmental justice claims against industry, as this research proposes to do.

2.4.1 Federal Civil Rights Laws

Title VI of the Civil Rights Act of 1964 states that no person, regardless of race, color, or national origin, should be subjected to discrimination under any program or activity receiving federal assistance. This includes all federally regulated industries as well. Although Title VI would seem to ensure that minority populations would be free from any disproportionate harm, the legal realities of prosecuting environmental justice cases under this act have not been that clear cut. The first lawsuit that charged environmental discrimination under Title VI was Bean v. Southwestern Waste Management (482 F.Supp. 673). The federal judge presiding over the case ruled against the plaintiffs, despite clear evidence of environmental inequity, on the grounds that discriminatory intent was not established in the case. Proving intentional discrimination against minority communities has and continues to be one of the most formidable issues in environmental justice court cases.

While not as widely cited as Title VI, the Fair Housing Act of 1968 could also provide a strong justification for cases brought against companies responsible for the pollution of neighborhoods and communities (Newton 1996). Under the Fair Housing Act, it is unlawful to discriminate against any person in the sale or rental of housing on the basis of race, color, religion, familial status, or national origin. More relevant to the question of environmental justice is the portion of the act that makes it illegal to discriminate against any minority group in
terms of siting facilities or services connected to these housing units. According to Newton (1996), some experts believe that this portion of the act requires that all residents receive equal treatment and that the presence of disproportionate siting of polluting industries and hazardous waste sites violates this principle. Equal treatment should also apply to cleanup of contaminated sites and relocation of residents in extreme circumstances (Colten 2001).

2.4.2 Federal Environmental Laws

Just as the Civil Rights Act of 1964 set forth a comprehensive national policy on discrimination, so too does the National Environmental Policy Act (NEPA) of 1969 set forth national environmental policy goals for the protection, maintenance, and enhancement of the environment. One of the most important components of NEPA was the introduction of the Environmental Impact Statement into federal policy. In examining environmental impacts, NEPA required that the government consider such impacts as health and environmental effects, the risk of accidental but foreseeable adverse health and environmental effects, and socioeconomic impacts (Bullard 2000).

Title III of the Superfund Amendments and Reauthorization Act (SARA) of 1986, also known as the Emergency Planning and Community Right-to-Know Act (EPCRA), has several elements that may have implications for equity issues. EPCRA requires that states establish emergency response commissions to collect detailed information from local manufacturers regarding hazardous materials releases. The act also requires that the USEPA compile this information into an annual inventory called the Toxic Release Inventory (TRI) and that they make this inventory available to the public in a computerized database. As the Louisiana Advisory Committee to the U.S. Commission on Civil Rights (1993) points out, however, making this information available to racial minority and low-income communities have proven
problematic. Specifically, the USEPA has identified a number of barriers to the effective dissemination of environmental information, including language, metropolitan proximity, and educational biases.

A number of other laws enacted that could impact, either directly or indirectly, issues of environmental justice. The Clean Air Act, for example, sets standards for air pollution and attempts to regulate industry by reducing individual pollutants at their sources, while the Safe Drinking Water Act protects public drinking water sources from harmful contaminants. Congress has enacted other laws that deal specifically with solid waste disposal. The first of these was the Solid Waste Disposal Act of 1965, followed in 1970 by the Resource Recovery Act, which dealt with the recycling of useful materials from the waste stream. Also enacted in 1970 was the Resource Conservation and Recovery Act (RCRA), which authorized the USEPA to set standards for facilities that generate or manage hazardous wastes and to establish a permit system for hazardous waste treatment, storage, and disposal facilities. As the Louisiana Advisory Committee (1993) points out, RCRA covers many environmental equity concerns in minority and low-income communities, the most important of these being the permitting and siting of waste facilities. Finally, in 1980, Congress passed the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), which established a fund designed to pay for the cleanup of the nation’s worst hazardous waste sites. In addition to the designation process itself, under CERCLA, the USEPA devotes considerable resources to community risk communication and outreach programs designed to inform and assist those communities impacted by superfund sites.

Finally, federal law established that the government is responsible for protecting and maintaining the marine environment. The Outer Continental Shelf Lands Act (OCSLA) of 1953,
as amended in 1988, established federal jurisdiction over submerged lands on the Outer Continental Shelf (OCS) seaward of state boundaries. The act established the Mineral Management Service (MMS), an agency of the United States Department of the Interior, and assigned to it oversight of all OCS oil activity occurring in the Gulf of Mexico. MMS has a legal mandate under OCSLA to consider the potential impacts of oil and gas exploration on the human environment. The human environment is defined by OCSLA as the “physical, social, and economic components, conditions, and factors which inter actively determine the state, condition, and quality of living conditions, employment, and health of those affected, directly or indirectly, by activities occurring on the Outer Continental Shelf” (Luton and Cluck 2000). E.O. 12898 extends this mandate even further, specifically requiring the agency to consider how these potential impacts are distributed among various racial, ethnic, and socio-economic groups.

2.5 Conclusion

The literature reveals environmental equity to be a multifaceted social issue that crosses several disciplinary boundaries. The work of critical theorists has been important in defining the underlying notions of justice, privilege, and social capital, but the applied work coming from sociology, history, and especially geography has defined the field itself. Because of the inherent spatiality of environmental equity research, geographers have contributed much to the research. The availability of desktop GIS and other modeling software over the last decade has resulted in an explosion of new research, moving environmental equity studies in several new directions.

Despite the breath of environmental equity literature, and perhaps because of it, critics continue to debate the usefulness of environmental equity in public policy. Governmental agencies and legal scholars have had to grapple with unclear goals and research methodologies, as well as conflicting interpretations of results. At the same time, minority and low-income
communities continue to demand equal protection. This research attempts to bridge the gap between the academic research, governmental regulations, and community activism.
CHAPTER 3 – MEASURING THE ENVIRONMENTAL AND HUMAN IMPACTS OF THE OIL INDUSTRY IN COASTAL LOUISIANA

The purpose of this study is to compare the potential environmental impacts of extensive onshore and offshore oil and gas development in three Louisiana coastal parishes and examine any socioeconomic inequality patterns in the distribution of infrastructure. This chapter examines how I measure, model, and assess these impacts.

First, I will review the risks and hazards associated with offshore oil production, onshore oil production, and petroleum refining. These impacts can occur with respect to both the physical and psychological health of human beings, public welfare such as property damage, and the ecological health of natural systems (Liu 2001). I begin by examining the historical rates of occurrence of petroleum-related hazards in each of the case study parishes to establish relative risk rates and conclude with a detailed description of all petroleum-related hazards associated with each industry sector.

In the second half of the chapter, I will discuss the methods used to measure these impacts, focusing specifically on cumulative and multiple adverse exposure modeling and spatial data analysis methods. Following a review of data sources, I discuss the overlay analysis that lies at the heart of the cartographic modeling methodology used in this dissertation. This methodology enables the development of both proximity- and risk-based hazards models.

Finally, I discuss the statistical calculations that enable me to determine the levels of environmental equity in each of the three case study parishes. This dissertation uses both parametric and nonparametric procedures to determine if low-income or minority residents are significantly impacted by multiple potentially hazardous sources. As stated earlier, if low-income or minority residents are significantly impacted by multiple potentially hazardous
sources, then a case can be made that governmental actions or inactions may have contributed to the development of environmental inequity in the community.

3.1 Oil and Gas Related Environmental Hazards

Hazards are products, processes, and other conditions that potentially impact individuals and their property. More specifically, anthropogenic hazards relate to the presence of potentially hazardous facilities, the transport of materials and products, the methods of production processes used, and the disposal of products and wastes (McManus 2000).

The hazards analysis developed here differs from safety-type risk assessments in a number of ways. Risk analysis is most often used in regulatory standard setting and rule making, whereas hazards assessment is more likely to be used in planning or programmatic contexts (Cutter 2001). Issues such as potency of exposure and the sensitivities of different populations (e.g. children, the elderly, women) to potential exposures are not explored here. Rather, this analysis uses hazards assessment to explore potential environmental and human health concerns and impacts by identifying threats and determining the frequency of hazards events.

3.1.1 Risk and the Frequency of Oil-Related Hazard Events in Southeast Louisiana

Risk calculation utilizes past hazards events to estimate the probability of future releases. In this analysis, I use the frequency of occurrence to measure risk. The frequency of occurrence is a straightforward calculation from the historical data and the length of that record in years (Cutter et al. 2000). The number of hazard events divided by the number of years in the data set gives the annual rate of occurrence. This portion of the research utilized data queried from the United States Coast Guard National Response Center (NRC) database, including the records of all incidents reported between 1999 and 2003 involving the discharge of petroleum and other
hazardous substances from pipelines, fixed facilities, storage tanks, and roadway spills (U.S. Coast Guard 2005).

Table 7 provides the hazards frequencies for each of the primary hazards affecting Lafourche Parish and the OCS-industry. Chemical releases from stationary facilities are generally the focus of most environmental justice studies, and rightfully so. In all three case study parishes, fixed facilities have had the greatest frequency of releases. Of these parishes, however, Lafourche Parish had the lowest frequency of fixed-facility releases. However, of all the study area parishes, Lafourche Parish had the greatest frequency of pipeline releases reported to the NRC. Clearly this would be a function of the amount of pipelines that come onshore in Lafourche and transport the product to downstream storage and processing facilities. Contrast this with the onshore extraction industry where tank farms are onsite or nearby, thus requiring fewer miles of pipeline to move product from the extraction site to the initial storage site. Finally, although Lafourche Parish has had more releases from petroleum storage tanks than either of the other two parishes, the frequencies for the offshore, onshore, and refining industries are all quite similar. This is not surprising given that each industry necessarily requires a great deal of petroleum storage. In Lafourche Parish, we find a predominance of intermediate-sized petroleum bulk storage facilities, contrasted with a multitude of smaller tank farms in Jefferson Parish and a lesser number of large-scale storage tanks on the grounds of the refineries in Saint Bernard Parish.

Jefferson Parish has had more fixed-facility and roadway releases than either of the other two parishes over the time period examined (Table 8). This is a function of the overall diffusion of the onshore petroleum extraction industry, though, with a significantly larger population, we would expect to find more releases and accidents reported to the NRC. However, as noted
above, the onshore extraction industry in Jefferson Parish has had fewer pipeline releases than the offshore industry in Lafourche Parish and slightly fewer storage tank releases.

Table 9 provides the hazards frequencies for each of the primary hazards affecting Saint Bernard Parish, a center for the petroleum refining industry. The extremely low frequency of both pipeline and roadway releases immediately stands out. Two factors likely explain these results. First, crude petroleum generally arrives at the refinery via a few large-diameter pipelines. As a result, Saint Bernard Parish does not have the extensive network of pipelines that distinguish centers of onshore and offshore petroleum extraction, such as Jefferson and Lafourche Parishes. In addition, the refinery serves as the focal point of the refining district and is not as reliant on support industries as the offshore industry, for example. Ultimately, both the onshore and offshore industries have extraction sites and support industries, respectively, that are geographically diffused across the parishes, requiring more roadway transportation. In terms of fixed facilities and storage tank releases, Saint Bernard Parish is similar to Jefferson Parish, in terms of parish-wide release frequencies.

Thus far, I have focused on parish-wide release frequencies, with mention made of the clustering and dispersion of facilities. While a more in-depth analysis of the hazards associated with each sector of the oil and gas industry will follow, suffice it to say that within each parish, these industries are not distributed evenly. For example, Jefferson Parish has reported more total fixed-facility releases over the same five-year time span, but Chalmette, in Saint Bernard Parish, has reported far more potentially hazardous releases to the NRC than any other single location (Table 10).

A brief examination of the ten locations reporting the greatest number of releases reveals that four are located in Lafourche Parish (Galliano, Golden Meadow, Port Fourchon, and
### Table 7  Annual Rate of Occurrence of Identified Hazards for Lafourche Parish, Louisiana

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Number of Events</th>
<th>Number of Years</th>
<th>Hazard Frequency (annual rate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical release</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- fixed</td>
<td>131</td>
<td>5</td>
<td>26.2</td>
</tr>
<tr>
<td>Chemical release</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- roadway</td>
<td>22</td>
<td>5</td>
<td>4.4</td>
</tr>
<tr>
<td>Chemical release</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- pipeline</td>
<td>82</td>
<td>5</td>
<td>16.4</td>
</tr>
<tr>
<td>Chemical release</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- storage tank</td>
<td>61</td>
<td>5</td>
<td>12.2</td>
</tr>
</tbody>
</table>

Source: U.S. Coast Guard, 2005

### Table 8  Annual Rate of Occurrence of Identified Hazards for Jefferson Parish, Louisiana

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Number of Events</th>
<th>Number of Years</th>
<th>Hazard Frequency (annual rate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical release</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- fixed</td>
<td>235</td>
<td>5</td>
<td>47.0</td>
</tr>
<tr>
<td>Chemical release</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- roadway</td>
<td>45</td>
<td>5</td>
<td>9.0</td>
</tr>
<tr>
<td>Chemical release</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- pipeline</td>
<td>55</td>
<td>5</td>
<td>11.0</td>
</tr>
<tr>
<td>Chemical release</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- storage tank</td>
<td>47</td>
<td>5</td>
<td>9.4</td>
</tr>
</tbody>
</table>

Source: U.S. Coast Guard, 2005

### Table 9  Annual Rate of Occurrence of Identified Hazards for Saint Bernard Parish, Louisiana

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Number of Events</th>
<th>Number of Years</th>
<th>Hazard Frequency (annual rate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical release</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- fixed</td>
<td>215</td>
<td>5</td>
<td>43.0</td>
</tr>
<tr>
<td>Chemical release</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- roadway</td>
<td>7</td>
<td>5</td>
<td>1.4</td>
</tr>
<tr>
<td>Chemical release</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- pipeline</td>
<td>16</td>
<td>5</td>
<td>3.2</td>
</tr>
<tr>
<td>Chemical release</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- storage tank</td>
<td>54</td>
<td>5</td>
<td>10.8</td>
</tr>
</tbody>
</table>

Source: U.S. Coast Guard, 2005
<table>
<thead>
<tr>
<th>Parish</th>
<th>Location</th>
<th>Number of Events</th>
<th>Number of Years</th>
<th>Hazard Frequency (annual rate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saint Bernard</td>
<td>Chalmette</td>
<td>173</td>
<td>5</td>
<td>34.6</td>
</tr>
<tr>
<td>Jefferson</td>
<td>Westwego</td>
<td>53</td>
<td>5</td>
<td>10.6</td>
</tr>
<tr>
<td>Jefferson</td>
<td>Waggaman</td>
<td>30</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Saint Bernard</td>
<td>Meraux</td>
<td>27</td>
<td>5</td>
<td>5.4</td>
</tr>
<tr>
<td>Lafourche</td>
<td>Galliano</td>
<td>22</td>
<td>5</td>
<td>4.4</td>
</tr>
<tr>
<td>Lafourche</td>
<td>Golden Meadow</td>
<td>22</td>
<td>5</td>
<td>4.4</td>
</tr>
<tr>
<td>Lafourche</td>
<td>Port Fourchon</td>
<td>21</td>
<td>5</td>
<td>4.2</td>
</tr>
<tr>
<td>Jefferson</td>
<td>Lafitte</td>
<td>20</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Jefferson</td>
<td>Harvey</td>
<td>17</td>
<td>5</td>
<td>3.4</td>
</tr>
<tr>
<td>Lafourche</td>
<td>Leeville</td>
<td>16</td>
<td>5</td>
<td>3.2</td>
</tr>
<tr>
<td>Jefferson</td>
<td>Metairie</td>
<td>15</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Jefferson</td>
<td>Avondale</td>
<td>14</td>
<td>5</td>
<td>2.8</td>
</tr>
<tr>
<td>Jefferson</td>
<td>Gretna</td>
<td>14</td>
<td>5</td>
<td>2.8</td>
</tr>
<tr>
<td>Jefferson</td>
<td>Marrero</td>
<td>13</td>
<td>5</td>
<td>2.6</td>
</tr>
<tr>
<td>Jefferson</td>
<td>Grand Isle</td>
<td>12</td>
<td>5</td>
<td>2.4</td>
</tr>
<tr>
<td>Lafourche</td>
<td>Cutoff</td>
<td>11</td>
<td>5</td>
<td>2.2</td>
</tr>
<tr>
<td>Lafourche</td>
<td>Larose</td>
<td>9</td>
<td>5</td>
<td>1.8</td>
</tr>
<tr>
<td>Jefferson</td>
<td>Harahan</td>
<td>8</td>
<td>5</td>
<td>1.6</td>
</tr>
<tr>
<td>Jefferson</td>
<td>Kenner</td>
<td>8</td>
<td>5</td>
<td>1.6</td>
</tr>
<tr>
<td>Lafourche</td>
<td>Raceland</td>
<td>7</td>
<td>5</td>
<td>1.4</td>
</tr>
</tbody>
</table>

Source: U.S. Coast Guard, 2005
Leeville), four in Jefferson Parish (Westwego, Waggaman, Lafitte, and Harvey), and two in Saint Bernard Parish (Chalmette and Meraux). Each of these locations represents specific aspects of the oil and gas industry in southeast Louisiana. The four sites in Lafourche Parish are located in the far southern reaches of the parish and are home to several offshore oil support industries. In Jefferson Parish, Lafitte is the site of a large oil field, while the other three locations are home to petroleum bulk storage facilities and oilfield service industries. Finally, Chalmette and Meraux, in Saint Bernard Parish, each house a large petroleum refinery. An examination of the frequency of occurrence for of these industries reveals that there are particular risks associated with each sector of the oil and gas industry and that these risks are not necessarily distributed evenly across the region.

3.1.2 Oil-Related Activities

The activities examined here are those that relate directly to onshore and offshore oil production and processing, including gas processing and crude oil refining. This includes but is not limited to those facilities listed on the toxic release inventory. While the oil industry may have other secondary impacts on the environment, due in part to increases in population, it is those activities that are directly related to the extraction and processing of offshore oil and gas that are most clearly overseen by state and federal agencies, such as LADEQ, USEPA, and MMS.

This study identifies and maps the locations of oil-related activities and the potential threats posed by these activities. These oil-related activities can be classified into two major categories: (1) those areas of infrastructure that support oil and gas activities and (2) those areas that are supported by oil and gas activities (Louis Berger Group 2004). Infrastructure that supports the oil and gas industry, particularly the OCS industry, includes those activities that lead
up to the extraction of the product from the well. This includes the platform fabrication, shipbuilding, and pipe-coating industries. Furthermore, bases that provide supplies for the rigs and maintenance yards that repair the ships and rigs are included in this category.

Infrastructure supported by the oil and gas industry includes those activities that follow the extraction of product from the offshore wells. This includes gas processing plants, refineries, and petrochemical plants, as well as the pipelines that transport the various products to and from each of these facilities. This category also includes gas and oil bulk storage facilities which store the product following extraction. Lastly, this category includes any waste management facilities that handle waste streams generated by oil and gas exploration and production activities. This may include generic waste management facilities, special-purpose oilfield waste management facilities, and transfer facilities at ports, where the waste is transferred from supply boats to either barge or truck for transport to a final point of disposition (Louis Berger Group 2004).

Two infrastructure categories are important to each category, port facilities and transportation corridors. Port facilities play a vital role as the point of departure to offshore regions. The offshore oil industry relies heavily on specialized port infrastructure that specifically serves the industry’s needs. Such activities as repair and maintenance of supply vessels, fabrication yards, and supply bases are all generally located in ports nearest to offshore drilling operations (Louis Berger Group 2004). Finally, transportation infrastructure is vital for activities supporting and supported by the oil and gas industry. Roadways, railways, and waterways all provide access to and from the oilfields and the ports that supply the offshore rigs. Most supplies needed on the offshore rigs require transportation to the port. Likewise, any waste streams generated offshore must be transported back to shore, transferred to barge or truck, and shipped away from the port.
The following sections identify the specific oil- and gas-related activities examined in this study, including those supporting and supported by the offshore industry. Each section details the type of activities that generally occur at a typical facility, as well as the potential environmental hazards associated with these activities.

3.1.2.1 Transportation Corridors

The environmental impacts of transportation corridors are complex and varied, dealing with not only the vehicular traffic itself, but in some cases the cargo carried by these vehicles. The potential impacts of transportation corridors also have a temporal dimension, as density and type of traffic have identifiable daily patterns. The associated transportation risks are often independent of the cargo. One report concluded that the risks of “latent fatality caused by emissions from vehicle exhaust and resuspended particulates” are often estimated to be approximately the same or greater than the cargo-related risks (Biwer and Butler 1999). The USEPA has identified 21 Mobile Source Air Toxics (MSATs) emitted by motor vehicles, which are listed in its Integrated Risk Information System (IRIS) database (Table 11). These air toxics, or “Hazardous Air Pollutants” (HAPs), include various volatile organic compounds and metals, as well as diesel particulate matter and diesel exhaust gasses (USEPA 2000a).

Louisiana Highway 1, the primary north-south corridor through Lafourche Parish, is one of the most widely studied roadways in the study area due to its position as the principal transportation route for trucks entering and exiting Port Fourchon. Highway 1 is largely a rural two-lane arterial road that passes through many of the principal towns and villages in Lafourche Parish. Highway 1 connects with U.S. Highway 90, the primary east-west corridor bisecting the parish, just outside Raceland, less than 60 miles north of Port Fourchon. U.S. 90 runs east to
Table 11 List of Mobile Source Air Toxics (MSATs)

<table>
<thead>
<tr>
<th>Acetaldehyde&lt;sup&gt;4&lt;/sup&gt;</th>
<th>Diesel Particulate Matter &amp; Diesel Exhaust Organic Gases</th>
<th>MTBE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acrolein&lt;sup&gt;4&lt;/sup&gt;</td>
<td>Ethylbenzene</td>
<td>Napthalene</td>
</tr>
<tr>
<td>Arsenic Compounds&lt;sup&gt;1,4&lt;/sup&gt;</td>
<td>Formaldehyde&lt;sup&gt;4&lt;/sup&gt;</td>
<td>Nickel Compounds&lt;sup&gt;1,4&lt;/sup&gt;</td>
</tr>
<tr>
<td>Benzene&lt;sup&gt;4&lt;/sup&gt;</td>
<td>n-Hexane</td>
<td>POM&lt;sup&gt;3&lt;/sup&gt;</td>
</tr>
<tr>
<td>1,3-Butadiene&lt;sup&gt;1,4&lt;/sup&gt;</td>
<td>Lead Compounds&lt;sup&gt;1,4&lt;/sup&gt;</td>
<td>Styrene</td>
</tr>
<tr>
<td>Chromium Compounds&lt;sup&gt;1,4&lt;/sup&gt;</td>
<td>Manganese Compounds&lt;sup&gt;1,4&lt;/sup&gt;</td>
<td>Toluene</td>
</tr>
<tr>
<td>Dioxin/Furans&lt;sup&gt;2,4&lt;/sup&gt;</td>
<td>Mercury Compounds&lt;sup&gt;4&lt;/sup&gt;</td>
<td>Xylene</td>
</tr>
</tbody>
</table>

<sup>1</sup> Although the different metal compounds differ in their toxicity, the on-road mobile source inventory contains emissions estimates for total metal compounds (i.e. the sum of all forms)

<sup>2</sup> This entry refers to two large groups of chlorinated hydrocarbons, their cancer risks, their quantitative potencies are usually derived from that of the most toxic, 2,3,7,8-tetrachlorodibenzo-p-dioxin.

<sup>3</sup> Polycyclic Organic Matter includes organic compounds with more than one benzene ring, and which have a boiling point greater than or equal to 100 degrees centigrade. A group of seven polynuclear aromatic hydrocarbons, which have been identified by EPA as probable human carcinogens (benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, 7,12-dimethylbenz(a)anthracene, and indeno(1,2,3-cd)pyrene) are sometimes used as surrogates for the larger group of POM compounds.

<sup>4</sup> Although the different metal compounds differ in their toxicity, the on-road mobile source inventory contains emissions estimates for total metal compounds (i.e. the sum of all forms)

Source: U.S. Environmental Protection Agency, 2000a
New Orleans and west through Houma to Lafayette. In both New Orleans and Lafayette, U.S. 90 connects with U.S. Interstate 10, part of the interstate highway system. All commerce moving on Highway 1 through Port Fourchon to offshore rigs has to stop and be loaded on a boat, consequently the portion of Highway 1 connecting U.S. 90 to the port is intermodal (Hughes et al. 2001). Port Fourchon is first and foremost a land-based support terminal for the OCS oil and gas industry, and the majority of the commerce moving on the intermodal portion of Highway 1 also serves the industry.

According to one study, the average daily traffic along Highway 1 appears to be heavily influenced by the level of oil and gas activities and could grow by as much as 6 percent during the next ten years (Guo et al. 1998). A recent publication by the Greater Lafourche Port Commission stated that from 1999 to 2000, there was a 12 percent increase of southbound truck traffic on LA 1. However, from 2000 to 2001, this figure increased by another 41 percent. Furthermore, a recent MMS study concluded that there will be an 80 percent increase in average daily traffic, from 7,400 in 1997 up to an estimated 13,000 in the next decade (Guo et al. 1998). Truck traffic is expected to account for 13 percent of this proportion, a percentage that will increase with expanding OCS activity. In fact, in some years, truck traffic has increased by as much as 24 percent, while the national average rose from 2 to 5 percent.

Currently, five trucking companies that specialize in providing motor freight services to the petroleum industry all have dispatchers at Port Fourchon, while a number of other trucking firms also make a significant number of deliveries to the port (Hughes et al. 2001). There are number of risks associated with this amount of truck traffic, especially when it is heavily concentrated, as in this case. These risks are tied to the ability of the roadways to adequately handle the increased traffic flow, both in terms of traffic congestion, and road deterioration.
According to the LA 1 Coalition, a nonprofit corporation working to improve Louisiana Highway 1, between 1991 and 1996, there were over 5,000 accidents along this transportation corridor. Studies indicate that Highway 1 is twice as deadly as similar highways (LA 1 Coalition 2002). Furthermore, studies indicate that Highway 1 will continue to deteriorate due to OCS activities. One analysis of Highway 1 indicates that 98 percent of the road is in need of improvement. Overall, researchers estimated that 36 percent of the road is in need of major widening and another 42 percent needs to be resurfaced (Guo et al. 1998).

Other roadways in southeast Louisiana are also vital transportation links for the oil and gas industries. Interstate 510 (I-510), for example, is a short spur route of Interstate 10 that runs south from Interstate 10, intersects with U.S. Highway 90, and ends at the Almonaster Boulevard interchange. From this point, the highway continues south as Paris Road (LA 47), ending at the Chalmette Refinery in Saint Bernard Parish. Two other large arterial roads cross the parish, connecting Chalmette with New Orleans to the west and lower Saint Bernard Parish to the east. Louisiana Highway 46 (Saint Bernard Highway) and Louisiana Highway 39 (Judge Perez Drive) connect the population of the parish with the two large oil refineries and gas processing plants that are housed in the parish.

On Jefferson Parish’s west bank, two primary roads service the majority of the parish’s oil-based infrastructure. Along the Mississippi River, the Westbank Expressway (U.S. 90 Business) is the major transportation artery that connects all of the industrial centers. The Westbank Expressway is built to freeway standards and is planned to become part of the proposed Interstate 49, connecting New Orleans and Lafayette, Louisiana. The primary north-south artery connecting the oilfields of central Jefferson Parish to the industrialized areas on the Mississippi River is the Barataria Boulevard (LA 45). In Marrero, LA 45 intersects with the West Bank Expressway and moves southward as a four lane, divided highway. As the highway
exits the heavily developed northern towns, it narrows to a two lane undivided road designated as Jean Lafitte Boulevard, which eventually dead-ends in Lafitte.

While a great deal of research has been conducted on the impacts of expanding oil production on the roadways of Lafourche Parish, little, if any, work has been done on oil and gas-related traffic in either Saint Bernard or Jefferson Parish. Each of these parishes have freeway-standard transportation arteries crossing them, yet workers can only access much of the oil- and gas-related infrastructure via small rural highways. Increased activity at any of these infrastructure sites presents a potential risk to residents living along the primary transportation routes, as we saw in Lafourche Parish.

3.1.2.2 Onshore and Offshore Oilfields

Currently, the Emergency Planning and Community Right-To-Know Act does not require the oil and gas extraction industry to report to the Toxic Release Inventory (TRI). The hazardous materials most often produced and transported onshore for disposal include produced water from the production phase, drilling muds from the development phase, and other wastes associated with the maintenance of operating wells, such as cleaning agents and waste paints.

Produced water is the largest volume waste produced in oil and gas extraction operations (USEPA 2000b). Produced water is the water that is brought up from a well along with the extracted oil and gas. This generally contains a number of primary organic pollutants, such as benzene and toluene, as well as primary metal pollutants, such as lead and zinc (Table 12). Producers can reinject or otherwise dispose of a large percentage of these wastes onsite, but they still must bring much of the nearly 15 billion barrels of wastewater produced annually onshore for disposal (USEPA 2000b). OCS generated liquid wastes that fail NPDES toxicity requirements, for example, are generally brought onshore and transported to disposal wells. This
### Table 12  Produced Water Effluent Concentrations – Gulf of Mexico (Coastal Waters)

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Settling Effluent</th>
<th>Improved Gas Flotation Effluent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil and Grease</td>
<td>26,600.00</td>
<td>23,500.00</td>
</tr>
<tr>
<td>Total Suspended Solids (TSS)</td>
<td>141,000.00</td>
<td>30,000.00</td>
</tr>
<tr>
<td><strong>Priority Organic Pollutants</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,4-Dimethylphenol</td>
<td>148.00</td>
<td>148.00</td>
</tr>
<tr>
<td>Benzene</td>
<td>5,200.00</td>
<td>1,226.00</td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>110.00</td>
<td>62.18</td>
</tr>
<tr>
<td>Naphthalene</td>
<td>184.00</td>
<td>92.02</td>
</tr>
<tr>
<td>Phenol</td>
<td>723.00</td>
<td>536.00</td>
</tr>
<tr>
<td>Toluene</td>
<td>4,310.00</td>
<td>827.80</td>
</tr>
<tr>
<td><strong>Priority Metal Pollutants</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cadmium</td>
<td>31.50</td>
<td>14.47</td>
</tr>
<tr>
<td>Chromium</td>
<td>180.00</td>
<td>180.00</td>
</tr>
<tr>
<td>Copper</td>
<td>236.00</td>
<td>236.00</td>
</tr>
<tr>
<td>Lead</td>
<td>726.00</td>
<td>124.86</td>
</tr>
<tr>
<td>Nickel</td>
<td>151.00</td>
<td>151.00</td>
</tr>
<tr>
<td>Silver</td>
<td>359.00</td>
<td>359.00</td>
</tr>
<tr>
<td>Zinc</td>
<td>462.00</td>
<td>133.85</td>
</tr>
</tbody>
</table>

Source: U.S. Environmental Protection Agency, 2000b
category of waste may also include water extracted from sludge, completion fluids placed in the well prior to the initiation of production, treatment fluids prepared at the wellsite for general maintenance, and workover fluids injected during major well maintenance (USEPA 2000b).

Likewise, offshore oil producers must transfer waste solids that are not disposed of onsite, largely muds and rock cuttings, to onshore facilities and transport them to specifically designated commercial oilfield waste disposal facilities (USEPA 2000b). The American Petroleum Institute (API) estimates that producers generate nearly 146 million barrels of drilling waste annually, and that roughly 12 percent of the mud and 2 percent of the rock cuttings fail permit limits and must be transported onshore for disposal rather than discharged (USEPA 2000b). In addition, oil producers also handle other waste streams that are not unique to oil and gas exploration and drilling, such as waste solvents, unused acid, and painting wastes. They must also transport these wastes onshore and transport them to an appropriate disposal facility.

The development of any new oilfield will necessarily result in an increase in hazardous materials transported onshore. It is estimated that between 0.2 and 2.0 barrels of total drilling waste are produced for each vertical foot drilled (USEPA 2000b). Much of this waste must be transported onshore and disposed of, thereby increasing the risk to those people currently living along the hazardous transportation routes. The USDOT currently recommends a default isolation distance of one-half mile around any roadway involved in a hazardous chemical fire. Following Cutter et al. (2000), this distance serves as the radius to construct a potential hazard zone around the primary transportation routes in each of the case study parishes.

3.1.2.3 Refineries and Gas Processing Plants

The petroleum production industry involves a wide range of activities, from bringing petroleum to the surface to separating the liquid and gas components and removing impurities.
The same reservoir frequently produces oil and natural gas, but operators must process each product separately. In most cases, pipelines transport the oil and gas from offshore wells to onshore processing facilities. If operators do not remove impurities from natural gas in the field, a natural gas processing plant removes them. Refineries, on the other hand, nearly always process crude oil (USEPA 2000b). While in other counties or parishes, the crude oil may be refined near the landing point, in Lafourche Parish, pipelines must transport the product to inland refineries in neighboring parishes. In Louisiana, eleven parishes house oil refineries, eight of which are coastal (Wicker et al. 1989). Refineries generally site on elevated, better-drained natural levees and terraces. For this reason, Lafourche Parish contains no crude oil refineries, despite the large volume of oil traversing the parish.

Unlike crude oil, natural gas coming ashore must be treated immediately for safety reasons (Baldwin and Baldwin 1975). This situation necessitates coastal facilities. In fact, 45 percent of the gas processing plants in Louisiana occupy sites in ten coastal parishes, with the majority built upon natural levees, chenier ridges, or the Pleistocene terrace (Wicker et al. 1989). One large gas processing plant is located in Lafourche Parish, in Larose, while two others are located in Terrebonne Parish, on the Lafourche Parish border. There are a number of gas processing plants located within Saint Bernard Parish. The largest of these are in the rural communities of Toca and Yscloskey. A third is located on the grounds of the Chalmette refinery in densely populated Chalmette. Unlike the other facilities examined here, the Chalmette facility does not process raw product from nearby wells. Rather, this facility processes waste gas from the Chalmette refinery.

While there is no typical natural gas composition, its primary constituents are methane and ethane. However, there is generally a wide range of other substances present in natural gas
Natural gas processing plants have two primary purposes. First, they remove all the impurities from the gas. These impurities may include water, hydrogen sulfide, carbon dioxide, nitrogen, and helium. Second, they separate the gas into its useful components for distribution to customers (Louis Berger Group 2004).

The primary byproduct of the production process is produced water, especially as a well nears the end of its productive stage. While many petroleum components are easily separated from the produced water, some components are water-soluble and thus much more difficult to remove. Those found in high quantities include chloride, sodium, calcium, magnesium, and potassium, while lesser amounts of the following may also be present:

- Organic compounds such as benzene, naphthalene, toluene, phenanthrene, bromodichloromethane, and pentachlorophenol;
- Inorganics such as lead, arsenic, barium, antimony, sulfur, and zinc; and
- Radionuclides such as uranium, radon, and radium (USEPA 2000b: 39).

Onshore gas processing operations may pose a risk to the environment if produced water is not properly disposed of, either through treatment or reinjection. According to the USEPA, the inappropriate discharge of produced water onto soil can result in salinity levels too high to sustain plant growth. Furthermore, if introduced to a water supply, the water can become unusable for human consumption. The introduction of metals and organic compounds from produced water is also a concern (USEPA 2000b).

There are a number of other potential impacts to human health and safety associated with natural gas processing and processing plants. These include both hazardous waste generation and air emissions. Natural gas must undergo a conditioning process to remove impurities so that the product is of high enough quality to pass through the transportation and pipeline systems. The two most significant conditioning processes are dehydration and sweetening.
<table>
<thead>
<tr>
<th>Category</th>
<th>Substance</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hydrocarbons</strong></td>
<td>Methane</td>
<td>CH₄</td>
</tr>
<tr>
<td></td>
<td>Ethane</td>
<td>C₂H₆</td>
</tr>
<tr>
<td></td>
<td>Propane</td>
<td>C₃H₈</td>
</tr>
<tr>
<td></td>
<td>Iso-Butane</td>
<td>C₄H₁₀</td>
</tr>
<tr>
<td></td>
<td>Normal-butane</td>
<td>C₄H₁₀</td>
</tr>
<tr>
<td></td>
<td>Iso-pentane</td>
<td>C₅H₁₂</td>
</tr>
<tr>
<td></td>
<td>Normal- pentane</td>
<td>C₅H₁₂</td>
</tr>
<tr>
<td></td>
<td>Hexane</td>
<td>C₆H₁₄</td>
</tr>
<tr>
<td></td>
<td>Heptane</td>
<td>C₇H₁₆</td>
</tr>
<tr>
<td></td>
<td>Octane</td>
<td>C₈H₁₈</td>
</tr>
<tr>
<td></td>
<td>Nonane</td>
<td>C₉H₂₀</td>
</tr>
<tr>
<td></td>
<td>Decane</td>
<td>C₁₀H₂₂</td>
</tr>
<tr>
<td><strong>Inerts</strong></td>
<td>Helium</td>
<td>He</td>
</tr>
<tr>
<td></td>
<td>Nitrogen</td>
<td>N₂</td>
</tr>
<tr>
<td></td>
<td>Argon</td>
<td>Ar</td>
</tr>
<tr>
<td><strong>Sulphur Compounds</strong></td>
<td>Hydrogen Sulfide</td>
<td>H₂S</td>
</tr>
<tr>
<td></td>
<td>Mercaptan</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sulphur</td>
<td>S</td>
</tr>
<tr>
<td><strong>Other Gases</strong></td>
<td>Oxygen</td>
<td>O₂</td>
</tr>
<tr>
<td></td>
<td>Carbon Dioxide</td>
<td>CO₂</td>
</tr>
</tbody>
</table>

Source: Louis Berger Group, 2004
Dehydration is the process by which water is removed from the gas stream. When using a liquid desiccant, the gas is exposed to a glycol that absorbs the water. Glycols are volatile and can be hazardous if inhaled as a vapor. At natural gas processing plants, however, solid desiccants called molecular sieves find common usage. These are crystals with large surface areas that attract and bond with the water molecules (USEPA 2000b). Plant operators must periodically replace and dispose of the used desiccants.

Sweetening is the procedure used to remove hydrogen sulfide and sometimes carbon dioxide from the gas stream. The most common method of sweetening is amine treatment, by which plant operators expose the gas stream to an amine solution that reacts with the hydrogen sulfides, separating them from the natural gas. Another method of sweetening involves the use of iron sponge, which reacts with hydrogen sulfide to form iron sulfide, which then requires either burial or incineration (USEPA 2000b). Hydrogen sulfide, a toxic substance, poses the greatest risk to human health and safety and is potentially fatal at high concentrations. The sulfur gas may be disposed of by flaring, incineration, or, when a market exists, sending it to a sulfur recovery facility. Gas processing plants may also remove nitrogen and other gasses from the natural gas. Similarly hydrocarbons such as benzene, toluene, ethylbenzene, and xylene (BTEX) may also be present in the natural gas and require separate removal and processing (USEPA 2000b).

There are several potential air pollution sources in the production process. According to the USEPA, emissions at natural gas processing plants are much greater than those found at field production operations due to the greater scale and concentration of equipment (USEPA 2000b). As previously mentioned, if no market exists, plants may flare off sulfur gas. This combustion process releases carbon monoxide, nitrogen oxides, and sulfur dioxide into the air. In addition,
production involves the use of machinery including pumps, heater-treaters, and motors that require fuel combustion. Emissions from these include nitrogen oxides, sulfur oxides, ozone, carbon monoxide, and particulates. Finally, leaking tubing, valves, tanks, or open pits could potentially release volatile organic compounds (VOCs) into the air (USEPA 2000b).

3.1.2.4 Pipelines, Pumping Stations, and Oil Storage Facilities

In most cases, pipelines transfer oil and natural gas produced in both onshore and OCS offshore regions to an inland refinery, storage tank, or tanker terminal for further sea transport. An estimated 12,000 miles of offshore pipeline traverse the Gulf of Mexico; 16 percent are off of Louisiana’s southeast coast (Louis Berger Group 2004). An estimated 2,200 miles of pipeline cross the marshlands of southeast Louisiana. A majority of these pipeline transfer oil and gas from Port Fourchon across the terrain of Lafourche Parish.

There are five primary types of pipeline events that could potentially impact human health and safety (USDOT and USEPA 1999). These event types are:

- Normal operation
- Pipeline leak
- Pipeline rupture
- Pipeline rupture plus ignition
- Construction

The normal operation of gas and oil pipeline systems would result in minimal impacts to local populations. However, there does exist a potential for impacts to human health and safety in the event of an accidental release of the pipeline product. The two primary hazard scenarios associated with such a release would include pipeline leaks and pipeline ruptures. Both scenarios could conceivably result in fire or explosion.

While the impacts of a pipeline rupture may appear to be more severe, the effects of a small persistent leak may in fact result in the release of a greater amount of contaminants into the
environment. As one study reports, a leaking pipeline system can remain pressurized even though large leaks are present in the line, meaning that small leaks may go undetected over a long period of time (Maresca 1990). The groundwater contamination that results from such leaks present a potentially serious threat that could have a direct impact on public health, as subsurface aquifers and underground wells are often potable water sources.

The pipeline’s content determines its degree of potential hazard. For example, gasoline is much more flammable than crude oil, thus any spills or ruptures from a gas pipeline would have an increased risk of ignition. In fact, releases from gasoline pipelines are twice as likely to ignite as crude oil pipeline releases, primarily because of the higher vapor pressure of gasoline (USDOT and USEPA 1999). Furthermore, gasoline has a greater toxics concentration than crude oil. This combination of greater volatility and greater toxics concentration would make the hazards posed by inhalation of gasoline vapors higher than the corresponding risk from crude oil (USDOT and USEPA 1999). Potential human health and safety impacts that may result from a release of gasoline include:

- Fire or explosion
- Short-term exposure to hazardous vapors resulting from a gasoline spill
- Long-term exposure to hazardous vapors resulting from contaminated soils, groundwater, or surface water
- Exposure to toxic constituents of gasoline from ingestion.

These risks are heightened whenever there are exposed sections of pipeline that cross either a road or a waterway. This analysis weighs pipeline crossings more heavily than a buried pipeline, due to the fact that exposed pipelines are much more susceptible to the elements, thus potentially increasing the risk of a pipeline failure.

Storage tanks provide temporary storage for crude oil during the transportation process. Finished petroleum products are also kept in storage tanks before transport off site. Commonly,
mixtures of iron rust from corrosion, sand, water, and emulsified oil and wax accumulate at the bottom of these tanks (USEPA 1995). Tank bottom liquids and sludge are often removed during periodic cleaning of tanks and may contain amounts of hazardous materials, including etraethylortetramethyllead, other metals, and phenols. USEPA lists solids generated from leaded gasoline storage tank bottoms as a RCRA hazardous waste. In addition storage tanks account for considerable volatile organic compound (VOC) emissions at petroleum refineries. A study of petroleum refinery emissions found that the majority of tank losses occurred through tank seals on gasoline storage tanks (USEPA 1995). Although there are no refineries located in Lafourche or Jefferson Parishes, there are a number of petroleum bulk storage facilities located in each parish. In Lafourche Parish, these are located in and around Port Fourchon, where much of the product is initially brought ashore. In Jefferson Parish, smaller tank farms can be found in the onshore oilfields, with many of the larger farms located further upstream in storage areas along the Mississippi River.

3.1.2.5 Shipyards and Shipbuilding Yards

The shipbuilding and repair industry fabricates metal ships, barges, and other large vessels, whether self-propelled or towed by other craft (USEPA 1997). Lafourche Parish, as the primary embarkation site for the offshore oil industry, is home to a great many shipbuilding and repairing facilities, all of which are located along the two major waterways crossing the parish, Bayou Lafourche and the Intracoastal Waterway. Several common shipyard operations have the potential to generate RCRA hazardous wastes. According the USEPA, releases to the air, water, and land account for 37 percent of the shipbuilding and repair industry’s total reportable emissions and offsite transfers account for the remaining 63 percent. Air releases make up over 98 percent of the industry’s reportable emissions. VOCs account for
approximately 86 percent of these while metal-bearing waste make up the remainder. In total, Xylenes, n-butyl alcohol, toluene, methylethylketone, and methyl isobutyl ketone account for about 65 percent of the industry’s reported releases (USEPA 1997). These organic compounds are typically found in solvents that are used extensively by the industry in paint thinning and for cleaning and degreasing metal parts and equipment. Styrene accounts for about 4 percent of the industry’s releases. Styrene comprises a substantial portion of the resin mixtures and gelcoat used in fiberglass-reinforced construction. Finally, copper-, zinc-, and nickel-bearing wastes account for about 14 percent of the industry’s reported releases. Shipyards release these unanticipated fugitive emissions during metal plating operations and as overspray in painting operations and can also be released as fugitive dust emissions during blasting operations (USEPA 1997).

The shipbuilding and repairing industry involves a great many industrial processes, each of which has specific potential hazards (Table 14). For example, machining and metalworking are vital in the construction of large deepwater craft used in the Gulf of Mexico OCS region. There are a number of hazardous substances associated with machining, particularly those metalworking fluids contaminated with oils, phenols, creosol, alkalies, phosphorus compounds, and chlorine. Each one of these substances has the potential to spill into local waterways or leach into the local groundwater.

Solvent cleaning and degreasing ship parts and surfaces are also common sources of potentially hazardous waste streams. This process involves soaking, spraying, or otherwise treating parts and surfaces with a solvent. In addition to the solvents themselves, shipyards commonly use alkaline and acid cleaning solutions. Finally, the cleaning and degreasing process also produces cleaning filter sludges with toxic metal concentrations (USEPA 1997).
<table>
<thead>
<tr>
<th>Industrial Process</th>
<th>Material Inputs</th>
<th>Air Emissions</th>
<th>Wastewater</th>
<th>Residual Wastes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal Plating and Surface Finishing</td>
<td>Abrasives (steel shot, lead shot, steel grit, garnet, copper slag, and coal</td>
<td>Particulates (metal, paint, and abrasives) and VOCs from solvent cleaners and paint strippers.</td>
<td>Wastewater contaminated with paint chips, cleaning and paint stripping solvents, surface contaminants, and oil residues from bilges and cargo tanks.</td>
<td>Paint chips (potentially containing metals, tributyl-tin), spent abrasives, surface contaminants, and cargo tank residues.</td>
</tr>
<tr>
<td></td>
<td>slag), detergents, solvent paint strippers and cleaners, and caustic solutions.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Painting</td>
<td>Paints, solvents, and water.</td>
<td>VOCs from paint solvents and equipment cleaning solvents, and overspray</td>
<td>Waste equipment cleaning water and water wash spray paint booth sump water contaminated with paints and solvents.</td>
<td>Leftover paint and solvents, waste paint and solvent containers, spent paint booth filters, and spent equipment.</td>
</tr>
<tr>
<td>Fiberglass Reinforced Construction</td>
<td>Fiberglass, resin, solvents, curing catalysts, and wood and plastic reinforcing materials.</td>
<td>VOC emissions released during construction operations and curing (e.g. styrene) and during cleaning with solvents (e.g. acetone and methylene chloride).</td>
<td>Little or no wastewater generated.</td>
<td>Waste fiberglass, gelcoat, resin, unused resin that has exceeded its shelf life, spent solvents, and used containers.</td>
</tr>
<tr>
<td>Machining and Metal Working</td>
<td>Cutting oils, lube oils, and solvents.</td>
<td>VOC emissions from the use of cleaning and degreasing solvents.</td>
<td>Wastewater containing solvents, emulsified lubricating and cutting oils and coolants.</td>
<td>Waste cutting oils, lube oils, and metal chips and shavings.</td>
</tr>
</tbody>
</table>

Source: U.S. Environmental Protection Agency, 1997
Prior to the final painting and coating stage, vessels under construction must undergo metal plating and surface finishing and preparation to increase the hull’s corrosion and abrasion resistance. This process generally involves chemical and electrochemical conversion, case hardening, metallic coating, and electroplating. The electroplating operations produces a number of hazardous waste streams, including the wastewater treatment sludges, spent cyanide plating bath solutions, plating bath residues from the bottom of cyanide plating baths, and spent stripping and cleaning bath solutions from cyanide plating operations (USEPA 1997). These materials are not airborne and represent a potential source of water and groundwater pollution.

Following the electroplating stage, the ship’s metal surfaces must undergo preparation, painting, and coating before the process is completed. Depending on the particular application, shipyards may use several different types of paints. Paint types range from water-based coatings to high performance epoxy coatings, and selection depends on the environment that the coating will be exposed to. Anticorrosive and antifouling paints typically coat a ship’s hull and are the main two types of paint used in the shipbuilding industry. Antifouling paints help prevent the growth of marine organisms on the vessel’s hull. Copper-based and tributyl-tin-based paints provide antifouling properties. These paints release small quantities of toxics that discourage marine life from growing on the hull. Anticorrosive paints are either vinyl, lacquer, urethane, or newer epoxy-based coating systems (USEPA 1997). The shipbuilding industry uses both compressed air and airless paint sprayers, although use of the latter dominates. Both sprayer types present a risk of airborne pollution, although the risk is higher with compressed air sprayers due to the higher pressure involved in the spraying system.

Many shipyards also engage in ship repair and cleaning. Some of the shipbuilding processes, such as painting and coating of vessels also appear in repair operations, but a number
of other processes associated specifically with the ship repair industry exist as well, producing hazardous materials such as vessel sludges, cleaning wastewater, and cleaning wastewater sludges. As with shipbuilding, the vessel surface must undergo extensive preparation to remove surface contaminants such as mill scale, rust, dirt, dust, salts, old paint, grease, and flux (USEPA 1997). Blasting abrasives, which may result in the release of a combination of blasting abrasives and paint chips, are commonly used to accomplish this task. Airborne particulate emissions from this operation may also contain toxic metals, which are a potential concern for the area surrounding the shipyard, especially if they are blown off-site or into surrounding surface waters (USEPA 1997). Shipyard facilities typically control the release of particulate emissions by preparing surfaces indoors when possible, or by surrounding the work area with shrouding fences made of steel, plastic, or fabric.

3.2 Modeling Cumulative Impact

This study utilizes a number of methodologies that both draw from and contribute to USEPA guidelines for conducting environmental justice research. The study methods included a site-based equity analysis, utilizing demographic data obtained from the 2000 Census. Wherever possible, census block-level data provides the geographic scale, because it offers the finest level of detail available. According to USEPA, the geographic area of analysis should not artificially dilute or inflate the affected minority population (USEPA 1999a). The first stage involved compiling spatial data on present-day social and oil-related activity in each of the case study parishes. The approach involved combining minority, low-income, and environmental burden factors to examine the spatial distribution and overall hazard vulnerability of these populations (Hemmerling and Colten 2004).
The first step identifies what USEPA terms potential areas of environmental justice concern. These are study areas that contain a significant minority and/or low-income population, regardless of whether or not there exist any disproportionate environmental effects on these populations (USEPA 1998). Next, I compiled and mapped the locations of oil-related activity in each of the case study parishes. This includes the spatial distribution of onshore oil-related activity in Jefferson Parish, OCS-related activity in Lafourche Parish, and oil and gas processing related activities in Saint Bernard Parish. Finally, I constructed two cumulative hazard models: one proximity-based and the other risk-based.

3.2.1 Geographical Sources and Databases

The foundation of spatial data analysis and spatial modeling is obviously spatial data itself. At the most basic level, spatial data is made up of observations of some phenomenon that possesses a spatial reference (Fotheringham et al. 2000). The accuracy of this spatial reference is essential in the modeling process given that researchers often overlay and analyze this data based upon their co-location in geographical space. Environmental equity researchers have access to several government databases. Much of this data is available either as raw data for download or as informational maps. However, despite improved availability, all data is not of equal quality (Thomas 2001). It is important to remember that the model is only as accurate as the underlying data. This dissertation, like most environmental equity studies, relies on secondary data sources collected by the US Census Bureau, the US Environmental Protection Agency, or some other federal or state government agency. There are some general questions about the quality of these secondary data sources.

The Census Bureau reported 3.1 million erroneous enumerations and 5.7 million imputations for a total of 8.8 million persons not counted directly and correctly (U.S. Census
Monitoring Board 2001). When the Census Bureau received no response from occupied addresses, it “imputes” people based on data that the neighbors gave. Similarly, when people filled out a form and were counted but didn't give their race, age, sex or marital status, the bureau attributed one to them anyway, basing it on data their neighbors gave (Simpson 2001).

Erroneous census information may impact environmental equity studies in several ways. To begin, the Census Bureau undercounted minorities and low-income persons at a higher rate than the white population in 2000. This differential undercount has persisted since 1940, though it has continued to drop with each subsequent census. A geographical bias also exists in the census data. The overall rate of undercount was slightly higher in non-metropolitan areas than elsewhere. With regard to race, Hispanic undercounts were higher in non-metropolitan areas, while the opposite was true for African Americans.

The U.S. Census Monitoring Board has also found that higher poverty rates are also associated with higher rates of undercount. The Census Bureau has difficulty enumerating neighborhoods with high poverty, low education, crowded housing, and high crime rates, leading to higher rates of omission and erroneous enumeration. This problem is exacerbated in neighborhoods where residents speak a foreign language (U.S. Census Monitoring Board 2001).

Most of the environmental hazards databases are self-reported, leaving many questions about both attribute and positional accuracies. This is true of both the USEPA Toxic Release Inventory (TRI) and the United States Coast Guard National Response Center (NRC) data this dissertation utilized. TRI releases, for example, are self-reported annual estimates, and facilities may either over- or underestimate their releases, depending upon their estimation methodology. Some facilities fail to report at all or report only some of their covered chemicals. Additionally, the amounts reported could be the result of a single release or may have been released evenly throughout the year (Thomas 2001).
Finally, many of national geospatial databases contain geographic data that are positionally incorrect. Again, information in these databases is self-reported, including infrastructure location. In the case of geographic pipeline data contained within the National Pipeline Mapping System, for example, the positional accuracy of the GIS layer depends on the spatial accuracy of the pipeline operators' submission to the U.S. Department of Transportation. Similarly, environmental hazards databases rely on the spatial accuracy of facility owners’ data. Wherever possible, attempts were made to verify the accuracy of the data obtained, either through air photo interpretation or direct fieldwork using a hand-held global positioning system (GPS).

3.2.1.1 Louisiana State University ATLAS Website

One of the greatest secondary sources of data has been the Louisiana State University ATLAS website (CADGIS Research Laboratory 2002). Serving as a data repository and internet portal for Louisiana GIS datasets, the ATLAS website gathered together many of the images and GIS coverages used in this research, including georeferenced USGS Digital Ortho Quarter Quad aerial photographs (DOQQs) and U.S. Census Bureau geographical data.

3.2.1.2 U.S. Bureau of Census

The United States decennial census was the major source of population and housing data used in this research, including race, ethnicity, income, and house values. While the decennial census is the most important source of demographic data, it represents a snapshot in time of the enumeration areas and soon becomes outdated. The usefulness of census data gradually diminishes as the time from the last census increases, particularly in rapidly changing areas. For slowly changing areas, using previous census data presents fewer biases (Liu 2001).
The outcome-based portion of this research utilizes 2000 census data (U.S. Bureau of the Census 2002a). I extracted total population, race (white, black, Native American, and Asian), and ethnicity (Hispanic) data from Census Summary File 1 (SF1), and social, economic, and housing characteristics from Census Summary File 3 (SF3). In addition, I used some 1990 block-level census information from the 100-percent count data in CD-ROM Summary Tape Files (STF1A and B), specifically median contract rent and median house values, which were only enumerated at the block-group level in the 2000 census (U.S. Bureau of Census 1990).

Census-defined geography has a hierarchical structure that the Census Bureau uses to collect, process, and distribute census data (Liu 2001). In Louisiana, parishes are the primary political divisions, followed by tracts, block groups, and blocks, in descending size. Each unit of census geography has an established minimum, maximum, and optimum population threshold that is standard throughout the United States. Because of these thresholds, rural census units are much larger than urban units and also contain much more uninhabited area.

The process-based portion of this research also relies heavily on decennial census data. However, the standardized census geography used in the 1990 and 2000 censuses was not completely enumerated in the historical censuses. In fact, 1990 was the first year the Census Bureau enumerated the entire United States at the block and block group levels (Liu 2001). Furthermore, census tract coverage, generally seen as the most stable through time, is incomplete for the rural areas where most of the oil- and gas-related industries operate. In addition, pre-1960 census tracts tend to have much larger geographical areas than those in more recent censuses, resulting in a study area that is less representative of the true impact area (Liu 2001). Because of these inconsistencies, I used the Jury Ward, a political jurisdiction, as a measure of population change through time. Like the early census tracts, wards tend to be substantially
larger than census blocks and block groups, increasing the possibility of aggregation errors and ecological fallacies. Nevertheless, political jurisdictions are generally the smallest geographical levels of decision making involving land uses and other social problems, making them useful units of analysis in environmental justice analyses (Liu 2001).

3.2.1.3 U.S. Coast Guard National Response Center

The United States Coast Guard National Response Center (NRC), established by Executive Order in 1974, handles communications for emergency responders and provides current information to national and regional response teams (Hogue 2000). The NRC serves as the primary contact point for reporting all oil, chemical, radiological, biological, and etiological discharges into the environment anywhere in the United States and its territories. This includes incidents that occur in connection with activities regulated under the Outer Continental Shelf Lands Act and the Deepwater Port Act, as well as those that affect natural resources under the jurisdiction of the Fishery Conservation Management Act (USCG 2005). All the data that is collected by the NRC is available in spreadsheet format and available to the public. Pertinent to this study is data related to the release of hazardous substances from pipelines, fixed facilities, storage tanks, and roadway accidents.

3.2.1.4 U.S. Department of Transportation

The Pipeline Safety Act of 1992 states that the Office of Pipeline Safety (OPS) must adopt rules requiring pipeline operators to identify facilities located in unusually sensitive areas and high density population areas, to maintain maps and records detailing that information, and to provide those maps and records to federal and state officials upon request. The U.S. Department of Transportation (USDOT) developed the National Pipeline Mapping System
(NPMS) to gather and disseminate this information in a geographic information system (GIS) database format (USDOT 2001). This database contains the location and selected attributes of natural gas and hazardous liquid transmission pipelines, and liquefied natural gas (LNG) facilities operating in the United States.

3.2.1.5 U.S. Environmental Protection Agency

Manufacturing facilities under section 313 of Title III of the Superfund Amendments and Re-authorization Act (SARA) must report estimated releases and transfers of toxic chemicals to the USEPA. The Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986 brought about the creation of a database that stores this information and makes it available to the public (USEPA 2002). The Environmental Protection Agency thus gathers and disseminates information on the generation and management of waste streams and gathers these together in the Biennial Reporting System (BRS). This database tracks a variety of sites, including Treatment, Storage, and Disposal (TSD) facilities, Corrective Action Sites (CAS), and hazardous waste generators, all of which present potential risks. Sources of hazards data include the Toxic Release Inventory System (TRIS), which contains information about the release and transfer of more than 650 toxic chemicals to the environment. Also pertinent to this study is the Emergency Response Notification System (ERNS) database, which stores information on the reported release of oils and other hazardous substances to the air, land, or water. All of the sites identified in these databases have a Standard Industrial Classification (SIC) code that classifies them by industry. Of particular interest for this study are those industries classed under SIC code 13, which encompasses the oil and gas extraction process. In the case of the offshore oil industry, those facilities listed under SIC code 1321 (Natural Gas Liquids) are of importance, as these include facilities that separate natural gas from crude oil. Also important here are industries with
SIC codes 3731 and 3732 (Ship Building and Repairing and Boat Building and Repairing, respectively) and 2911 (Petroleum Refining Industry). Finally, industries with SIC codes 4613 (Refined Petroleum Pipelines) and 5171 (Petroleum Bulk Stations and Terminals) conduct important downstream petroleum-related activities.

3.2.1.6 U.S. Geological Survey

The U.S. Geological Survey (USGS) represents a major data source for geographical information. Of particular importance for this research were the Digital Ortho Quarter Quads (DOQQs), which I used to verify the geographic coordinates of the USEPA data. USGS geographically rectified these air photos and they are reliable sources both for their data content and base layer utility.

In addition to the most recent remotely sensed images and aerial photographs, USGS is also a major source of paper maps, both contemporary and historical, which I scanned and digitized to be used in the GIS. Again, these data sources have been useful in conducting historical analysis of many of the case study areas.

Finally, USGS served as a major source for natural resource distribution and wildlife habitat. The Gap Analysis Program (GAP) represents a state and national level endeavor to provide broad geographic information on the status of various animal species and their habitats to provide land managers, planners, scientists, and policy makers. Sponsored and coordinated by the Biological Resources Division of the U.S. Geological Survey, GAP is also receives support at the national level from the Department of Defense, the U.S. Environmental Protection Agency, the National Mapping Division of the U.S. Geological Survey, and The Nature Conservancy.
3.2.1.7 U.S. Minerals Management Service

The Minerals Management Service (MMS), a federal agency created by Secretarial Order 3071 on January 19, 1982, manages more than a billion offshore acres and collects billions of dollars in mineral revenues annually. MMS is the bureau of the U.S. Department of the Interior that manages the natural gas, oil, and other mineral resources on the outer continental shelf. MMS conducts an extensive environmental studies program in the Gulf of Mexico and has sponsored more than 220 environmental studies in the Gulf of Mexico, costing over $130 million, to assess the effect of oil and gas drilling and production. The results of these studies appear in a number of reports that serve as the primary source for OCS-related data. Of particular interest to this study are studies that locate and identify any OCS-related facilities that support deepwater activity in the Gulf of Mexico Region (GOMR), especially the recent study completed by the Louis Berger Group for MMS, which includes a web-based GIS database of pertinent infrastructure (Louis Berger Group 2004).

3.2.2 Integrating and Analyzing Data with GIS

A Geographic Information System (GIS) provides the technology for displaying and overlaying locational information and population and site characterization on one or more maps (Liu 2001). Generally, a GIS consists of four essential subsystems without which it cannot be considered fully functional (Johnson 2003). First is data input or assembly. As described above, data can come from a number of sources and can be in a variety of formats. This data must be managed or stored in such a way that users can access and query it in consistent ways. Thirdly, and most importantly, a GIS gives researchers the ability to manipulate or analyze data and to compare, aggregate, reclassify, and create projections of future situations. This ability gets to the heart of spatial data analysis and spatial modeling. Without it, a GIS is little more than an input-
output system (Johnson 2003). Finally, a GIS provides users with an effective means of displaying data. At the most basic this includes the production of maps, though it may also include other forms of output such as charts, graphs, and tables. Again, a fully functional GIS must necessarily include each of these four elements.

In environmental equity research, one of the principal advantages of using a GIS is the ability to identify alternative units of analysis through its analytic capability. In general, a single unit of census geography such as a census tract or zip code may be a poor unit of analysis or could be misleading because of border effects when attempting to evaluate environmental equity claims (Liu 2001). The GIS allows researchers to use alternative methodologies such as adjacency analysis and buffer analysis to more effectively model the area of potential impact around a hazardous site. Another powerful ability of the GIS in evaluating environmental equity is the ability to intersect two or more layers, creating a new geometry. This type of overlay analysis lies at the heart of the cartographic modeling methodology used in this dissertation. The following sections will detail this methodology in relation to both proximity- and risk-based environmental equity analyses.

### 3.2.2.1 Proximity-Based Analyses

Previous studies have shown that the results of equity analyses are sensitive to the methods used to delineate the impact areas (Sheppard et al. 1999). In this portion of the analysis, the approach taken is largely proximity-based, although modified to include some risk-based aspects. In examining the potential impacts of petroleum-related activities, a purely risk-based analysis would provide an incomplete view of the industry, since USEPA requires that businesses only report certain releases and thus only a handful of facilities have documented a release of any kind. Very few studies have explored methods for characterizing and mapping
releases for the types of non-TRI-reporting facilities used in this study (Dolinoy and Miranda 2004). In order to examine the industry as a whole, and because we are dealing with potential rather than actual impacts, it is necessary to incorporate a proximity-based analysis into the study.

Proximity-based equity refers to the question of whether the distance-related impacts of one or more facilities are distributed evenly among the social groups in the local population (Glickman and Hersh 1995). These impacts are not only health or safety-related as in a risk-based analysis, but may also include effects that have negative impacts on the overall quality of life, including unsightliness, noise, and odor. If these impacts are strong enough, they will “diminish the collective self-esteem and reputation of a community and the property values within it” (Glickman and Hersh 1995).

3.2.2.1.1 Buffering

In conducting a proximity-based analysis, the geographical unit of analysis is a uniform circular buffer created around each facility or structure in question. Proximity-based buffers determine the presence or absence of any effect, regardless of magnitude, and thus do not rigorously account for distance decay and the diffusion of toxic chemicals released into the atmosphere (Sheppard et al. 1999). Because this type of analysis assumes that any chemical release has the potential to impact all locations within the buffer, the selection of buffering distances becomes all the more important.

Using USEPA’s Risk Management Program computer modeling software (RMP*Comp), I performed a worst-case release scenario and offsite consequence analysis for each petroleum-related facility and determined the distance at which certain effects might occur to the public because of an accidental release (called the “endpoint” distance). In the case of flammable
substances, people at the endpoint distance could be injured by the force of the blast, by flying glass, or by falling objects. For the release of a toxic substance, people at the endpoint distance would be able to walk away from the exposure without any long-term health consequences, although some short-term consequences such as eye or throat irritation would be likely (USEPA 1999c). Following USEPA guidelines, I used the release that resulted in the greatest distance to the endpoint to determine the size of the facility buffers. U.S. Department of Transportation (USDOT) guidelines establish default isolation zones for hazardous releases on arterial highway segments (Cutter et al. 2000). These distances are all used to create site-specific around each facility.

3.2.2.1.2 Modeling

After creating the buffer zones, I overlaid them to create a cumulative hazard density model that allows for an examination of the spatial variability in locational exposure based on proximity to multiple sources of environmental threats (Cutter, Hodgson, and Dow 2001). The model consists of seven different oil- and gas-related infrastructure types as well as three additional data layers used as weighting surrogates. The first of these weighting surrogates, the facility’s status as a USEPA Large Quantity Generator (LQG) of toxic substances, speaks to the volume of hazards produced. The second weighting surrogate, whether or not the facility has appeared on the TRI, speaks to that facility’s history of toxic releases, both routine and accidental. The TRI tracks manufacturing facilities that process more than 25,000 pounds or use more than 10,000 pounds of any one of the 650 TRI chemicals and requires them to report emissions to the USEPA (Dolinoy and Miranda 2004). The final surrogate weight applied to the model involved pipeline crossings. Locations were pipelines cross streams, bayous, and
roadways are more exposed, thus increasing their vulnerability to accidental releases. All three factors imply a higher potential for hazardousness.

It is important to remember that we are considering potential hazards. Thus, a shipyard classed as a Large Quantity Generator of hazardous waste has greater potential hazardousness and receives a heavier weight in the analysis than a facility that is not. Furthermore, if this facility has a history of toxic releases, either routine or accidental, it receives a cumulatively heavier weight. Similarly, the exposed pipeline sections that cross either a road or a waterway receive a heavier weight in the model than a buried pipeline, due to the fact that exposed pipelines are much more susceptible to the elements, thus potentially increasing the risk of a pipeline failure.

In this proximity-based analysis, a simple arithmetic overlay produces a conceptual model of the potential hazardscape related to the onshore impact of oil- and gas-related infrastructure in each of the case study parishes. To accomplish this, I reclassified and overlaid the maps using a process termed “sieve mapping” (Kitchin and Tate 2000: 170). Each facility, buffered out to the toxic endpoint distance, receives a value of one. Additionally, TRI sites, LQG sites, and pipeline crossings receive a value of one. Using GIS, I transformed all of the vector surfaces into a number of 30-meter resolution raster grid cells. Raster grid cells are significantly smaller than the original vector surfaces and the GIS is able to aggregate data to a variety of larger areal units (Mennis 2002). Using the model building capability of ArcView 3.2 and ArcGIS 9.1, all of the rasterized facilities and buffers were combined into a single composite of intersecting grid cells. This composite surface classifies all locations in the parish according to their cumulative hazards density value, which was then broken down into quintiles, with one indicating the lowest hazard potential and five the highest. Those areas with no identified
potential hazards were assigned a value of zero and classed separately. Finally, I assigned a hazards rating to each census block and block group in the study based on the hazards quintile of the grid cell located at the centroid of the enumeration area. This allowed me to operationalize the model and analyze the potential environmental equity impacts of the entire network of oil- and gas-related infrastructure in each of the three case study parishes.

In attempting to operationalize this conceptual model, I have focused on the following three elements: biophysical, social, and place vulnerability (Cutter et al. 2000). These three outcome indicators enabled measurement of the potential hazardousness of each parish as it relates to expanding oil- and gas-related activity. Biophysical vulnerability measures the delineation of industry-specific hazard zones, and social vulnerability was measured using social and demographic characteristics. The overlap of the two gives overall place vulnerability, the third outcome indicator.

3.2.2.2 Risk-Based Analyses

One of the major problems encountered in conducting environmental equity analyses is the necessity to classify various waste streams according to their potential hazardousness to the environment and the community. This is especially important when conducting research that compares two or more types of facilities. A proximity-based analysis effectively examines proximity to multiple sources of environmental threats, but is unable to quantify the relative degree of risk. Risk-based analysis, in contrast, utilizes mathematical processes to model the distribution of contaminants in the environment estimate the potential environmental effects (Batterman and Huang 1996). In this type of analysis, risk derives not only the distance from a facility, but from the “magnitude of the hazards and the size, shape, and orientation of the associated impact areas” (Glickman and Hersh 1995:9). Risk-based environmental equity
combines toxic release information with chemical toxicity and models distance decay and the diffusion of toxic chemicals released into the atmosphere.

### 3.2.2.2.1 Measuring Potential Risk Exposures by Facility

This research extends the locational model used in the previous section to incorporate relative measures of potential health threats based on the toxicity and the relative magnitude of potential toxic emissions. The Toxic Release Inventory (TRI) provided state-level data for all reporting facilities for 1991-2000. This portion of the research gathered and analyzed data on all chemicals released by facilities with specific oil-related Standard Industrial Codes (SIC). To maintain consistency in the data set, I removed several classes of toxins from the analysis due to TRI reporting changes enacted in 2000. In addition, USEPA added seven chemicals and two chemical compound categories to the list of toxic chemicals subject to reporting under EPCRA section 313. The following chemicals were not on the list previously and had never been included as part of the TRI prior to 2000 (Eck 2000):

- dioxin and dioxin-like compounds
- benzo (g,h,i) preylene
- benzo (j,k) fluorine or fluoranthene
- 3-methylcholanthrene
- octachlorostyrene
- pentachlorobenzene
- tetrabromobisphenol A
- vanadium (except in alloys, which is exempt)
- vanadium compounds

USEPA eliminated the _de minimis_ exemption for the dioxin and dioxin-like compounds category, meaning that as of 2000, facilities must include all amounts of dioxin and dioxin-like compounds in threshold determinations and release and other waste management calculations regardless of the concentration of these in mixtures or trade name products (USEPA 2000).

Dioxin (2,3,7,8-Tetrachlorodibenzo-p-Dioxin) is a Persistent, Bioaccumulative, Toxic (PBT)
chemical that forms as a byproduct of the combustion of organic materials. Polychlorinated dibenzo-para(p)-dioxins (CDDs) and polychlorinated dibenzofurans (CDFs) constitute a group of PBT chemicals that are termed “dioxin-like,” meaning that these compounds have similar physical-chemical properties and therefore have similar toxic responses (USEPA 2000). In total, the TRI now includes some twenty PBT chemicals and chemical categories.

Finally, in 2000, the USEPA lowered the reporting thresholds for 18 chemicals and chemical categories that meet the Emergency Planning and Community Right-to-Know Act (EPCRA) section 313 criteria for persistence and bioaccumulation, such as mercury and mercury compounds, polychlorinated biphenyls (PCBs), and polycyclic aromatic compounds. In many cases, the federal agency reduced reporting threshold for many of these toxins from 100 pounds of release to ten pounds. As a result, many of these toxins “appear” in the 2000 TRI. In order to maintain consistency in the data set across time, this research examined data from the 2000 TRI and removed any PBT chemicals with a maximum release of fewer than 100 pounds.

Once adjusted, I queried the TRI data by SIC code, extracting all relevant petroleum-related facilities in Louisiana. Using basic descriptive statistics, I examined the total statewide releases over the ten-year span from 1990 to 2000 and determined the mean frequency of release for each class of chemical. Where the total number of releases was greater than the overall mean for a specific SIC code, I included that chemical in the data set. This allowed me to create an average hazard potential for each class of facility.

Unlike manufacturing facilities (such as shipyards, storage facilities, and refineries), oil and gas extraction facilities are not required by EPCRA to report to the TRI. As a result, data for oil extraction and reinjection wells had to be obtained from other sources. The Aerometric Retrieval System (AIRS) is an air pollution data delivery system managed by USEPA’s Office of
Air Quality Planning and Standards (USEPA 2000). Using its data, the amount of Hazardous Air Pollutants (HAPs) released by the oil fields could be determined and quantified in much the same way as the TRI-reporting facilities.

The air releases associated with oil and gas fields represent only part of the potential wastes released. As USEPA notes, produced water is the largest volume waste generated in oil and gas extraction operations (USEPA 2000). In order to more accurately model the total releases from oil and gas extraction operations, this research includes any priority organic and metal pollutants listed by the USEPA Office of Water as contaminants in Gulf of Mexico produced water (See Table 12).

The combination of these two values gives an estimate of the total chemical releases for each oil field. In calculating the toxicity for the individual production and reinjection wells, the analysis utilized the air releases that were associated with the entire oil field and the toxicity associated with the produced water. These values, summed and multiplied by the total number of oil fields located within the parish, divided by the total number of wells in the parish provide a rough estimate of the releases associated with each individual well or waste pit.

Finally, I determined the potential releases associated with each of the line-based infrastructure types, the transportation corridors and pipelines. The USEPA has measured Hazardous Air Pollutants for roadways in each parish in both tons per year and tons per year per square mile, and they provide a basis to model the total roadway releases. For the pipelines, two surrogates enable the modeling of the potential releases: the chemicals associated with the petroleum bulk storage facilities serve as a measure for crude oil pipelines while those associated with natural gas processing plants provide the basis for potential releases from natural gas pipelines.
The next step in the research was to determine the chemical toxicity of each chemical in the analysis. Previous research has shown that the Environmental Defense Fund Toxic Equivalent Potential (TEP) has indexed more chemicals than many of the other toxicity indices, such as Threshold Limit Values, the Pratt Index, and the USEPA Priority Chemical List. Yet, subtle differences between these toxicity indices have been shown to create statistical and spatial variations in the overall results of equity analyses (Cutter, Scott, and Hill 2002). This research utilizes chemical toxicity measures developed by the Indiana Pollution Prevention and Safe Materials Institute (IPPI), which developed a quantitative method for measuring progress in pollution prevention. The IPPI used the University of Tennessee Total Hazard Value (Total UTN), supplemented by a score to quantify hazard to workers (Whaley 1996). One criticism made of the Total UTN is that it tends to focus on contaminants that tend to occur in aqueous natural systems because of its emphasis on the aquatic environment. Conversely, the worker score focuses on gases and vapors in the workplace environment, where the primary route of exposure is most commonly inhalation of airborne contaminants. Taken together in the Indiana Relative Comparative Hazard Score (IRCHS), the two scores tend to be complementary, emphasizing different routes of exposure, ranking chemicals by hazard to the environment as well as workers and neighboring residents (Whaley 1996).

This analysis also utilizes a standardized value to estimate the potential amount of chemical that may be released. By using a standard score in place of actual pounds, I am able to use this calculation to classify facilities not reporting on the TRI. In cases where the facility does not appear on the TRI, the base data provides the potential toxicity value. The multiplier used in these cases is one, which represents those releases of 0 to 99 pounds of chemical. Thus, we are assuming that a facility not reporting on the TRI has no releases, although there is the potential for release.
Using the toxicity measures obtained from the IRCHS and the relative amount of chemical releases, a relative potential risk exposure score was calculated for both class of facility and individual facilities:

\[
RPRS_f = \sum_{c}^{n} (A_c \cdot T_c)
\]

where: \( RPRS_f \) = relative potential risk score for a given facility, \( f \); \( n \) = number of chemicals released by facility, \( f \); \( A_c \) = standardized maximum amount of chemical \( c \); \( T_c \) = toxicity measure of chemical \( c \) based on the Indiana Relative Comparative Hazard Score.

This computation is similar to the relative potential risk exposure model developed by Susan Cutter (Cutter, Hodgson, and Dow 2001, Cutter, Scott, and Hill 2002). However, Cutter’s model utilizes the amount of chemicals released by the facility in pounds. By using a standard score in place of actual pounds, I am able to use this calculation for all facilities, including those not reporting on the TRI (Tables 15-21).

3.2.2.2 Buffering

To begin to make sense of these complex industrial landscapes, I buffered each of the pertinent facilities and examined the Regional Management Plans (RMPs) for many facilities located within the study areas to model worst case scenario chemical releases based upon the facility type. The model helps determine the distance at which certain effects might occur to the public because of an accidental release (called the “endpoint” distance). In the case of flammable substances, at the endpoint distance, people could be injured by the force of the blast, by flying glass, or by falling objects. For the release of a toxic substance, people at the endpoint distance would be able to walk away from the exposure without any long-term health consequences, although some short-term consequences such as eye or throat irritation would be likely.
<table>
<thead>
<tr>
<th>Refinery Releases</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzene</td>
<td>48</td>
</tr>
<tr>
<td>Toluene</td>
<td>29.1</td>
</tr>
<tr>
<td>ethyl benzene</td>
<td>24.3</td>
</tr>
<tr>
<td>Xylene</td>
<td>26.1</td>
</tr>
<tr>
<td>Cyclohexane</td>
<td>23.5</td>
</tr>
<tr>
<td>Trimethylbenzine</td>
<td>17.4</td>
</tr>
<tr>
<td>sulfuric acid</td>
<td>29.3</td>
</tr>
<tr>
<td>propylene glycol</td>
<td>14.2</td>
</tr>
<tr>
<td>Ammonia</td>
<td>21.8</td>
</tr>
<tr>
<td>Ethylene</td>
<td>19.3</td>
</tr>
<tr>
<td>Naphthalene</td>
<td>29.2</td>
</tr>
<tr>
<td>Chlorine</td>
<td>31.6</td>
</tr>
<tr>
<td>methyl tert-butyl ether</td>
<td>28.7</td>
</tr>
<tr>
<td>butadiene (1-3)</td>
<td>40.6</td>
</tr>
<tr>
<td>Methanol</td>
<td>24.7</td>
</tr>
<tr>
<td>hydrofluoric acid</td>
<td>50</td>
</tr>
<tr>
<td>Cumene</td>
<td>31.7</td>
</tr>
<tr>
<td>Phenol</td>
<td>30.6</td>
</tr>
<tr>
<td>Diethanolamine</td>
<td>20.3</td>
</tr>
<tr>
<td>phosphoric acid</td>
<td>17.2</td>
</tr>
<tr>
<td>molybdenum trioxide</td>
<td>6.8</td>
</tr>
<tr>
<td>Nickel</td>
<td>32.1</td>
</tr>
<tr>
<td>Zinc</td>
<td>10.6</td>
</tr>
<tr>
<td>Cobalt</td>
<td>19.9</td>
</tr>
<tr>
<td>Hexane</td>
<td>31</td>
</tr>
<tr>
<td>Nitrate compounds (ammonium nitrate solution)</td>
<td>18.1</td>
</tr>
<tr>
<td>polycyclic aromatic compounds (average of all pac)</td>
<td>28.1</td>
</tr>
</tbody>
</table>

**TOTAL** 704.2

Source: Indiana Clean Manufacturing Technology and Safe Materials Institute, 2004; U.S. Environmental Protection Agency 2004
### Table 16 Common Shipyard Releases and Associated Toxicity Values

<table>
<thead>
<tr>
<th>Shipyard Releases</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Xylene</td>
<td>26.1</td>
</tr>
<tr>
<td>butyl alcohol</td>
<td>19.4</td>
</tr>
<tr>
<td>Copper</td>
<td>29.4</td>
</tr>
<tr>
<td>Styrene</td>
<td>32.7</td>
</tr>
<tr>
<td>Zinc</td>
<td>10.6</td>
</tr>
<tr>
<td>zinc oxide fume and dust (ZnO)</td>
<td>11.6</td>
</tr>
<tr>
<td>Chromium</td>
<td>32.7</td>
</tr>
<tr>
<td>methyl ethyl ketone</td>
<td>27.9</td>
</tr>
<tr>
<td>Toluene</td>
<td>29.1</td>
</tr>
<tr>
<td>Nickel</td>
<td>32.1</td>
</tr>
<tr>
<td>Copper</td>
<td>29.4</td>
</tr>
<tr>
<td>Trimethylbenzine</td>
<td>17.4</td>
</tr>
<tr>
<td>Methanol</td>
<td>24.7</td>
</tr>
<tr>
<td>Manganese</td>
<td>21.3</td>
</tr>
<tr>
<td>manganese (II) oxide</td>
<td>22.8</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>367.2</strong></td>
</tr>
</tbody>
</table>

Source: Indiana Clean Manufacturing Technology and Safe Materials Institute, 2004; U.S. Environmental Protection Agency 2004

### Table 17 Common Petroleum Bulk Storage Releases and Associated Toxicity Values

<table>
<thead>
<tr>
<th>Petroleum Bulk Storage Releases</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzene</td>
<td>48</td>
</tr>
<tr>
<td>Toluene</td>
<td>29.1</td>
</tr>
<tr>
<td>ethyl benzene</td>
<td>24.3</td>
</tr>
<tr>
<td>Xylene</td>
<td>26.1</td>
</tr>
<tr>
<td>Trimethylbenzine</td>
<td>17.4</td>
</tr>
<tr>
<td>Naphthalene</td>
<td>29.2</td>
</tr>
<tr>
<td>methyl tert-butyl ether</td>
<td>28.7</td>
</tr>
<tr>
<td>Hexane</td>
<td>31</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>233.8</strong></td>
</tr>
</tbody>
</table>

Source: Indiana Clean Manufacturing Technology and Safe Materials Institute, 2004; U.S. Environmental Protection Agency 2004
Table 18 Common Natural Gas Liquids Releases and Associated Toxicity Values

<table>
<thead>
<tr>
<th>Natural Gas Liquids Releases</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trimethylpentane</td>
<td>20.1</td>
</tr>
<tr>
<td>Benzene</td>
<td>48</td>
</tr>
<tr>
<td>Toluene</td>
<td>29.1</td>
</tr>
<tr>
<td>ethyl benzene</td>
<td>24.3</td>
</tr>
<tr>
<td>ethylene glycol</td>
<td>16</td>
</tr>
<tr>
<td>Methanol</td>
<td>24.7</td>
</tr>
<tr>
<td>Xylene</td>
<td>26.1</td>
</tr>
<tr>
<td>Chlorine</td>
<td>31.6</td>
</tr>
<tr>
<td>Hexane</td>
<td>31</td>
</tr>
<tr>
<td>hydrochloric acid</td>
<td>34.5</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>285.4</strong></td>
</tr>
</tbody>
</table>

Source: Indiana Clean Manufacturing Technology and Safe Materials Institute, 2004; U.S. Environmental Protection Agency 2004

Table 19 Common Oil and Gas Field Air Releases and Associated Toxicity Values

<table>
<thead>
<tr>
<th>Oil and Gas Field Air Releases</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trimethylpentane</td>
<td>20.1</td>
</tr>
<tr>
<td>Benzene</td>
<td>48</td>
</tr>
<tr>
<td>ethyl benzene</td>
<td>24.3</td>
</tr>
<tr>
<td>ethylene glycol</td>
<td>16</td>
</tr>
<tr>
<td>Hexane</td>
<td>31</td>
</tr>
<tr>
<td>Methanol</td>
<td>24.7</td>
</tr>
<tr>
<td>Toluene</td>
<td>29.1</td>
</tr>
<tr>
<td>Xylene</td>
<td>26.1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>219.3</strong></td>
</tr>
</tbody>
</table>

Source: Indiana Clean Manufacturing Technology and Safe Materials Institute, 2004; U.S. Environmental Protection Agency 2004
### Table 20 Common Roadway Air Releases and Associated Toxicity Values

<table>
<thead>
<tr>
<th>Roadway Air Releases</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>butadiene (1-3)</td>
<td>40.6</td>
</tr>
<tr>
<td>Acetaldehyde</td>
<td>37.9</td>
</tr>
<tr>
<td>Acrolein</td>
<td>57</td>
</tr>
<tr>
<td>Benzene</td>
<td>48</td>
</tr>
<tr>
<td>Diesel</td>
<td>14.7</td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>43.1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>241.3</strong></td>
</tr>
</tbody>
</table>

Source: Indiana Clean Manufacturing Technology and Safe Materials Institute, 2004; U.S. Environmental Protection Agency 2004

### Table 21 Common Oil and Gas Field Waste Pit Releases and Associated Toxicity Values

<table>
<thead>
<tr>
<th>Oil and Gas Field Waste Pits</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>dimethylphenol-2,4</td>
<td>15</td>
</tr>
<tr>
<td>Benzene</td>
<td>48</td>
</tr>
<tr>
<td>ethyl benzene</td>
<td>24.3</td>
</tr>
<tr>
<td>Naphthalene</td>
<td>29.2</td>
</tr>
<tr>
<td>Phenol</td>
<td>30.6</td>
</tr>
<tr>
<td>Toluene</td>
<td>29.1</td>
</tr>
<tr>
<td><strong>PRIORITY ORGANIC POLLUTANTS</strong></td>
<td><strong>176.2</strong></td>
</tr>
<tr>
<td>Cadmium</td>
<td>32.9</td>
</tr>
<tr>
<td>Chromium</td>
<td>32.7</td>
</tr>
<tr>
<td>Copper</td>
<td>29.4</td>
</tr>
<tr>
<td>Lead</td>
<td>33.3</td>
</tr>
<tr>
<td>Nickel</td>
<td>32.1</td>
</tr>
<tr>
<td>Silver</td>
<td>16.6</td>
</tr>
<tr>
<td>Zinc</td>
<td>10.6</td>
</tr>
<tr>
<td><strong>PRIORITY METAL POLLUTANTS</strong></td>
<td><strong>187.6</strong></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>363.8</strong></td>
</tr>
</tbody>
</table>

Source: Indiana Clean Manufacturing Technology and Safe Materials Institute, 2004; U.S. Environmental Protection Agency 2004
The endpoint distances enable the creation of a series of buffers around each of the facilities. In the proximity-based analysis, I used uniform buffers to test for the absence or presence of potential effects. Here, I use a series of buffers to model the potential dispersion of hazards around various facilities and infrastructure types. A quartic function is applied to a limited area around each incident location defined by the radius of the buffer at the toxic endpoint.

\[
g(x_j) = \sum \left\{ \left[ W_i \cdot I_j \right] \cdot \left[ \frac{3}{h^2 \cdot \pi} \right] \cdot \left[ 1 - \frac{d_{ij}^2}{h^2} \right]^2 \right\}
\]

where: \( g(x_j) \) = relative potential risk score at any given distance, \( j \); \( W_i \) and \( I_j \) = relative potential risk score for a given facility at the point location, \( i \); \( h \) = endpoint distance; \( d_{ij} \) = distance from the facility to any reference point within the buffer, \( j \).

Using the quartic function, the relative potential risk score falls off gradually with distance until the radius is reached. Outside of the specified radius, the value of the potential risk score is assumed to be zero. For line data, such as transportation corridors and the various types of pipeline, the quartic formula enables the calculation of five equidistant buffers. For point locations, such as oil wells, waste pits, and pipeline crossings, where the locations may number in the hundreds, I employed CrimeStat II to create a kernel density surface. The CrimeStat program allows me to input the relative potential risk score and specify that the quartic function be used to calculate the density surface. Further analysis is possible through the GIS.

In order to scale the results, I calculated the quartic function twice. First, I used the actual endpoint distance to determine the potential risk score. I then used a distance of one as the endpoint for all facilities. By adjusting the potential relative risk score by the ratio of the two values, I am able to maintain accurate comparative ratios between different facilities.
3.2.2.3 Modeling

The standardized amount and toxicity of each chemical is incorporated into the riskscape, allowing for the creation of a toxicity surface for each facility. With this data, I model each parish’s total risk surface. This is done by creating an arithmetic overlay model that incorporates all of the facilities into a single overarching hazardscape. Once the model integrates all the facilities, I used the resultant hazards value to classify each location in the case study parishes by a new weighted hazardousness of place rating.

In this analysis, a simple arithmetic overlay produced a conceptual model of the potential hazardscape related to the onshore impact of oil-related infrastructure in each of the three case study parishes (Hemmerling and Colten 2003, Hemmerling and Colten 2004). To accomplish this, I again used sieve mapping to reclassify and overlay the hazards maps. Each facility, buffered to the toxic endpoint distance, receives a value based on the relative potential risk score. As in the proximity-based analysis, I transformed all of the vector surfaces into a number of 30-meter resolution raster grid cells which can be aggregated to a variety of larger areal units (Mennis 2002). Using the model building capability of ArcView, all of the rasterized facilities and buffers were combined into a single composite of intersecting grid cells. This allowed me to classify all locations in the parish according to their cumulative risk-based hazards density which was then broken down into quintiles for further analysis. Again, those areas with no identified potential hazards received a value of zero and separate classification. Finally, each census block and block group received a hazards rating, based on the relative potential risk score of the grid cell located at the centroid of the enumeration area. This allows me to operationalize the model and analyze the potential environmental equity impacts of the entire network of oil-and gas-related infrastructure in the study area.
3.3 Statistical Analysis

At the most basic level, environmental equity analyses examine the relationship between
the distribution of an environmental impact and the distribution of a disadvantaged
subpopulation such as minorities and the poor. To this end, the analyst first estimates the two
distributions and then identifies their association (Liu 2001). In this research, this association is
measured using a number of descriptive and inferential statistics.

Descriptive statistics are procedures for organizing, summarizing, and describing
observations or data from measurements (Liu 2001). This includes such basic statistical
measures as the mean, median, and mode, as well as categorical measures such as quartiles and
standard deviations. In terms of environmental equity research, descriptive statistics are the
building block upon which later analyses are built. Using measures of central tendency, the
analyst is able to determine whether or not minority or low-income groups are found in
significant numbers within the study area. When used in tandem with GIS technology, the
analyst may be able to identify specific subsections within the study area that have statistically
significant numbers of disadvantaged subpopulations.

Unlike descriptive statistical methods, inferential statistics are methods used to make
inferences to a population based on the observations made on a sample (Liu 2001). Generally,
this involves the identification of both the null and alternative hypotheses. In the case of
environmental equity analysis, the null hypothesis would state that there is a uniform risk
distribution, that there is no difference in the potential exposure among members of any specific
disadvantaged subpopulation, be it minority, low-income, or any other at-risk population.
Conversely, the alternative hypothesis would state that the percentage of a specific subpopulation
near a hazardous facility is greater than that further away. Here, we are using two samples to
make inferences about their respective populations. This research uses both nonparametric and parametric analyses to make inferences about the risk to specific subpopulations.

I used nonparametric procedures to analyze the racial and ethnic characteristics within specified hazardous areas relative to the characteristics of the portion of the parish outside of these areas. Odds ratios and the chi-square test of significance demonstrate whether any observed differences were statistically meaningful or merely due to chance. Odds ratios allow for inferences about how much higher or lower are the odds of a minority individual (relative to a non-minority) living in proximity to a potentially hazardous facility (Pine et al. 2002). An odds ratio of one, for example, implies that the two variables being compared are independent, and this serves as a baseline for comparison. Values of odds ratios further from one in a given direction imply stronger levels of association.

At the facility level, I used nonparametric procedures to analyze the racial and ethnic characteristics within each facility buffer relative to the characteristics of the portion of the parish outside of the buffer. Census enumeration units lying within a buffer were aggregated to create a new study area, one determined by the modeled impact of any potential chemical release or industrial hazard. The next step was to compare the social variables in each study area to those in the reference area to evaluate the degree of equity between them. According to USEPA guidelines, it is necessary to compare a potentially impacted minority community to the larger geographic area to aid in distinguishing potential impacts on minority communities within the affected area of a proposed action (USEPA 1999). This study examines the local impacts of the OCS oil and gas industry and uses the overall parish as the reference area. Using the parish values as relative thresholds takes into account regional differences in population distribution and thus provides a much more meaningful determination of significance.
To analyze the cumulative hazardscape in each parish, I used hazardousness deciles, with each decile containing roughly ten percent of the total census blocks in the parish. Odds ratios and the chi-square test were then used to analyze the racial and ethnic characteristics in each decile relative to the characteristics of the census blocks outside of that decile.

In southeast Louisiana, where many rural census block groups are too large to adequately utilize spatial buffers, this nonparametric analysis could not be performed for economic data. According to USEPA, it is important for researchers to recognize that the aggregation of data and lack of current information on income at the block level may fail to reveal certain relevant characteristics about the population. For example, the aggregation of data to the block group level in a particular geographic area may mask a “pocket” of low-income individuals that exists among the larger general population (USEPA 1999). Similarly, attempting to aggregate any rural block groups based on spatial buffers may lead to misleading calculation of within-buffer population character, since the population of the block group may actually be concentrated in a portion of the block group not encompassed by the buffer (Mennis 2002).

Parametric regression analysis was also run on the data at varying spatial scales to test for the existence and strength of association between the socioeconomic variables and the hazardousness of place rating while controlling for the effects of multiple independent variables. In using regression analysis, this research does not mean to imply that race, ethnicity, and income cause vulnerability. Indeed, as Buzzelli et al. (2003) point out, we cannot infer causality on the basis of one study alone, regardless of the modeling framework. All data was tested for any obvious problems with multicollinearity and to determine whether some likelihood that linear relationships exist between the hazardousness ranking and each of the predictor variables. Residual plots were examined and any cases where the studentized residuals exceeded two were removed from the model.
I regressed the hazardousness of place rating against race and ethnicity at the block level, and race, ethnicity, income, median house value, and median contract rent at the block group level. Because economic data was unavailable at the block level in the 2000 census, economic variables could not be included in the block-level analysis. According to USEPA, mean house value as well as monthly rent can serve as proxies for income levels (USEPA 1998). This is important because, prior to the 2000 census, house values and monthly rent were counted at the block level, compared to income, which was only counted at the block group level and higher. Regression analysis allows this research, specifically, to show whether there is a positive, negative, or no correlation between the social and economic independent variables in the relationship with proximity to various oil-related facilities.

3.4 Summary

The methods developed in this chapter quantified the potential impacts of the oil and gas industry on local populations in southeast Louisiana, focusing specifically on cumulative and multiple adverse exposure modeling and spatial data analysis methods. The cumulative hazardscape models developed in this chapter shift the focus of environmental justice and equity research from facility-level analysis to industry-level analysis. As Flanagan notes, facility-level analysis privileges individual facilities over communities (Flanagan 2005). Industry-level analysis, on the other hand, acknowledges the interconnections between facilities and infrastructure, allowing researchers to more accurately capture potential risk at the community level. The same methodology can be expanded to encompass ecological health perspectives and risk to species biodiversity.
4.1 Hazardousness of Place Model

To operationalize the conceptual model, this research focused on the following three elements: biophysical, social, and place vulnerability (Cutter et al. 2000). The delineation of oil-specific hazard zones provided the biophysical vulnerability and social and demographic characteristics yielded a measure of social vulnerability. The overlap of the two provides the overall place vulnerability, the third outcome indicator. These three outcome indicators enabled measurement of the potential hazardousness of each parish relative to oil- and gas-related activities.

4.1.1 Biophysical Vulnerability

The identification of potential hazards as well as their frequency and potential impacts are essential components of biophysical vulnerability (Cutter et al. 2000). Previous chapters identified both the potential impacts and the frequency of accidental release for each segment of the oil and gas industry in each of the case study parishes. As noted in chapter 3, the likelihood of chemical releases along transportation and pipeline corridors are far more common than accidental releases from stationary sources, although the latter tend to be of a much greater magnitude. The proximity- and risk-based hazardscape models discussed in the previous chapter show various patterns of biophysical vulnerability, specific to each respective parish and industry sector.
4.1.1.1 Lafourche Parish

In examining the modeled hazard zones of Lafourche Parish, we see that OCS-related industry and activities are not equally distributed across the parish. As expected, industry has clustered along Highway 1, particularly in South Lafourche. In terms of the total number of diverse facilities clustering together, two areas stand out as sites where industry has concentrated, Port Fourchon and Larose (Figure 5). The geographical location of these two areas plays a large part in the concentration of industry found there.

Port Fourchon is one of the few ports on the Gulf of Mexico equipped to handle the needs of deepwater oil and gas development. It is the most reasonable port for many OCS-related industries since it is closest to much of the deepwater development. Most of the other ports in Louisiana are located too far inland, and other ports in the Gulf of Mexico region, such as Galveston and Mobile, are too distant (Keithly 2001). As of May of 1999, more than 100 businesses operated out of Port Fourchon, the vast majority have direct or indirect involvement in supporting OCS-activity (Hughes et al. 2001). This includes petroleum production firms, oilfield pipeline laying companies, and independent drilling companies. Several shipbuilding firms have facilities at Port Fourchon, including one major shipbuilding facility. Port Fourchon also contains the only facility in the world where deepwater supply vessels can take on fuel, water, deck cargo, barites, cements, liquid muds, and completion fluids efficiently at the same dock. The C-Port facilities have cut supply vessel turnaround time from about two and a half days to fifteen hours (Russell 2006).

Larose is an unincorporated community located at the junction of Bayou Lafourche and the Intracoastal Waterway sixteen miles south of U.S. Highway 90. This community of 7,306 residents is home to a number of shipbuilding and repairing industries, including two major
Figure 5 Proximity-Based Hazardscape of Lafourche Parish, Louisiana
shipbuilding facilities located along the Intracoastal Waterway, both of which USEPA identifies as Large Quantity Generators of toxic substances as well as Toxic Release Inventory sites. In addition, there is a major gas processing plant located one-half mile west of Larose. The Larose Gas Processing Plant is capable of storing both propane and butane on site, while methane, condensate and natural gas liquid products both move through the facility via pipelines.

Other communities identified by the proximity model include the incorporated towns of Lockport and Golden Meadow, as well as the small community of Grandbois. Lockport occupies the site where Louisiana Highway 1 crosses a former channel of the Intracoastal Waterway about 5 miles south of U.S. Highway 90. Most of its 2,624 citizens work in sugar cane farming, paper production, oil and gas exploration, shipbuilding, and fishing. The fishing town of Golden Meadow is the southernmost town in Lafourche Parish, located at the edge of the levee system on land two feet above sea level. According to the Louisiana Department of Natural Resurces (LDNR), there is a small Houma Indian community on the northern shore of Catfish Lake, just to the west of Golden Meadow (LDNR 2002). This community consists of five families that hunt and trap the area for a living.

The community of Grandbois is unique among the sites identified by the model. Rather than occupying a site along the Highway 1 corridor, it is adjacent to the Intracoastal Waterway near the border of Lafourche and Terrebonne parishes. Most of the approximately 300 residents alternate between growing and harvesting food and working as laborers in the shipyards or on the oil rigs (Austin 2001). In addition to an oilfield waste facility, the community is also home to a large shipyard listed as a Toxic Release Inventory site. Grandbois and the surrounding area are within the Bayou Pointe-au-Chien Environmental Management Unit. The marshlands of this area are ideal for production of waterfowl food and waterfowl game species and fur-bearing
animals both thrive throughout this area. In addition, both brackish and freshwater fishing are excellent throughout the unit. Wherever OCS-related activity has the potential to affect fish, vegetation, or wildlife, that activity may also affect subsistence patterns of consumption and indicate the potential for disproportionately high and adverse human health or environmental effects on low-income populations, minority populations, and Indian tribes (CEQ 1997).

In terms of total potential exposure, however, there is a much more dispersed statistical risk surface (Figure 6). This is likely a result of the relatively low toxicity values of the respective industries. As we saw in the previous chapter, the range in toxicity values for the OCS-related infrastructure ranges from 233.8 to 367.2, not a wide variance. Any combination of infrastructure classes, regardless of type, is likely to show a similar potential toxicity as any other combination.

It is important to note that thus far, the discussion has revolved around the statistical surface, specifically the standard deviations. In terms of raw numbers, the proximity- and risk-based surfaces identify the same area of maximum potential risk. If the raw numbers are divided into a number of natural breaks, Larose and Port Fourchon, the sites with the greatest concentration of diverse OCS-related industries, show the highest potential toxicity values, ranging from 783.08 to 1,034.64.

4.1.1.2 Jefferson Parish

Oil fields and petroleum bulk terminals stand out in the hazardscape of Jefferson Parish, the case study for onshore oil extraction. This is true for both the proximity-based hazards surface (Figure 7) and the risk-based hazards surface (Figure 8). Where onshore oil processing occurs, we see numerous wells, natural gas processing and separation plants, waste pits (where waste products are re-injected into the subsurface formation), and storage facilities. Many of
Figure 6 Risk-Based Hazardscape of Lafourche Parish, Louisiana
Figure 7 Proximity-Based Hazardscape of Jefferson Parish, Louisiana
Figure 8 Risk-Based Hazardscape of Jefferson Parish, Louisiana
these facilities are concentrated near the extraction points. After processing the product, producers send it via pipeline to a storage facility, before transferring it for refining.

As we saw in Lafourche Parish, many of the facilities in the parish tend to follow the waterways. The most significant portion of the parish impacted by onshore oil and gas is the area along the Mississippi River in Avondale, and to a lesser extent, Marrero. The hazardscape in this area is dominated by a number of Petroleum Bulk Terminals, including many contained in the Toxic Release Inventory.

Avondale is an unincorporated community of 5,441 residents located in the urbanized northern portion of the parish on the Westbank of the Mississippi River. Although the largest employer in Avondale is the Avondale Shipyards, owned by Northrop Grumman, the town is still a major center for the onshore oil industry. There are some 91 wells located on the Avondale oil field, representing just about 9 percent of the total wells in the parish. However, there are forty-six waste pits associated with the Avondale Field, fully 25 percent of the total active waste pits in the parish. In addition, Avondale and the surrounding area represents a major petroleum storage area. There are two large tank farms located in Avondale, in addition to twelve smaller tank batteries.

This area consists of a mix of residential, commercial and industrial interests. The people from the larger region use the area for recreation and several water and overland transportation corridors including River Road, Lapalco Boulevard, the West Bank Expressway, and the Mississippi River traverse the area. Other residential communities in this area include Live Oak Manor, Bridge City, Waggaman, Willswood, and South Kenner. These communities are largely minority, with higher than average numbers of African Americans, Native Americans, Asians, and Hispanics.
Further to the south, along the bayous and waterways, we find the Barataria oil and gas field. Development in this area consists of a number of strip settlements along Louisiana Highway 45 on the east bank of Bayou Barataria and along Louisiana Highway 301, including Barataria, which has higher than average proportions of Native Americans and Asians, and Lafitte, which has a higher than average African American population.

Barataria is a small unincorporated community located in the sparsely populated Barataria region of Jefferson Parish, the elongated central portion of the parish that includes many small communities scattered along the major bayous, principally Bayou Barataria and Bayou des Families (GCR & Associates 2003). This community of 1,333 is located on the Bayou Barataria waterway, at the juncture of three large oil fields, the Barataria, Barataria West, and Barataria South. In total, these three fields have an estimated 174 wells, almost 17 percent of the total wells in the parish. Associated with these wells are some thirty-four active waste pits and seven storage tank batteries.

Although both the risk- and proximity-based analyses have revealed the same areas of high potential risk, there are distinct differences between the two hazardscape models. Interestingly, the areas of potential risk appear much more compressed and distinctive in the risk-based analysis than in the proximity-based analysis. The highest range of toxicity values (from 2,720 to 3,693) is in Avondale, while the proximity-based analysis has both Avondale and Barataria with the same concentration of facilities. Interestingly, it would appear that the risk-based analysis of Jefferson Parish appears to identify more locations of localized high risk, while at the same time masking locations with lower risk levels.
4.1.1.3 Saint Bernard Parish

Finally, this research examines a large refining district, Saint Bernard Parish. Once the oil and gas are separated from impurities in the field, the product is ready for refining. Petroleum refineries engage in distillation, fractionation, and cracking of crude petroleum into refined petroleum products including reformulated unleaded gasoline, jet fuel, diesel, kerosene, liquefied petroleum gas, still oil, and sulfur. Additionally, aromatic chemicals such as ethylene may be produced and then piped to petrochemical plants for further refining.

The areas of particular interest here, in terms of both the proximity- and risk-based analyses (Figures 9 and 10, respectively), are Chalmette and Meraux, a densely populated area that is home to two large oil refineries, one of which also has a gas fractionating plant. Both of these communities share a strategic location on the Mississippi River, close to the intermodal Saint Bernard Port, Harbor and Terminal District, with terminals located at Chalmette and Arabi. We see an extremely dense hazardscape with some of the highest ratings across all of the case studies.

Chalmette is the unincorporated seat of Saint Bernard Parish. Located within the New Orleans Metropolitan Region, Chalmette was home to 32,069 residents in 2000, a population density of nearly 4,370 persons per square mile. Chalmette is home to the largest employer in Saint Bernard Parish, Mobil’s Chalmette refinery, which employs approximately 665 persons. The refinery is listed as a USEPA TRI site, as well as a Large Quantity Generator of hazardous waste. In addition to the refinery, Chalmette is home to a gas processing plant and a calcining plant with the capacity to produce 230,000 tons of petroleum calcined coke. The nearby Chalmette Terminal and Business Park, part of the Saint Bernard Port, Harbor and Terminal
Figure 9 Proximity-Based Hazardscape of Saint Bernard Parish, Louisiana
Figure 10 Risk-Based Hazardscape of Saint Bernard Parish, Louisiana
District, is home to over fifty businesses, including a 60-acre intermodal facility. A number of liquid bulk tanks are located at the port, including those storing petroleum and calcined coke.

Meraux, an unincorporated community adjacent to Chalmette on the east, has a much less dense population, with 10,192 residents residing on just over 4 square miles of land, a total density of almost 2,448 persons per square mile. This town is home to the Murphy Oil Refinery, a TRI reporter and Large Quantity Generator of hazardous waste.

The model also identifies two other areas, the unincorporated towns of Toca, Ysclosky, and Saint Bernard. Because of the gas processing plants located in these communities, they show localized highs in the both hazardscapes, though nowhere near the toxicity levels present in Chalmette and Meraux.

The proximity-based and the risk based analyses identify many of the same locations as being potentially hazardous. There are however, subtle differences between them. For example, in Chalmette, we notice that the risk based analysis logically identifies the area between the Chalmette and Murphy refineries as possessing the greatest potential toxicity, in the area where the buffer zones intersect. Indeed, this area has the potential for greater exposure to toxins and chemicals than any other location in the parish. The proximity-based analysis, on the other hand, shifts the zone of the greatest cumulative hazards slightly to the southwest, away from the Murphy refinery. This shift is due to the presence of the Gulf Liquids New River Gas Plant, built on the grounds of the Chalmette refinery. Because the proximity-based model developed here is a measure of the number of different oil- and gas-related facilities in proximity, and not necessarily their quantitative hazardousness, the model necessarily would be skewed towards neighborhoods experiencing multiple hazards sources. It is important to remember that,
according to USEPA, the more chemicals mixed together, the greater the cumulative risk to a community.

While chemical mixtures are present in any refining operation, the question here is whether or not the releases are so fundamentally different to create additional potential toxologic interactions and physical hazards. The cryogenic gas plant, for example, receives much of the residual gas from the Chalmette refinery, processing it through compression and low temperature saturation. The natural gas extracted through this process is stored in a 15,000 gallon tank and then piped offsite, while the residual gas and hydrogen are returned to the Chalmette refinery. All of these processes, while not raising the total chemical releases to the level of the Murphy refinery, do present several additional sources of risk that are not present in either refinery, making the risk to surrounding neighborhoods qualitatively different from those in neighborhoods at risk from two similar facilities.

4.1.1.4 Three Parish Comparison of Biophysical Vulnerability

Thus far, I have focused on a number of localized hazard models, geared specifically to each sector of the oil industry. The next step in the analysis is to examine the relative hazardousness of each oil industry sector. By incorporating toxicity values into the hazardscape models, this research is able to show a relative comparison among the different types of facilities. When using a cumulative hazardscape weighted by toxicity, this research examines all facilities in the study area on a single sliding scale. For example, as would be expected, the refining district in St. Bernard Parish dominates the overall hazardscape. Nonetheless, localized high points around Avondale and the Barataria Fields still stand out, despite much lower relative values. Other local high points near individual gas processing plants in each of the individual parishes are significantly less important when compared to the other hazardous areas in the
region. The areas around Larose in Lafourche Parish and Toca, Saint Bernard, and Yscloskey in Saint Bernard Parish, for example, all fall below the mean in terms of overall hazardousness.

4.1.2 Social Vulnerability

In addition to the geographic distribution of the various minority populations, an additional environmental justice concern may exist if there is more than one minority group present where the minority percentage meets the parish threshold values. This allows us to see area clusters of census blocks with high minority populations within the parish.

Following USEPA guidelines, the U.S. Census defined parameters served as the income and poverty measures (USEPA 1999a). The 2000 census defines a person as poor if his or her income was below $8,501 in 1999. The average poverty threshold for a family of four persons was $17,029 in 1999. In Louisiana, an estimated 15.8 percent of families and 19.6 percent of individuals have incomes below these thresholds.

4.1.2.1 Lafourche Parish

Census analysis reveals some very clear minority population clustering in Lafourche Parish (Figures 11-14). For the most part, the African American population clusters in North Lafourche, particularly around Thibodaux and Raceland. The Native American population is concentrated along Highway 1 in south Lafourche, between Larose and Golden Meadow. Also, some concentrations exist along the Lafourche-Terrebonne border, in the area of Houma and Bayou Pointe-Au-Chien. Both the Asian and Hispanic populations are geographically dispersed, living along the Highway 1 corridor, and into Thibodaux. When examined cumulatively, the minority population exhibits a great deal of clustering in and around the area of Larose extending southward towards Cutoff. Further inspection also reveals several smaller minority clusters in and around Thibodaux.
Figure 11 Distribution of African American Population by Census Block in Lafourche Parish, Louisiana, 2000
Figure 12 Distribution of Native American Population by Census Block in Lafourche Parish, Louisiana, 2000
Figure 13 Distribution of Asian Population by Census Block in Lafourche Parish, Louisiana, 2000
Figure 14 Distribution of Hispanic Population by Census Block in Lafourche Parish, Louisiana, 2000
Low-income populations tend to be dispersed across the parish, at least at the block group level (Figure 15). Geographically, census block groups where residents earn, on average, 20 percent or more beneath the parish average are located in the marshlands of Lafourche south of Golden Meadow, as well as in and around Thibodaux. The population along the Louisiana Highway 1 corridor for the most part is not low-income, although Lockport does have areas of very low-income levels. Other economic factors exhibit a similar dispersed pattern. Areas of low median contract rent, defined by the Census Bureau as the monthly payment agreed to or contracted for, regardless of furnishings, utilities, fees, meals, or services that may be included, exist in the marshlands of south Lafourche, along the Louisiana Highway 1 corridor, and around Thibodaux (Figure 16). Finally, median house values have a similar pattern, although house values tend to be higher in developed areas (Figure 17). The marshlands below Golden Meadow and the farmland along the U.S. 90 corridor to the east of Bayou Lafourche have the lowest median house values, with other smaller clusters located in Thibodaux, Raceland, and Lockport. It is important to recognize that the block group aggregation of data and lack of current information on income levels may fail to reveal certain relevant characteristics about the population, such as “pockets” of low-income individuals that exists among the larger general population (USEPA 1999a). In order to determine if block group low-income patterns hold at the block level, I examined 1990 median house value data, which was available at the block level. Although the growth of the oil industry throughout the 1990s would have altered much of the economic landscape of Lafourche Parish, this data reveals a similar pattern to that found at the block group level in 2000. The marshlands below Golden Meadow and the area to the east of Thibodaux contain a number of census blocks with low-value housing. The area around Grandbois appears in the 1990 census as an area with extremely low property values.
Figure 15 Per Capita Income by Census Block Group in Lafourche Parish, Louisiana, 2000
Figure 16 Median Contract Rent by Census Block Group in Lafourche Parish, Louisiana, 2000
Figure 17 Median House Value by Census Block Group in Lafourche Parish, Louisiana, 2000
4.1.2.2 Jefferson Parish

The African American population in Jefferson Parish is the most clustered of all of the racial groups, with the majority of the population located in the more developed northern portion of the parish (Figures 18-21). On the east bank of the Mississippi River, the African American population can be found in two distinct areas. In Kenner, in the extreme northwest of the parish, a significant number of African American residents reside in close proximity to the Louis Armstrong International Airport, on the north, south, and east. This population extends eastward from the airport along U.S. Highway 61, the Airline Highway, for the length of River Ridge. Another distinct cluster can be found south of the Airline Highway in the town of Jefferson, in the vicinity of Causeway Boulevard.

Communities on the west bank of the Mississippi River, there a number of significant African American population clusters. One is on the eastern edge of Waggaman between Highway 18, the River Road, and U.S. Highway 90. Further to the east, on the U.S. Highway 90 Business Loop, the Westbank Expressway, in Marrero there is another significant cluster of African American population. Other clusters can be found in Woodmere and Harvey along the Harvey Canal and in Gretna, on the border of Jefferson Parish and Algiers in Orleans Parish.

The Native American, Asian, and Hispanic populations all tend to be much more dispersed across the parish, on both the east and west banks of the Mississippi River. The Native American population is the only minority group to be found in significant numbers in the relatively rural Barataria region of central Jefferson Parish, particularly in the towns of Crown Point, Jean Lafitte, Barataria, and Lafitte. The Asian population is the most dispersed of all of the racial and ethnic groups examined here, with clusters of Asian population found in virtually all towns in the developed northern portion of the parish. The Hispanic population is also quite dispersed, although the majority of the west bank population may be found to the east of the
Figure 18 Distribution of African American Population by Census Block in Jefferson Parish, Louisiana, 2000
Figure 19 Distribution of Native American Population by Census Block in Jefferson Parish, Louisiana, 2000
Figure 20 Distribution of Asian Population by Census Block in Jefferson Parish, Louisiana, 2000
Figure 21 Distribution of Hispanic Population by Census Block in Jefferson Parish, Louisiana, 2000
Harvey Canal. Significant Hispanic population concentrations reside in Kenner, on the east bank, along Loyola and Williams Boulevards, north of Interstate 10.

Block groups with a significant low-income population correlate highly with areas of high African American population, including the neighborhoods around Louis Armstrong International Airport, the Airline Highway, and the town of Jefferson on the east bank (Figure 22). On the west bank, this includes areas of Waggaman, Marrero, and Harvey. Of all of the areas with significantly high clustering of African American population, only Woodmere is not significantly low-income.

Areas with significantly low house values (Figure 23) tend to be located around major transportation locations. This includes the Louis Armstrong International Airport, which is surrounded on all four sides by block groups with significantly low median house values. Airports are potential sources of environmental inequity due to high levels of air and noise pollution and likely negatively impact the house values (Most et al. 2004; Sobotta et al. 2007). Similarly, house values are lower in proximity to U.S. Highway 90 (on both banks of the Mississippi River), the Westbank Expressway, and Airline Highway. Finally, house values tend to be significantly lower along the Harvey Canal stretching to the Intracoastal Waterway on the border of Jefferson and Plaquemines parishes.

The locations in the parish with significantly low median contract rent values tend to differ from areas with low incomes and low house values (Figure 24). For example, rent values along U.S. Highway 61, Airline Highway, are not significantly lower than the parish average, except around Causeway Boulevard near Jefferson. Similarly, rental costs around the airport do not differ significantly from the parish average. Marrero, on the west bank of the Mississippi River, does have block groups in which low-income, low house values, and low median contract
Figure 22 Per Capita Income by Census Block Group in Jefferson Parish, Louisiana, 2000
Figure 23. Median House Value by Census Block Group in Jefferson Parish, Louisiana, 2000.
Figure 24 Median Contract Rent by Census Block Group in Jefferson Parish, Louisiana, 2000
rents are significantly correlated. The towns of Barataria and Lafitte, in the rural central portion of the parish, have significantly lower rental costs, although neither the house values nor the income levels are significantly lower than the parish average.

4.1.2.3 Saint Bernard Parish

With the exception of the African American population, the minority populations in Saint Bernard Parish are dispersed throughout the parish (Figures 25-28). The African American population is unique in that, with rare exception, the population does not reside in significant numbers in any of the three most populous locations in the parish, Arabi, Chalmette, and Meraux. Nearly all of the African American population in Saint Bernard Parish is concentrated to the east in Violet. Other African American clusters are in the rural area along Bayou Terre aux Boeufs toward the small community of Reggio.

The Asian population has a settlement pattern that is almost exactly the opposite. Significantly high concentrations of Asians reside in the communities of Arabi, Chalmette, and Meraux, with very few blocks of high Asian population in Violet westward. The Native American population is much more dispersed, with significantly high clusters of population stretching from the Orleans Parish border at Arabi, out beyond Violet and Poydras to the smaller rural communities of Toca and Kenilworth. The Hispanic population is the most dispersed of all the minority groups in Saint Bernard Parish, with significantly large concentrations in Arabi and Chalmette, all the way out into the many rural communities reaching toward Lake Borgne and the Mississippi River – Gulf Outlet Canal. As mentioned earlier, the mechanization of agriculture has driven Isleños and others from agriculture into the towns and cities. While many have remained in the fishing villages of lower Saint Bernard Parish, many more have found
Figure 25 Distribution of African American Population by Census Block in Saint Bernard Parish, Louisiana, 2000
Figure 26 Distribution of Native American Population by Census Block in Saint Bernard Parish, Louisiana, 2000
Figure 27 Distribution of Asian Population by Census Block in Saint Bernard Parish, Louisiana, 2000
Figure 28 Distribution of Hispanic Population by Census Block in Saint Bernard Parish, Louisiana, 2000
employment in petroleum, natural gas, lumbering, manufacturing, salt, and sulphur industries, possibly explaining the dispersion of the Hispanic population in Saint Bernard Parish (Din 1988).

There are relatively few areas with significantly low incomes or significantly low median house values and contract rents. The block groups with low incomes tend to be in areas with high proportions of African Americans, particularly in Violet and Poydras. Interestingly, Violet does not appear to have either significantly lower rents or house values. These tend to be further downriver in Poydras, a community with significantly high levels of African Americans, Native Americans, and Hispanics.

In the three largest communities in Saint Bernard Parish, Arabi, Chalmette, and Meraux, there are very few areas that have low-incomes, low house values, or low median contract rents (Figure 29-31). In Chalmette, the most populous of the three communities, there are three areas that are home to the only statistically significant concentrations of African Americans. These same areas are also the locations of the only low-income and low-value housing in the three communities.

4.1.3 Place Vulnerability

An area of high potential hazardousness in combination with socioeconomic vulnerability determines place vulnerability, which provides a useful composite indicator for potential environmental inequity. I assign each census block a hazardousness rating dependant upon the hazardousness of place rating at its centroid. Census blocks are small enough that the value at the centroid serves as an effective surrogate for the value of the entire block. Once each block receives a hazardousness value, I divide the parish into hazardousness deciles. Each decile contains roughly 10 percent of the total number of census blocks in the parish, allowing for an effective compare population data.
Figure 29 Per Capita Income by Census Block Group in Saint Bernard Parish, Louisiana, 2000
Figure 30 Median House Value by Census Block Group in Saint Bernard Parish, Louisiana, 2000
Figure 31 Median Contract Rent by Census Block Group in Saint Bernard Parish, Louisiana, 2000
4.1.3.1 Lafourche Parish

Nearly a quarter of Lafourche Parish’s population resides in the least potentially hazardous OCS-related decile. As figure 32 shows, these deciles contain the largest proportion of all minority groups, including 38.4 percent of the African American population. In total, almost one third of the population reside in the 20 percent least hazardous census blocks (deciles 1 and 2), compared to just over 12 percent in the 20 percent most hazardous census blocks (deciles 9 and 10). The least hazardous census blocks seem to be either located entirely outside the Highway 1 corridor in sparsely populated marshland, or else in the less densely populated areas between the individual communities that line the high ground fronting Bayou Lafourche. In particular, much of the land along Highway 1 north of Raceland, including much of Thibodaux, is not impacted by OCS-related activity.

Despite the localized high potential hazardousness of areas identified by the biophysical vulnerability model, such as Larose and Port Fourchon, the most potentially hazardous census blocks, in terms of OCS-related development, clearly are dispersed across the parish. This reflects the fact that the actual focal points of the industry, the wells, are located offshore, allowing the support industries more economic choice in where to site onshore facilities. As a result, census blocks with the most potential to be impacted by expanding OCS-related activity tend to cluster loosely along Louisiana Highway 1, particularly south of Larose, with some extension along the Intracoastal Waterway. Outside of this corridor, the primary potential for impact would be from the pipelines crossing the sparsely populated wetland fringe.

Overall, large numbers of minority residents reside in and around Thibodaux, particularly African American, Asian, and Hispanic. In addition, the social vulnerability analysis shows a large clustering of minorities around the junction of Bayou Lafourche and the Intracoastal
Figure 32 Proportion of the Population Residing in OCS-Related Hazardousness Deciles in Lafourche Parish, Louisiana
Waterway in Larose. The physical hazards model revealed two areas that are of particular concern for potential environmental hazards, Port Fourchon and Larose.

Most of the land surrounding Port Fourchon is in a semialtered state, while developers have drained and filled the wetlands immediately around Port Fourchon and Fourchon Island for industrial and marine support facilities. There are very few permanent habitations found around Port Fourchon, and none of these areas are home to significant minority populations. This stands in stark contrast to the demographics of the population in and around Larose. Although at or above the parish average in terms of economic conditions, Larose is home to sizable concentrations of African American, Native American, Asian, and Hispanic populations. In terms of the overall vulnerability of place in Lafourche Parish, Larose stands out as an area of particular interest (Figure 33).

Combining economic conditions and minority population produces a different pattern. Examining census blocks with a higher-than-average proportion of minority population in tandem with census block groups with incomes 20 percent or more below the parish level, the majority of the Louisiana Highway 1 corridor does not stand out. There are areas of concern located in and around Golden Meadow (Figure 34) and in Lockport (Figure 35). Other locations are along the Lafourche-Terrebonne border in Grandbois (Figure 36), and in Thibodaux, the parish seat. The large rural blocks and block groups outside of the population centers have much lower population densities and therefore contain a relatively large proportion of uninhabited area.

The areas examined and analyzed here are important for a number of reasons. Larose, for example is home to the largest concentration of facilities outside of Port Fourchon, and is also home to high proportions of all examined minority groups. Lockport and Golden Meadow both have multiple facilities as well, though not to the same scale as Larose. Both of these areas have
Figure 33 Minority Population by Census Block and OCS-Related Infrastructure in Larose, Louisiana
Figure 34 Minority Population by Census Block and OCS-Related Infrastructure in Golden Meadow, Louisiana
Figure 35 Minority Population by Census Block and OCS-Related Infrastructure in Lockport, Louisiana
Figure 36 Minority Population by Census Block and OCS-Related Infrastructure in Grandbois, Louisiana
a greater proportion of low-income residents than Larose, however, increasing the vulnerability of those populations residing there.

4.1.3.2 Jefferson Parish

The physical hazards model revealed that the majority of the onshore oil-related infrastructure exists on the west bank of the Mississippi River (i.e. the southern portion of the parish). With less than 1 percent of the total onshore oil wells located there, the influence of the east bank on the overall hazardousness of place model is negligible. However, with a total of over 4,000 census blocks, nearly 60 percent of the parish total, the suburban communities of the East Bank would heavily skew the place vulnerability analysis. Therefore, in determining the onshore oil-related place vulnerability in Jefferson Parish, this portion of the analysis focused exclusively on the West Bank communities, where the potential impacts would be greatest.

The onshore oil industry appears to have two distinct nodes that dominate the overall hazardscape: the oil fields and the bulk storage facilities. The census blocks in the most hazardous deciles are in proximity to both types of facility (Figure 37). The most potentially hazardous census blocks lie along the U.S. Highway 90 and the Westbank Expressway, extending toward the Mississippi River in Avondale and Marrero, where a number of bulk storage facilities exist (Figure 38). Other potentially impacted populations reside in proximity to the oil fields in Barataria and Lafitte (Figure 39). As we saw in Lafourche Parish, several large blocks and block groups exist outside of the population centers that contain a relatively large proportion of uninhabited area. Only 15.3 percent of the population resides in the most hazardous census blocks (deciles 9 and 10).

On the other hand, fully 28.5 percent of the population reside in the 20 percent least hazardous census blocks on Jefferson Parish’s west bank (deciles 1 and 2). Furthermore, 16.8
Figure 37 Proportion of the Population Residing in Onshore Oil-Related Hazardous Deciles in Jefferson Parish, Louisiana
Figure 38 Minority Population by Census Block and Oil-Related Infrastructure in Avondale, Louisiana
Figure 39 Minority Population by Census Block and Oil-Related Infrastructure in Barataria, Louisiana
percent of residents reside in the least hazardous decile, including the majority of the parish’s whites, Asians, and Hispanics. This includes areas in Terrytown, Harvey, and South Kenner, in the northern portion, as well as many less densely populated blocks bordering the marshes and wetlands in the Barataria region.

Examining census blocks with statistically significant proportions of minority residents in tandem with census block groups having median per capita incomes 20 percent or more below the parish mean reveal that most of the socially vulnerable populations remain significant, suggesting a high correlation between minority and low-income status in Jefferson Parish. High minority, low-income census blocks appear in clusters within all communities in Jefferson Parish, with the exception of River Ridge, Harahan, and Elmwood.

4.1.3.3 Saint Bernard Parish

Some 12,820 persons reside in the 20 percent most potentially hazardous census blocks in Saint Bernard Parish (Figure 40; deciles 9 and 10), compared to 9,011 in the 20 percent least hazardous blocks (Figure 40; deciles 1 and 2). The most potentially hazardous areas are clearly those areas surrounding the oil refineries in Chalmette and Meraux. Unlike the other sectors of the oil industry explored in Lafourche and Jefferson Parishes, the refining sector is highly concentrated. The refineries themselves serve as focal points for the entire oil-related infrastructure in the parish. Crude petroleum and natural gas pipelines bring raw materials into the refineries, and carry refined product out. Louisiana Highway 47, Paris Road, merges with Interstate 510, connecting the refineries with Interstate 10, South Louisiana’s primary interstate highway. The refineries each have bulk storage facilities in the Saint Bernard Port, Harbor, and Terminal District. The two refineries are both Large Quantity Generators of hazardous waste as
Figure 40 Proportion of the Population Residing in Refining-Related Hazardousness Deciles in Saint Bernard Parish, Louisiana
well as TRI facilities, and consequently the most potentially hazardous census blocks in the parish are in proximity to the refineries.

The population within both Chalmette and Meraux is largely non-minority, and in most cases, middle to upper income. In fact, the largest minority concentration found in either community is not in proximity to the refineries. Rather, the clustering appears in the vicinity of a large shopping center, where there is a nearby low-income housing development (Figure 41). The only other large concentration of African Americans in Chalmette is found just to the east of the Murphy Refinery. Again, this minority cluster seems to be around lower-income housing, in this case, a trailer park.

The least hazardous deciles in the parish largely are in the rural areas, where pipelines and pipeline crossing represent the most likely hazard to residents. Two vital links in the refinery-based infrastructure found in the rural areas of the parish are the large gas processing plants in Toca and Yscloskey. In much the same way that the refineries serve as focal points for the oil-related infrastructure on a large scale, the gas plants do so on a smaller scale. For this reason, the census blocks around the gas plants are potentially more hazardous than other census blocks in rural Saint Bernard Parish, though not hazardous enough to be included in the most hazardous risk-based deciles with the refineries. Both of these areas have high concentrations of Hispanic residents, likely Isleños (Figures 42 and 43). Most of the population in Toca and Yscloskey reside along the primary roadways. However, the low population in these towns results in a relatively small number of large census blocks and block groups

4.2 Statistical Analysis

This dissertation utilizes a combination of parametric and non-parametric procedures to determine if minority or low income persons are disproportionately impacted by the petroleum
Figure 41 Minority Population by Census Block and Oil Refining Infrastructure in Chalmette, Louisiana
Figure 42 Minority Population by Census Block and Oil Refining Infrastructure in Toca, Louisiana
Figure 43 Minority Population by Census Block and Oil Refining Infrastructure in Yscloskey, Louisiana
production and refining industries. The hazardscape model provides the hazardousness of place values, which I analyze using odds ratios and stepwise multiple regression.

4.2.1 Lafourche Parish

The patterns of racial and ethnic distributions around each of the OCS-related facilities all show a similar pattern (Figure 44). The closer the value of the odds ratio is to one, the more equitable the distribution of the population. The level of association between the minority population and the facility increases as the odds ratio value moves further from one (Pine et al. 2002). This analysis uses the Chi-Square test to determine if the odds ratio is significant (Table 22). The most equitable distribution is found around the pipelines. This is most likely due to the large geographical area that the pipelines cover in Lafourche Parish. Each of the other facilities shows particular patterns of racial and ethnic inequities. These patterns are most pronounced in the case of the Houma Indian population around each facility. All of the facilities located in south Lafourche show a statistically significant disproportionately high Native American population around them. For example, if we look at which populations are more or less likely to live around the shipyards, we see that Native Americans are 2.27 times more likely to live in proximity than elsewhere in the parish, and Asians are 1.96 times as likely. This stands in contrast to the white population, which is 0.61 times as likely and the African American population, which is only 0.19 times as likely to be found living in proximity to a shipyard. The only exception to this is the distribution of minority population around the petroleum bulk storage facilities. Most of the bulk terminals are in unpopulated wetlands. There is, however, one large petroleum bulk terminal located in Thibodaux. Very few Houma Indians live around this facility. In fact, this research shows that the Houma Indian population clusters in south Lafourche, while the African American population clusters in north Lafourche. With the
Figure 44 Odds Ratios for Lafourche Parish, Louisiana OCS-Related Infrastructure
Table 22 Comparison of Population for Selected OCS-Related Infrastructure in Lafourche Parish, Louisiana

<table>
<thead>
<tr>
<th></th>
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<th>Not Proximate</th>
<th>Parish</th>
<th>Chi-Square Signif.</th>
</tr>
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<td>1.2</td>
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</table>

Source: U.S. Census Bureau, 2000; U.S. Environmental Protection Agency, 2004
majority of OCS-related infrastructure located in south Lafourche as well, the Houma Indian population experiences a disproportionate amount of potential impacts.

Contingency analysis of the weighted hazards model reveals that both the Native American and Hispanic populations are significantly more likely to reside in the most hazardous census blocks in the parish, while the African American population is significantly less likely to reside in proximity (Figure 45, Table 23). Conversely, the Native American, Asian, and Hispanic populations are all significantly less likely to reside in the least hazardous census blocks than anywhere else in Lafourche Parish, while the African American population is almost 1.7 times as likely to reside there.

An examination of the Pearson Product Moment Correlations between each independent variable and their individual effects upon the dependant variable at the block group level verified these results. The percentage Native American is most heavily influenced by the hazards-of-place model, with a positive linear correlation of 0.383. However, the analysis also reveals that there is a strong negative correlation of –0.384 between the percentage African American and the hazards-of-place model. Both of these correlations are significant at the .001 level. In addition, a slightly weaker positive correlation exists between the hazardousness model and the percentage Hispanic (.203) and median household income (.324). Both of these values are still significant however, with the percentage Hispanic correlated at the .05 level and income at the .01 level. The Pearson Product Correlation Coefficient does not attempt to explain causality, but rather the degree of correlations among the variables, whether positive, negative, or zero.

Further analysis reveals that minority population is a more important factor than income in determining the degree of environmental inequity in Lafourche Parish. This analysis used stepwise multiple regression to examine the significance of various minority categories, as well
Figure 45 Odds Ratios for Lafourche Parish, Louisiana OCS-Related Hazardousness Deciles
### Table 23 Comparison of Population Proportions for OCS-Related Hazard Deciles in Lafourche Parish, Louisiana

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<thead>
<tr>
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<th>Chi-Square Signif.</th>
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</tr>
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</table>

Source: U.S. Census Bureau, 2000; U.S. Environmental Protection Agency, 2004
Table 24 Results of Stepwise Multiple Regression Analysis for Lafourche Parish, Louisiana with the Hazardousness of Place Rating as the Dependant Variable

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<th>Regression Coefficient</th>
<th>Student's t</th>
<th>Prob&gt;t</th>
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</tr>
<tr>
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<tr>
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</tr>
<tr>
<td>Percent Hispanic</td>
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<tr>
<td>Mean Household Income</td>
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<tr>
<td>Median Contract Rent</td>
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<td>Median House Value</td>
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</table>

N = 66; $R^2 = 0.219$; Adjusted $R^2 = 0.195$; $F = 8.891$ (0.000)
as economic factors such as mean household income, median contract rent, and median house value (Table 24). I included the percentage African American and Native American in the final regression model, reflecting the clustering of these populations around infrastructure, in the case of Native Americans, or away from it, in the case of African Americans. Both were significant at the 95 percent confidence level.

Income tends to be marginally higher in potentially hazardous areas of the parish, significant only to the 90 percent confidence level. As we can see, there does in fact appear to be significant numbers of low income persons in both Lockport (Figure 46) and Larose (Figure 47), although there does not appear to be a great deal of clustering, at least at the block group level.

**4.2.2 Jefferson Parish**

The Native American population is the only minority group to be statistically more likely to reside in the most hazardous deciles in Jefferson Parish (Figure 48, Table 25). The Asian and Hispanic populations are in fact statistically more likely to reside in the least hazardous census blocks than anywhere else on the west bank. The African American population is statistically less likely to be found residing in both the most and least hazardous census block groups on the west bank. In fact, the African American population is one and a half times more likely to reside in moderately hazardous deciles.

Regression analysis supports these results (Table 26). Race and ethnicity are not as important as income is determining the potential hazardousness of the census block group in Jefferson Parish. Both the percentage African American and Hispanic are in fact negatively correlated with the potential hazardousness of the census block group, at the 99 percent confidence interval, while the percentage Asian is also negatively correlated with the hazard model, although not significantly. The percentage Native American is the only minority variable
Figure 46 Household Income by Block Group and Proximity to OCS-Related Infrastructure in Lockport, Louisiana
Figure 47 Household Income by Block Group and Proximity to OCS-Related Infrastructure in Larose, Louisiana
Figure 48 Odds Ratios for Jefferson Parish, Louisiana Onshore Oil-Related Hazardousness Deciles
Table 25 Comparison of Population Proportions for Onshore Oil-Related Hazard Deciles in Jefferson Parish, Louisiana

<table>
<thead>
<tr>
<th>Least Hazardous Deciles</th>
<th>Proximate</th>
<th>Not Proximate</th>
<th>Parish</th>
<th>Chi-Square Signif.</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>48.5</td>
<td>56.0</td>
<td>54.0</td>
<td>0.000</td>
</tr>
<tr>
<td>African American</td>
<td>39.7</td>
<td>35.1</td>
<td>36.3</td>
<td>0.000</td>
</tr>
<tr>
<td>Native American</td>
<td>0.5</td>
<td>0.7</td>
<td>0.6</td>
<td>0.000</td>
</tr>
<tr>
<td>Asian</td>
<td>4.8</td>
<td>3.3</td>
<td>3.7</td>
<td>0.000</td>
</tr>
<tr>
<td>Hispanic</td>
<td>6.5</td>
<td>4.9</td>
<td>5.3</td>
<td>0.000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Deciles 3 &amp; 4</th>
<th>Proximate</th>
<th>Not Proximate</th>
<th>Parish</th>
<th>Chi-Square Signif.</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>57.9</td>
<td>53.1</td>
<td>54.0</td>
<td>0.000</td>
</tr>
<tr>
<td>African American</td>
<td>31.5</td>
<td>37.5</td>
<td>36.3</td>
<td>0.000</td>
</tr>
<tr>
<td>Native American</td>
<td>0.7</td>
<td>0.6</td>
<td>0.6</td>
<td>0.177</td>
</tr>
<tr>
<td>Asian</td>
<td>4.3</td>
<td>3.6</td>
<td>3.7</td>
<td>0.000</td>
</tr>
<tr>
<td>Hispanic</td>
<td>5.5</td>
<td>5.3</td>
<td>5.3</td>
<td>0.031</td>
</tr>
</tbody>
</table>

<table>
<thead>
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<th>Deciles 5 &amp; 6</th>
<th>Proximate</th>
<th>Not Proximate</th>
<th>Parish</th>
<th>Chi-Square Signif.</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>45.0</td>
<td>56.8</td>
<td>54.0</td>
<td>0.000</td>
</tr>
<tr>
<td>African American</td>
<td>46.8</td>
<td>33.1</td>
<td>36.3</td>
<td>0.000</td>
</tr>
<tr>
<td>Native American</td>
<td>0.5</td>
<td>0.6</td>
<td>0.6</td>
<td>0.013</td>
</tr>
<tr>
<td>Asian</td>
<td>3.0</td>
<td>3.9</td>
<td>3.7</td>
<td>0.000</td>
</tr>
<tr>
<td>Hispanic</td>
<td>4.7</td>
<td>5.5</td>
<td>5.3</td>
<td>0.000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Deciles 7 &amp; 8</th>
<th>Proximate</th>
<th>Not Proximate</th>
<th>Parish</th>
<th>Chi-Square Signif.</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>62.2</td>
<td>52.6</td>
<td>54.0</td>
<td>0.000</td>
</tr>
<tr>
<td>African American</td>
<td>28.9</td>
<td>37.6</td>
<td>36.3</td>
<td>0.000</td>
</tr>
<tr>
<td>Native American</td>
<td>0.7</td>
<td>0.6</td>
<td>0.6</td>
<td>0.108</td>
</tr>
<tr>
<td>Asian</td>
<td>3.0</td>
<td>3.8</td>
<td>3.7</td>
<td>0.000</td>
</tr>
<tr>
<td>Hispanic</td>
<td>5.1</td>
<td>5.3</td>
<td>5.3</td>
<td>0.129</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Most Hazardous Deciles</th>
<th>Proximate</th>
<th>Not Proximate</th>
<th>Parish</th>
<th>Chi-Square Signif.</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>35.4</td>
<td>47.9</td>
<td>54.0</td>
<td>0.000</td>
</tr>
<tr>
<td>African American</td>
<td>27.7</td>
<td>37.9</td>
<td>36.3</td>
<td>0.000</td>
</tr>
<tr>
<td>Native American</td>
<td>0.8</td>
<td>0.6</td>
<td>0.6</td>
<td>0.000</td>
</tr>
<tr>
<td>Asian</td>
<td>2.8</td>
<td>3.9</td>
<td>3.7</td>
<td>0.000</td>
</tr>
<tr>
<td>Hispanic</td>
<td>4.1</td>
<td>5.5</td>
<td>5.3</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Source: U.S. Census Bureau, 2000; U.S. Environmental Protection Agency, 2004
Table 26 Results of Stepwise Multiple Regression Analysis for Jefferson Parish, Louisiana with the Hazardousness of Place Rating as the Dependant Variable

<table>
<thead>
<tr>
<th>Variable</th>
<th>Regression Coefficient</th>
<th>Student's t</th>
<th>Prob&gt;t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>948.383</td>
<td>9.177</td>
<td>0.000</td>
</tr>
<tr>
<td>Percent African American</td>
<td>-0.267</td>
<td>-3.213</td>
<td>0.002</td>
</tr>
<tr>
<td>Percent Native American</td>
<td>0.061</td>
<td>0.706</td>
<td>0.260</td>
</tr>
<tr>
<td>Percent Asian</td>
<td>-0.020</td>
<td>-0.251</td>
<td>0.802</td>
</tr>
<tr>
<td>Percent Hispanic</td>
<td>-0.285</td>
<td>-3.483</td>
<td>0.001</td>
</tr>
<tr>
<td>Mean Household Income</td>
<td>-0.208</td>
<td>-2.485</td>
<td>0.014</td>
</tr>
<tr>
<td>Median Contract Rent</td>
<td>-0.040</td>
<td>-0.426</td>
<td>0.671</td>
</tr>
<tr>
<td>Median House Value</td>
<td>0.006</td>
<td>0.055</td>
<td>0.956</td>
</tr>
</tbody>
</table>

N = 145; $R^2 = 0.153$; Adjusted $R^2 = 0.135$; F = 8.487 (0.000)
that is positively correlated with the hazards rating, although again not significantly. Low-income households, on the other hand, are significantly correlated with the cumulative hazardscape model, again at the 99 percent confidence interval. This suggests that economic factors are more important than racial factors in determining the degree of environmental inequity on the west bank of Jefferson Parish. One clear example of low-income populations clustering around onshore oil-related infrastructure can be seen in Avondale (Figure 49). The other economic factors, median contract rent and median house value, do not figure significantly in the regression model.

4.2.3 Saint Bernard Parish

Saint Bernard Parish is unique among the parishes in the study area, as it is the only location where no minority groups are statistically more likely to be found residing within the most hazardous census blocks (Figure 50, Table 27). In fact, the white population is the only group that is significantly more like to reside in proximity to the refinery-related hazards. The Asian population, is however, one and a half times as likely to reside in the most hazardous 40 percent of the parishes census blocks. The Hispanic and Native American populations in Saint Bernard Parish are more likely to reside in the least hazardous census blocks, as well as the moderately hazardous central decile. The African American population, on the other hand, is the least likely minority group to be found residing in both the highest and lowest deciles, as well as the second highest hazardousness decile. The extreme low odds ratios in these deciles suggest that the African American population in Saint Bernard Parish are highly concentrated in populated areas outside of Chalmette and Meraux, the areas impacted by the large oil refineries.

The contingency analysis of the individual facilities provides evidence of this (Figure 51, Table 28). The African American population is the least likely minority group to be found in
Figure 49 Household Income by Block Group and Proximity to Onshore Oil-Related Infrastructure in Avondale, Louisiana
Figure 50 Odds Ratios for Saint Bernard Parish, Louisiana Oil Refining-Related Hazardousness Deciles
Table 27 Comparison of Population Proportions for Oil Refining-Related Hazard Deciles in Saint Bernard Parish, Louisiana

<table>
<thead>
<tr>
<th>Least Hazardous Deciles</th>
<th>Proximate</th>
<th>Not Proximate</th>
<th>Parish</th>
<th>Chi-Square Signif.</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>89.8</td>
<td>85.2</td>
<td>85.9</td>
<td>0.000</td>
</tr>
<tr>
<td>African American</td>
<td>2.3</td>
<td>8.2</td>
<td>7.4</td>
<td>0.000</td>
</tr>
<tr>
<td>Native American</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.311</td>
</tr>
<tr>
<td>Asian</td>
<td>1.2</td>
<td>1.3</td>
<td>1.3</td>
<td>0.332</td>
</tr>
<tr>
<td>Hispanic</td>
<td>6.1</td>
<td>4.8</td>
<td>5.0</td>
<td>0.000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Deciles 3 &amp; 4</th>
<th>Proximate</th>
<th>Not Proximate</th>
<th>Parish</th>
<th>Chi-Square Signif.</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>77.0</td>
<td>88.2</td>
<td>85.9</td>
<td>0.000</td>
</tr>
<tr>
<td>African American</td>
<td>17.0</td>
<td>7.4</td>
<td>7.4</td>
<td>0.000</td>
</tr>
<tr>
<td>Native American</td>
<td>0.4</td>
<td>0.5</td>
<td>0.5</td>
<td>0.039</td>
</tr>
<tr>
<td>Asian</td>
<td>0.7</td>
<td>1.3</td>
<td>1.3</td>
<td>0.000</td>
</tr>
<tr>
<td>Hispanic</td>
<td>4.9</td>
<td>5.0</td>
<td>5.0</td>
<td>0.895</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Deciles 5 &amp; 6</th>
<th>Proximate</th>
<th>Not Proximate</th>
<th>Parish</th>
<th>Chi-Square Signif.</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>81.2</td>
<td>87.3</td>
<td>85.9</td>
<td>0.000</td>
</tr>
<tr>
<td>African American</td>
<td>10.3</td>
<td>6.6</td>
<td>7.4</td>
<td>0.000</td>
</tr>
<tr>
<td>Native American</td>
<td>0.7</td>
<td>0.4</td>
<td>0.5</td>
<td>0.000</td>
</tr>
<tr>
<td>Asian</td>
<td>1.7</td>
<td>1.2</td>
<td>1.3</td>
<td>0.000</td>
</tr>
<tr>
<td>Hispanic</td>
<td>6.2</td>
<td>4.6</td>
<td>5.0</td>
<td>0.000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Deciles 7 &amp; 8</th>
<th>Proximate</th>
<th>Not Proximate</th>
<th>Parish</th>
<th>Chi-Square Signif.</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>91.3</td>
<td>84.2</td>
<td>85.9</td>
<td>0.000</td>
</tr>
<tr>
<td>African American</td>
<td>2.2</td>
<td>9.0</td>
<td>7.4</td>
<td>0.000</td>
</tr>
<tr>
<td>Native American</td>
<td>0.4</td>
<td>0.5</td>
<td>0.5</td>
<td>0.248</td>
</tr>
<tr>
<td>Asian</td>
<td>1.9</td>
<td>1.1</td>
<td>1.3</td>
<td>0.000</td>
</tr>
<tr>
<td>Hispanic</td>
<td>4.1</td>
<td>5.2</td>
<td>5.0</td>
<td>0.000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Most Hazardous Deciles</th>
<th>Proximate</th>
<th>Not Proximate</th>
<th>Parish</th>
<th>Chi-Square Signif.</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>91.9</td>
<td>84.5</td>
<td>85.9</td>
<td>0.000</td>
</tr>
<tr>
<td>African American</td>
<td>3.3</td>
<td>8.4</td>
<td>7.4</td>
<td>0.000</td>
</tr>
<tr>
<td>Native American</td>
<td>0.4</td>
<td>0.5</td>
<td>0.5</td>
<td>0.148</td>
</tr>
<tr>
<td>Asian</td>
<td>0.7</td>
<td>1.4</td>
<td>1.3</td>
<td>0.000</td>
</tr>
<tr>
<td>Hispanic</td>
<td>3.7</td>
<td>5.3</td>
<td>5.0</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Source: U.S. Census Bureau, 2000; U.S. Environmental Protection Agency, 2004
Figure 51 Odds Ratios for Saint Bernard Parish, Louisiana Oil Refining-Related Infrastructure
Table 28 Comparison of Population for Selected Oil Refining-Related Infrastructure in Saint Bernard Parish, Louisiana

<table>
<thead>
<tr>
<th>Gas Processing Plants</th>
<th>Proximate</th>
<th>Not Proximate</th>
<th>Parish</th>
<th>Chi-Square Signif.</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>94.9</td>
<td>89.2</td>
<td>85.9</td>
<td>0.000</td>
</tr>
<tr>
<td>African American</td>
<td>2.1</td>
<td>7.0</td>
<td>7.4</td>
<td>0.000</td>
</tr>
<tr>
<td>Native American</td>
<td>0.7</td>
<td>0.4</td>
<td>0.5</td>
<td>0.018</td>
</tr>
<tr>
<td>Asian</td>
<td>0.7</td>
<td>1.3</td>
<td>1.3</td>
<td>0.000</td>
</tr>
<tr>
<td>Hispanic</td>
<td>4.6</td>
<td>5.1</td>
<td>5.0</td>
<td>0.110</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pipelines</th>
<th>Proximate</th>
<th>Not Proximate</th>
<th>Parish</th>
<th>Chi-Square Signif.</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>90.5</td>
<td>80.4</td>
<td>85.9</td>
<td>0.000</td>
</tr>
<tr>
<td>African American</td>
<td>6.4</td>
<td>7.7</td>
<td>7.4</td>
<td>0.006</td>
</tr>
<tr>
<td>Native American</td>
<td>0.5</td>
<td>0.4</td>
<td>0.5</td>
<td>0.677</td>
</tr>
<tr>
<td>Asian</td>
<td>1.3</td>
<td>0.3</td>
<td>1.3</td>
<td>0.000</td>
</tr>
<tr>
<td>Hispanic</td>
<td>4.7</td>
<td>10.0</td>
<td>5.0</td>
<td>0.000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Refineries</th>
<th>Proximate</th>
<th>Not Proximate</th>
<th>Parish</th>
<th>Chi-Square Signif.</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>93.5</td>
<td>85.4</td>
<td>85.9</td>
<td>0.000</td>
</tr>
<tr>
<td>African American</td>
<td>2.5</td>
<td>11.5</td>
<td>7.4</td>
<td>0.000</td>
</tr>
<tr>
<td>Native American</td>
<td>0.4</td>
<td>0.6</td>
<td>0.5</td>
<td>0.009</td>
</tr>
<tr>
<td>Asian</td>
<td>1.6</td>
<td>0.8</td>
<td>1.3</td>
<td>0.000</td>
</tr>
<tr>
<td>Hispanic</td>
<td>4.5</td>
<td>5.7</td>
<td>5.0</td>
<td>0.000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transportation Corridor</th>
<th>Proximate</th>
<th>Not Proximate</th>
<th>Parish</th>
<th>Chi-Square Signif.</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>88.7</td>
<td>95.0</td>
<td>85.9</td>
<td>0.000</td>
</tr>
<tr>
<td>African American</td>
<td>7.5</td>
<td>1.7</td>
<td>7.4</td>
<td>0.000</td>
</tr>
<tr>
<td>Native American</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.991</td>
</tr>
<tr>
<td>Asian</td>
<td>1.3</td>
<td>1.1</td>
<td>1.3</td>
<td>0.234</td>
</tr>
<tr>
<td>Hispanic</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td>0.833</td>
</tr>
</tbody>
</table>

Source: U.S. Census Bureau, 2000; U.S. Environmental Protection Agency, 2004
proximity to either the oil refineries in Chalmette and Meraux or the gas processing plants in rural Toca and Yscloskey. The analysis shows that the African American population tends to cluster on the primary transportation corridors in Saint Bernard Parish, though away from communities with refining-related facilities. Conversely, it is the white population that is more likely to reside near both the refineries and gas processing plants. As in each of the other parishes, facilities in the rural regions, such as the gas processing plants in Saint Bernard Parish, tend to have statistically significant numbers of Native Americans residing in proximity.

Stepwise multiple regression analysis conducted at the block group level reinforces the findings of the contingency analysis (Table 29). All of the minority groups were negatively correlated with the hazardousness rating. The only significant factor in the regression model, however, was the percentage African American, which negatively correlated at a 95 percent confidence interval. The percentage Hispanic also negatively correlated with the overall hazardousness, though only significant at the 90 percent confidence interval. One of the economic variables proved to be significant in the model, though incomes showed a tendency to decrease as the hazardousness of the area increased. Visual examination of income distributions in Chalmette bears out this finding (Figure 52). Interestingly, high-income populations reside in proximity to much of the Murphy Refinery property. The income levels around the Chalmette refinery, on the other hand appear to be significantly lower. Similarly, we see lower income populations interspersed with higher-income individuals in rural Saint Bernard, such as Toca (Figure 53). Of course, this apparent mixing of classes could be more a product of the size of the census block groups in the area than an actual mixture. Rents and house values tended to rise in the more hazardous areas of Chalmette and Meraux, though not significantly.
Table 29 Results of Stepwise Multiple Regression Analysis for Saint Bernard Parish, Louisiana with the Hazardousness of Place Rating as the Dependant Variable

<table>
<thead>
<tr>
<th>Variable</th>
<th>Regression Coefficient</th>
<th>Student's t</th>
<th>Prob&gt;t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>2364.545</td>
<td>9.374</td>
<td>0.000</td>
</tr>
<tr>
<td>Percent African American</td>
<td>-0.336</td>
<td>-2.364</td>
<td>0.023</td>
</tr>
<tr>
<td>Percent Native American</td>
<td>-0.126</td>
<td>-0.886</td>
<td>0.380</td>
</tr>
<tr>
<td>Percent Asian</td>
<td>-0.027</td>
<td>-0.186</td>
<td>0.853</td>
</tr>
<tr>
<td>Percent Hispanic</td>
<td>-0.250</td>
<td>-1.805</td>
<td>0.078</td>
</tr>
<tr>
<td>Mean Household Income</td>
<td>-0.110</td>
<td>-0.737</td>
<td>0.465</td>
</tr>
<tr>
<td>Median Contract Rent</td>
<td>0.009</td>
<td>0.058</td>
<td>0.954</td>
</tr>
<tr>
<td>Median House Value</td>
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<td>0.673</td>
</tr>
</tbody>
</table>

N = 45; $R^2 = 0.113$; Adjusted $R^2 = 0.093$; $F = 5.590$ (0.023)
Figure 52 Household Income by Block Group and Proximity to Oil Refining-Related Infrastructure in Chalmette, Louisiana
Figure 53 Household Income by Block Group and Proximity to Oil Refining-Related Infrastructure in Toca, Louisiana
4.3 Summary of Findings

Of the three sectors of the oil industry explored in this study, analysis found that OCS-related hazards are the most dispersed, and thus the least overtly hazardous. This is due in large part to the fact that the actual extraction sites are located far offshore, away from the parish itself. As a result, onshore support industries have fewer constraints on where to locate. While Port Fourchon, for example, is clearly the most convenient place for industry to locate, relative to proximity to the offshore wells, it is not economically unfeasible for facilities to locate further upstream. Thus we see shipyards located all along Bayou Lafourche, from Fourchon to Golden Meadow, up through Larose and Lockport. Petroleum bulk storage facilities locate in many communities across south Lafourche, with a larger facility located in north Lafourche. In the case of some industries, such as platform and pipeline fabrication, facilities exist in adjacent parishes, reducing the overall hazardousness of the region.

The other two sectors are much more constrained, economically, geographically, and politically. In Jefferson Parish, the onshore-related infrastructure must necessarily occupy sites in the immediate vicinity of the oil fields. Thus we see much greater facility clustering and, consequently, hazardousness. Petroleum refining requires large-scale facilities and a large labor force, as well as transportation infrastructure and easy access to large amounts of water for reactive and cooling purposes. In coastal Louisiana, the potential siting locations for large refineries are extremely limited, not to mention the political incentives and disincentives involved in siting such a potentially hazardous facility.

It is the flexibility in locating new facilities that results in OCS-related infrastructure being lower on the potential hazardousness scale than both the onshore extraction and petroleum refining industries. The more dispersed the industries, the less the cumulative potential toxicity
of the region. We should be cautious in interpreting these results, however, so as not to assume that a more dispersed hazard surface is necessarily more equitable. Because the risk surface is more dispersed, more communities may in fact be exposed to potential hazards.
CHAPTER 5 – ENVIRONMENTAL EQUITY AND NATURAL RESOURCE VULNERABILITY IN COASTAL LOUISIANA

Traditionally, when conducting environmental impact assessments, federal agencies have needed to consider the impacts of development on threatened and endangered species, and to mitigate any potential impacts on them. The Endangered Species Act, for example, recognizes that human actions, both those aggressively hostile and passively destructive to habitats, can have disproportionate impacts on certain species, and requires people to restrict their behavior (Hill and Targ 2000). With the development and legal legitimization of the environmental justice movement, however, these agencies find themselves in a situation where they must also assure that their programs and policies maintain the natural and environmental resources upon which low-income or minority communities depend.

Such a mandate is explicitly stated in Executive Order 12898, issued by President William Clinton on February 11, 1994. One of the priorities of E.O. 12898 is to collect and analyze information on the consumption patterns of people who rely principally on fish or wildlife for subsistence and to communicate to the public the risks of those consumption patterns. In fact, when the President’s Council on Environmental Quality (CEQ) issued guidance to implement E.O. 12898, it required that agencies determine whether there are inter-related cultural, social, occupational, historical, or economic factors that may amplify the physical environmental effects of the proposed action (Foster 1999). According to CEQ, where an agency action may affect fish, vegetation, or wildlife, it may also affect subsistence patterns of consumption and indicate the potential for disproportionately high and adverse human health or environmental effects on low-income populations, minority populations, and Indian tribes (CEQ 1997).
The U.S. Environmental Protection Agency carries this mandate even further in its Environmental Justice Guidance by requiring consideration of both the cumulative and indirect impacts of agency action on vulnerable communities. The USEPA recognizes, for example, that certain natural resources may have both economic and cultural value to specific communities, and that analysts should consider the cumulative impacts from the perspective of these specific resources or ecosystems (Foster 1999). The USEPA guidance further recognizes that particular attention should be paid to the indirect effects of an action on minority and low-income communities. For example, USEPA notes that reduced access to fishing and farming locations may result from increased urbanization around a new facility due to increased employment or transportation system upgrades (Foster 1999). This reduced access to natural resources as a result of policy actions, according to USEPA, would represent a potential source of environmental injustice.

While most environmental equity studies have examined the spatial distribution of hazards and how they vary among different socioeconomic groups as a result of policy, relatively few studies have considered how the distribution of hazards impacts access to natural resources. Advocates have argued that it is the government’s responsibility to protect natural resources in a manner that encompasses the perspectives and needs of the most vulnerable individuals and species so that everyone can enjoy the benefit of healthy resources and environmental services (Hill and Targ 2000). Yet, perhaps because natural resource collection and consumption are viewed as lifestyle factors rather than intrinsic susceptibility factors, this aspect of environmental equity has not been widely explored.

Clearly, however, the environmental justice regulations are not designed to protect every bit of wildlife habitat for non-endangered or threatened species. In areas where natural resource
collection is a viable economic and cultural activity, it should be possible to identify areas of land that offer the greatest potential to support a multitude of valuable wildlife habitat. This would call for a place-based or resource-based analysis. As Hill and Targ (2001) note, resource protection like this would include “the protection of specific types of natural or environmental resources based on an ecological or place-specific basis.” Further, regulation of specific natural or environmental resources can serve to protect ecosystems and the people whose lives are intertwined with them (Hill and Targ 2000).

This chapter seeks to extend previous environmental equity research methodologies to include natural resource issues raised by E.O. 12898 and the federal environmental justice implementation guidelines. First, this research establishes a theoretical framework that connects locally based natural resource extraction activities with social vulnerability and environmental equity. Second, I examine the distribution of wildlife species that are important in the traditional livelihoods of local residents in southeast Louisiana, a largely rural region with a long history of hunting and trapping. Third, this research gauges the potential impacts of oil-related industries on wildlife habitat. Lastly, I discuss the importance of documenting diminishing local resource extraction and its implications for environmental justice policy.

5.1 Social Vulnerability and Natural Resource Collection

According to Susan Cutter, social vulnerability to risks and hazards derives from the activities and circumstances of everyday life (Cutter et al. 2000). While researchers have focused on social vulnerability as a function of residential and occupational environments, for many, the activities and circumstances of everyday life extend well beyond these realms. Rural regions, for example, generally are less vulnerable to risk because of lower population and housing densities (Cutter et al. 2000). However, in many rural areas, residents obtain or
supplement their food supplies by hunting or fishing. Researchers have demonstrated that the consumption and use of contaminated fish and wildlife is the primary route by which humans are exposed to many toxic contaminants such as chlordane, dioxins, DDT, and toxaphene (O’Neill 2003). Thus, the risk to these rural communities is heightened beyond simple residential exposure levels when interactions with cultural and social processes are taken into account. This is what Kaspersion et al. (1988) refer to as the social amplification of risk.

This social amplification of the risk surface varies depending on the cultural and social values of the impacted communities. It is generally accepted that communities defined by common ethnicity, social ties, health conditions, or other factors may have unique susceptibilities or common cultural practices that, if closely examined, would demonstrate that they are in fact impacted (Warren 1999). Susan Cutter notes that certain social factors can contribute to greater vulnerability on the part of some population subgroups (Cutter et al. 2000). In addition to consuming fish and wildlife in greater quantities than does the general population, for example, different ethnic or racial communities may consume and use different fish and wildlife species. These communities may also employ different practices in preparing and consuming fish and wildlife (National Environmental Justice Advisory Council; NEJAC 2002). For example, we generally assume that people eat only the fillet of finfish, and that they do not eat the fat, head, skin, bones, eggs, or internal organs, and that people dispose of the drippings or cooking fluid (NEJAC 2002).

As Hill and Targ (2001) point out, “attention to minority and low-income communities and the natural resources upon which they depend is necessary because actions that adequately protect the general population may not always protect discrete segments of the population.” In the case of natural resource collection and consumption, indigenous people, members of other
non-dominant groups, and low-income individuals often rely on these resources as indispensable nutritional and economic goods. It is this reliance on natural resource collection that sets the activities of these groups apart from the more recreation-based activities of other social groups. While there are important differences among various communities of color, low-income communities, and indigenous peoples, members of these groups depend on fish and wildlife to a greater extent and in different ways than does the general population (NEJAC 2002).

As suggested above, there are two important ways that natural resource collection and consumption intersect with environmental equity. First, environmental equity research is concerned with the public health risks associated with the possible contamination and subsequent consumption of certain natural resources, particularly fish and wildlife. In addition, research needs to account for the role that natural resource collection plays in the economic life of potentially impacted communities. This is especially important in rural areas, where residents are generally more dependant on locally based resource extraction activities (Cutter et al. 2000).

5.1.1 Heath Risks

Attention to minority and low-income communities and the natural resources upon which they depend is necessary because actions that adequately protect the general population may not always protect discrete segments of the population (Hill and Targ 2000). By directing federal agencies to collect, maintain, and analyze information on the consumption patterns of populations dependant upon fish and wildlife for subsistence, E.O. 12898 implies a need to establish the degree of spatial coincidence between potential contamination sources and the distribution of fish and wildlife populations. According to the CEQ, it must be determined whether agency action does in fact impact fish, vegetation, or wildlife. It is this determination that establishes whether or not the potential for environmental justice concern exists. If a
contaminant is released and that contaminant persists in the environment and bioaccumulates in fish and wildlife, it may find its way into humans who consume or use these resources. In fact, the consumption and use of contaminated fish, wildlife, and other aquatic resources is the primary route by which humans are exposed to many different toxic contaminants.

One of the most closely monitored environmental contaminants is mercury. When inorganic mercury enters the aquatic environment, it is readily converted to methyl mercury by aquatic microorganisms. The level of mercury contamination tends to increase at higher trophic levels through biomagnification. When the rate of uptake exceeds the elimination rate, the mercury concentration in fish begins to increase. Ultimately, in Louisiana rivers and lakes, large predatory fish, such as adult largemouth bass and bowfin, tend to have much higher levels of mercury than juvenile fish and those lower on the food chain (LDEQ 2004). Ultimately, this risk is passed on to subsistence fishermen. According to the Louisiana Department of Environmental Quality (LDEQ), the primary route of exposure to methylmercury in Louisiana is consumption of locally caught fish. Therefore, according to LDEQ, subsistence fishermen are at a much higher risk than the general population.

Similarly, mercury also bioaccumulates in terrestrial wildlife. According to a study by LDEQ, top predators of the aquatic food chain tend to have the highest concentrations of mercury. This includes commonly trapped mammalian species such as raccoons, mink, and otters. Waterfowl species are also susceptible to mercury contamination. A recent study found that female wood ducks and their eggs contain mercury at levels comparable to those in the environment where they are collected (Kennamer et al. 2005). According to the Michigan Department of Natural Resources, when waterfowl are exposed to chronic low levels of mercury contamination, mercury residue accumulates in the pectoral muscle of the bird (Michigan DNR 1993).
While mercury may be the most closely monitored environmental contaminant, it is not the only one. Lead, for example, represents one of the most persistent pollutants in the environment. Once in the soils and sediments, lead persists and may migrate, contaminating not only surrounding areas but also sediments in rivers and marshes downstream. Plants, fish, waterfowl, and other birds then uptake the lead present in contaminated sediments (O’Neill 2003). Clearly then, all other factors being equal, a higher level of resource consumption results in a greater potential for exposure to many contaminants in the environment that the fish or wildlife uptake, and the greater the risk of adverse health impacts.

One of the common strategies to deal with environmental contamination is risk avoidance and the issuance of health advisories. In the case of mercury, for example, the Louisiana Department of Health and Hospitals (LDHH) uses a limited meals approach in establishing health advisories. LDHH will consider issuing a health advisory limiting fish consumption for pregnant or breast feeding women and children less than 7 years of age for locations where the average concentration of mercury exceeds 0.5 parts per million (ppm) in fish and shellfish. At average concentrations exceeding 1.0 ppm, LDHH recommends that pregnant or breast feeding women and children less than 7 years of age avoid consumption altogether, and limited consumption for the general population (LDEQ 2000).

FDA standards serve as the basis for values that establish maximum allowable mercury levels of 1.0 ppm in fish to protect consumers at mercury concentrations ten times lower than the lowest levels associated with the initial adverse effects of mercury (Foulke, 1994). Yet, the consumption patterns and habits of the general population serve as the basis of these standards. Agencies generally assume that people eat only the fillet of finfish, for example, and only measure mercury levels in the fillets. Yet, as NEJAC notes, some racial, ethnic, and low-income
communities make use of the fat, head, skin, bones, eggs, and internal organs of fish, as well as
the drippings and leftover cooking fluids used in preparation (NEJAC 2002). Even if individuals
in these communities consume within limits established by LDHH, they may still find
themselves with a greater potential for exposure to environmental contaminants.

5.1.2 Economic Risks

For many racial, ethnic, and low-income communities, environmental justice is rarely
only about immediate health concerns or the distribution of hazards (Yamamato and Lyman
2001). For these communities, environmental justice is often about economic self-determination.
Mainstream cultural values tend to view hunting and fishing primarily as a recreational pursuit
and only secondarily as an economic activity (O’Neill 2003). Analyses based on the use of these
mainstream cultural values may overlook important disproportionate burdens that vary across
situated populations, communities, and their environments (Hill and Targ 2000). For rural
communities, many of which are already economically burdened, the loss of valuable hunting
and fishing grounds would represent a further economic blow to residents. For some
communities, natural resource collection is a primarily economic and subsistence activity.

This highlights a shortcoming of using risk avoidance measures as a means to deal with
environmental contamination. Fish and wildlife advisories generally focus on the problem of the
contamination of fish and wildlife, while not addressing the problem of the availability of fish,
aquatic plants, and wildlife for consumption and use by local residents (NEJAC 2002). Clearly,
risk avoidance strategies seek only to influence or require risk-bearers to alter their practices
(O’Neill 2003). In issuing advisories and setting consumption limits, agencies have largely
failed to consider which groups in society are likely to have to undertake avoidance. Restrictions
on fishing often have the unanticipated effect of making it more difficult for indigenous people,
members of other non-dominant groups, and low-income individuals to take advantage of a high-quality, low-priced food source (Lawrence 1999). This places a disproportionate burden on these groups, often forcing individuals to choose between their physical and economic well-being.

This highlights the differences in the ways in which researchers often view natural resource collection. For many evaluators, hunting and fishing are likely to be understood as pursuits that are not necessary for most practitioners, but important for recreational or economic reasons for some. While recreational hunters and fishermen may recognize fish and game as palatable, efficient, and relatively inexpensive sources of protein and nutrients, these are not the only such sources for them. These resources are therefore likely to be valued, but unlikely to be indispensable (O’Neill 2003). For subsistence hunters and fishermen, however, these resources are, in fact, indispensable, as nutritional, economic, and cultural necessities.

This dependence on natural resources has been acknowledged by the U.S. Environmental Protection Agency when addressing environmental justice concerns. Many of the regulations that the USEPA implements provide the agency with the authority to support the integrity of the environment and natural resources upon which minority and low-income communities depend (Hill and Targ 2000). NEJAC, for example, has acknowledged that fish, aquatic plants, and wildlife are important food sources, and that “if someone can fish, gather, harvest, or hunt nearby, he or she can bypass altogether the need to get to a store and to purchase food” (NEJAC 2002: 3). In fact, natural resource dependence has been cited as a primary indicator of economic status, particularly when viewed in conjunction with racial factors. Research has shown, for example, that minorities’ dependence on employment in natural resource-related fields, such as farming, fishing, and forestry, is positively associated with poverty, and that minority
employment in the agriculture, fishing, and forestry industries is a negative predictor of economic development (Adeola 1999).

5.2 Determining Natural Resource Vulnerability

The process used to determine natural resource vulnerability is similar to the one used to create the hazards-of-place model of vulnerability. I focused once again on three elements: biophysical, natural resource, and place vulnerability. These three outcome indicators enabled measurement of the potential hazardousness of the oil industry in each parish as it relates to natural resources. The delineation of oil- and gas-related hazard zones provided a measure of biophysical vulnerability, while habitat data for a number of indicator species provided a measure of natural resource vulnerability. The overlap of the two gives the overall place vulnerability, the third outcome indicator.

5.2.1 Pollution Potential

The weighted hazardscape model developed in chapter 3 provides a measure of pollution potential. Again, this model allowed for a determination of the overall hazardousness of each sector of the oil industry by allowing for the incorporation of multiple sources of potential risk into the hazardscape. Risk to wildlife goes beyond exposure to toxins and includes elements of habitat degradation and removal, as well as loss of feeding and breeding grounds.

5.2.2 Modeling Wildlife Habitat

Aquatic wildlife resources were extracted from the Louisiana Gulf-Wide Information System (G-WIS), a database created for MMS to support environmental assessments associated with oil and gas exploration, production, and transportation activities in the Gulf of Mexico. One portion of the G-WIS contains information on major crawfish and river shrimp concentrations in
the coastal waterways of Louisiana, and another describes freshwater (inland) fish resources in coastal Louisiana. Both data sets identify water-bodies and other aquatic habitats with similar species composition and relative abundance in various inland rivers, lakes, and, in some cases, adjacent wetlands.

Analysis of non-aquatic wildlife utilized U.S. Geological Survey USGS Gap Analysis Program (GAP) data to examine the habitats of those animals that are important in the more traditional livelihoods of local residents of southeast Louisiana, particularly the Native American population. The Louisiana Department of Wildlife and Fisheries (LDWF) identifies commonly hunted and fished wildlife while the Louisiana State University Agriculture Center identifies commonly trapped fur-bearing mammals in its annual natural resource summaries (LSU Agriculture Center 2002), while GAP provides geographical data on these species and their habitats.

This analysis modeled the diversity of commonly hunted and trapped wildlife species. Species diversity has been shown to generally decline in response to disturbance for a variety of different stressors and ecosystems (Suter and Bartell 1993). This portion of the research involved mapping the zones of natural resources potentially collected and consumed by local populations. To create the additive model, I extracted habitat data on the predicted distribution of animals vital to the fur harvest in Louisiana from the state’s GAP data. The most commonly trapped mammals in Louisiana are the nutria, raccoon, muskrat, mink, otter, and bobcat, in that order.

This habitat data allowed for the mapping of the overall distribution of species diversity in Louisiana’s fur trade. Using this cumulative distribution map, this research identified portions of each parish with the greatest diversity of animals vital to the fur harvest. These locations
would also be those that are the most economically viable for the portion of the population for whom trapping is a way of life.

In much the same way, I created a model of the cumulative distribution of game animals that are commonly hunted for direct consumption. In this case, I extracted data on the predicted distributions of a number of different species of waterfowl, including the wood duck, mallard, mottled duck, blue-winged teal, and both the fulvous and black-bellied whistling ducks, as well as the Canada goose. The only other bird species used in this analysis was the wild turkey, another common game bird. The only large game animal used in the model was the deer.

Finally, this analysis utilized fisheries data extracted from the Gulf-Wide Information System (G-WIS) database, a dataset developed to provide summary information on sensitive natural and human use resources for the purpose of oil spill planning, environmental assessment, and natural resource management. The dataset consists of a number of vector polygons that represent water bodies and other fish habitat with similar species composition and relative abundance in various inland rivers, lakes, and adjacent wetlands. In most cases, these data layers are based on quantitative Louisiana Department of Wildlife and Fisheries survey data collected through 1999 or 2000.

5.3 Locational Vulnerability of Natural Resources

The objective of this portion of the study is to identify the potential oil-related hazards that may specifically impact wildlife communities. Using the species-specific habitat zones along with the hazardscape model, this research identifies locations within the study area where wildlife habitats are most at risk from oil-related development.

The minority populations residing within a half-mile buffer of these potentially impacted natural resource areas were the focus of the next portion of the analysis. Odds ratios allowed for
an examination of the minority proportions of census blocks within these buffers compared to the proportions outside of them. This research does not make a determination whether or not nearby residents actually hunt or fish these potentially impacted areas. Geographical proximity alone cannot cause an interaction, but it does facilitate it (Torre and Rallet 2005). This portion of the analysis is therefore used to identify populations that are at heightened risk should they hunt or fish the wetlands surrounding their residences.

5.3.1 Oil-Related Degradation of Wildlife Habitat

The potential impacts of OCS-related development on wildlife habitats are numerous, ranging from habitat fragmentation to complete habitat removal. For example, when marshland is converted to canals, there is a loss in overall primary or plant productivity, regardless of a partial compensation by aquatic plant productivity (Wicker et al. 1989). Although pipeline laying does not totally remove any of the important components of the ecosystem, these components are usually affected more in the pipelined areas, primarily through the fragmentation of the landscape. Pipeline laying and the construction of roads bisect the area, potentially separating breeding populations, which could result in genetic isolation and the threat of local extinctions. In the case of pipeline canals, backfilling permitted plants and animals to completely reinvade the pipeline transect.

Complete habitat removal often results from the dredging of canals and channels, as well as resultant spoil deposition. In addition, land subsidence and the loss of wetlands often have a dramatic impact upon an area’s ecology. One associated issue is the problem of saltwater intrusion, whereby freshwater or intermediate marshland has become either saline or brackish, resulting in the displacement and subsequent loss of important wildlife habitat. For example, the marshes of southern Lafourche Parish are ideal for waterfowl food production, including
widgeon grass, southern najas, and three-cornered grass. However, this fragile freshwater habitat is already showing signs of degrading as saltwater intrusion and brackish marsh deterioration is already arriving.

In addition to habitat degradation, faunal communities are often directly impacted by toxic releases and spills. For example, oil releases may directly impact avian species in one of two ways. First, when plumage becomes fouled with oil, there is a loss of insulation. This may ultimately result in starvation, as the bird experiences a sharp rise in metabolism to compensate for this loss. Second, the bird may ingest oil as it preens, potentially resulting in gastrointestinal irritations and other health conditions (Bolen and Robinson 1995). Studies have indicated that oil toxicity is a definite factor in the mortality of impacted birds. One indirect effect of exposure to oil concerns reproduction. Ducks that have ingested lubricating oil temporarily ceased laying eggs. Furthermore, fertile mallard eggs exposed to small amounts of mineral oil experienced 68 percent less hatching success than untreated eggs (Bolen and Robinson 1995).

In addition to spills or toxic releases, fauna may also be impacted directly by OCS-related facilities. Animals may become trapped in oil pits and sumps constructed near oil fields, refineries, and petrochemical plants. Most of the impacted animals are ducks and other waterfowl, which mistake the oil for water (Bolen and Robinson 1995). While this is clearly more of a problem in arid and drought-prone regions, any oil pit or sump does present the potential for wildlife harm.

5.3.2 Spatial Analysis of Potentially Impacted Habitat

To correlate zones of increased petroleum-related activity with those areas with the potential to be used by local residents, either for direct consumption or as a livelihood, I overlaid the various habitat maps with the hazards map of oil- and gas-related industry. This correlation
allowed for the identification of clusters of wildlife habitat that have a high hazardousness rating (Standard Deviation >3) and a high species diversity rating (Standard Deviation >2). In Saint Bernard Parish, where there is an extremely steep risk gradient, we looked at areas with both extremely and moderately high hazardousness ratings (Standard Deviation >2).

5.3.2.1 Lafourche Parish

In total, the analysis identified forty clusters of potentially at-risk wildlife and fisheries habitat in Lafourche Parish. Given the overall distribution of commonly trapped mammal habitat in Lafourche Parish, it is not surprising that this habitat has the most acreage at risk by expanding OCS-related activity. The analysis identified seventeen locations of potentially at-risk trapping habitat totaling over 49,000 acres of land (Figure 54). Much of this acreage is found around communities located along the Highway 1 corridor, although the wetlands to the east of this corridor also have significant acreage. The greatest concentrations are in the South Lafourche A Environmental Management Unit which contains Larose and Cutoff.

The analysis also identified large clusters within the South Barataria and Raccourci Environmental Management Units between Golden Meadow and Leeville. Other communities of note include Lockport and Raceland, both located on the Highway 1 corridor, and Grandbois, a small Cajun and Houma Indian community located within the Bayou Pointe-au-Chien and Raccourci Environmental Management Units on the western edge of the parish. In total, some 546 census blocks are located within one half mile of potentially impacted trapping habitat. The population of these census blocks at the time of the last census was well over 19,000.

OCS-related activities had fewer impacts on potential hunting habitat in Lafourche Parish. The analysis identified fourteen locations with just over 27,000 acres of land (Figure 55). Areas along the Highway 1 corridor were less significant, although the marshlands within the
Figure 54 Locations of Potentially Impacted Trapping Zones in Lafourche Parish, Louisiana
Figure 55 Locations of Potentially Impacted Hunting Zones in Lafourche Parish, Louisiana
North Little Lake Environmental Management Unit, stretching between Larose and Little Lake, were significant. Also of note is the inclusion, once again, of the small community of Grandbois. In all, only 126 census blocks are within one half mile of potentially impacted hunting ground, encompassing 4,342 persons. Noticeably fewer people live in proximity to potentially impacted hunting habitat than trapping habitat, likely due to the clustering of quality hunting habitat.

Finally, only nine areas of potentially impacted freshwater fish habitat encompassing only 13,000 acres were significant (Figure 56). However, two-thirds of these areas are entirely within the South Lafourche A Environmental Management Unit along Bayou Lafourche. The southern extent of these areas includes that portion of Bayou Lafourche stretching from Larose to Cutoff. The northernmost area is located in a portion of Bayou Lafourche that crosses through Thibodaux. Although these areas of land encompass far less acreage, the vast majority of this land runs through the most populous portions of the parish. In total, some 653 census blocks are located within one half mile of the potentially impacted fisheries, with a total population of almost 23,000 residents.

The southern portion of Lafourche Parish contains sixteen Environmental Management Units (Figure 57). Strip residential and commercial development dominate land uses along Bayou Lafourche while the units outside of this area are almost exclusively marshland, grading from freshwater to saltwater. The Louisiana Department of Natural Resources has identified each of these units as being important fish, shellfish and wildlife propagation areas. Two units, however, are important areas for the Houma Indian Tribe, the Bayou Pointe-au-Chien and Raccourci Environmental Management Units. These two units encompass all of the land along Bayou Pointe-au-Chien along the western boundary of Lafourche Parish. Other significant units include North Little Lake, South Barataria, and South Lafourche A and B.
Figure 56 Locations of Potentially Impacted Fishing Zones in Lafourche Parish, Louisiana
Figure 57 Environmental Management Units in Lafourche Parish, Louisiana
5.3.2.1.1 Bayou Pointe-au-Chien

Bayou Pointe-au-Chien, the more northerly of the two units, is mostly low-lying marshland, with higher natural ridges found along Bayou Blue and Bayou Pointe-au-Chien. The surrounding marshlands are ideal for production of waterfowl food. Consequently, waterfowl and fur-bearing animals thrive throughout the unit. Commercial and sports fishing, primarily fresh and brackish water angling, are also excellent throughout the unit. Residential and commercial areas are small and cluster along Bayou Pointe-au-Chien near Grandbois. Most of the unit is part of Pointe-au-Chien Wildlife Management Area and is fairly unique in that extensive channelization of the fresh marsh and swamp has not occurred, with the exception of the extreme southern portion, where it borders the Raccourci management unit.

5.3.2.1.2 Raccourci

The Raccourci Environmental Management Unit consists of low-lying marshland and shallow lakes and bays that open into the Gulf of Mexico. There are numerous bayous throughout the area, as well as a number of pipeline and navigation canals. The vegetation in the unit grades from brackish to saline marsh. In addition to large amounts of oil and gas extraction, the major uses of this study unit are recreation, hunting, and fishing. Trapping lands are also found in the northern portion of the unit. One small Houma Indian community remains on the northern shore of Catfish Lake, just to the west of the town of Golden Meadow. This settlement consists of five families who hunt and trap for a living (LDNR 2002).

5.3.2.1.3 North Little Lake

Potentially impacted wildlife habitat is generally dispersed throughout Lafourche parish. One of the larger clusters is located within the North Little Lake Environmental Management Unit,
bounded by Lake Salvador on the north, the south by the Scully Canal, the east by Bayou Perot, and the west by Bayou Lafourche.

Little Lake is an excellent area for hunting and fishing. In addition, the area is a nursery for many important commercial fisheries’ species, including menhaden, shrimp, and blue crab. Despite the commercial importance of unit for commercial and recreational hunters and fishers, most of the land is devoted to mineral extraction. Several pipeline canals cross transferring oil from the nearby West Delta Farms, Little Temple, and Cut Off oil and gas fields, as well as several offshore facilities.

### 5.3.2.1.4 South Barataria and South Lafourche A and B

Located along the Highway 1 corridor from the Intracoastal Waterway south, the South Barataria, South Lafourche A, and South Lafourche B Environmental Management Units contain almost all of the population in the Lafourche Coastal Zone. Strip residential and commercial development dominates land use along both banks of Bayou Lafourche. South Lafourche A encompasses all the land within the south Lafourche Levee system. Bayou Lafourche and Highways 1 and 308 provide access to hunting and fishing areas in the adjacent swamps and marshlands.

Other than the Highway 1 transportation corridor, the predominant use of land in the South Barataria Environmental management unit is mineral extraction, hunting, trapping, and fishing, both commercial and recreational. Prime fish and shellfish exist in the eastern portion of the unit as well as several private and public oyster seed grounds.

### 5.3.2.1.5 Analysis of Human-Wildlife Proximity

Odds ratios for the proportion of minority population in the blocks within a half-mile of potentially impacted wildlife habitat reveal that there is an unequal social distribution of
potentially impacted wildlife and fishery habitat in Lafourche Parish (Table 30). The most equitable distribution is seen around the potentially impacted freshwater fisheries of the parish. With the exception of the Asian population, minority residents are no more likely to live in proximity to potentially impacted fisheries than anywhere else in the parish. The Asian population, however, are almost twice as likely to live in proximity to this habitat type. In fact, the Asian population shows a tendency to live in proximity to each type of impacted wildlife habitat. Similarly, Houma Indians are also significantly more likely to live in proximity to potentially impacted hunting and trapping grounds.

The African American population is much less likely to be found living in proximity to all potentially impacted wildlife and fisheries habitat. Given that 33 percent of the African American population resides in Thibodaux, these results are hardly surprising. Thibodaux, the largest population center in the parish, has significantly fewer areas of wildlife habitat in general. Similarly, because most of the OCS-related industries in Lafourche Parish are concentrated in the southern portion of the parish, Thibodaux has far fewer industries and a less significant risk surface.

### 5.3.2.2 Jefferson Parish

In total, one dozen areas where natural resources may be significantly impacted by onshore oil-related development exist in Jefferson Parish. The potentially impacted areas are located primarily in the developed northern portion of Jefferson Parish’s west bank, an area included in the Avondale and West Bank Environmental Management Units. Other areas of potential concern are located in the south central portion of the parish, particularly the Lower West Bank and Bayou Segnette Environmental Management Units.
Table 30  Odds Ratio Values of Potentially Impacted Wildlife Habitat in Lafourche Parish, Louisiana with Census Block Race Variables: White, African American, Native American, Asian, and Hispanic

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<td>.007*</td>
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<td>.000*</td>
<td>1.030</td>
<td>.537</td>
</tr>
</tbody>
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* Statistically significant at 99% confidence level

1Sample consists all census blocks within 0.5 miles of commonly hunted wildlife habitat potentially impacted by OCS-related development (n = 126)

2Sample consists all census blocks within 0.5 miles of commonly trapped mammal habitat potentially impacted by OCS-related development (n = 546)

3Sample consists all census blocks within 0.5 miles of freshwater fish habitat potentially impacted by OCS-related development (n = 653)
The potentially impacted habitat of commonly hunted fauna is clustered in four locations, encompassing approximately 8,087 acres of land (Figure 58). Three of these clusters are in the northern portion of the west bank in the Avondale and West Bank management units, while the fourth is in the Lower West Bank and Bayou Segnette management units. In total, 221 census blocks containing 12,475 persons are within one half mile of these potentially impacted habitat areas. These same areas are included in the 10,275 acres of identified potential trapping habitat, with one additional cluster located on an undeveloped area along the Mississippi River in Marrero (Figure 59). In total, 341 census blocks are located within a half mile of the potentially impacted trapping areas, containing some 19,909 persons.

Finally, of the three areas where onshore oil-related activities potentially impact freshwater fish and river shrimp, two are areas within the Mississippi River, along Avondale and Marrero (Figure 60). The third area is south of Westwego at Six-Mile Lake, along the boundary of the Avondale and West Bank units.

5.3.2.2.1 Avondale

The potentially impacted wildlife habitat in Jefferson Parish is concentrated in a few locations in the parish. Two of these clusters are within the Avondale Environmental Management Unit, bounded on the north by the Mississippi River, the south by the Lake Cataouatche Levee, the east by the corporate limits of Westwego, and the west by St. Charles Parish (Figure 61).

Four major vegetative associations exist within this management unit. Modified forested wetlands are the principal vegetation type in the unit, along with the natural levee forests found along the Mississippi River. Cropland exists between the River Road and U.S. Highway 90 and
Figure 58 Locations of Potentially Impacted Hunting Zones in Jefferson Parish, Louisiana
Figure 59 Locations of Potentially Impacted Trapping Zones in Jefferson Parish, Louisiana
Figure 60 Locations of Potentially Impacted Fishing Zones in Jefferson Parish, Louisiana
Figure 61 Environmental Management Units in Jefferson Parish, Louisiana
consists of pastureland and, to a lesser extent, tilled fields. The modified wetlands in the southern portion of the management area provide habitat for a variety of aquatic and terrestrial species, which support sporting and trapping activities.

Avondale Oil and Gas Fields, the Waggaman Gas Field, and the West Avondale Oil Field have been in production for many years. According to the Louisiana Department of Natural Resources, since this unit is entirely leveded, the oil and gas activities have not exacerbated any saltwater intrusion or erosion problems in the unit.

5.3.2.2.2 West Bank

Located to the east of the Avondale unit is the West Bank Environmental Management Unit. This unit includes the land between the Westwego corporate limits and the Jefferson-Orleans parish border. It is bounded on the north by the Mississippi River and the south by the Estelle pumping canal and Bayou Segnette. The northern two-thirds of the unit includes two heavily developed, communities of Gretna and Westwego, as well as Marrero, Harvey, and Estelle.

With development, wildlife harvesting has declined in the area. However, in areas around Bayou Fatma, the Estelle pump station, and the V-shaped levee, there are thick stands of naturally occurring vegetation, which supports a large variety of wildlife. A number of gas pipelines traverse the area, which also contains three oil and gas fields: the Crown Point Oil Field, the Marrero Gas Field, and the Walkertown Gas Field.

5.3.2.2.3 Lower West Bank

Further to the south is the Lower West Bank Environmental Management Unit. This area includes the communities of Crown Point, Lafitte, and Barataria. Although oil field development
in this unit is limited to just the Barataria Oil and Gas Filed, there are a number of oil and gas storage facilities, oil well access canals, and pipelines sited throughout the area.

Few animal species are harvested in the Lower West Bank Management Unit itself, which consists of a narrow corridor around the major transportation route. However, the management unit directly to the west, Bayou Segnette, contains natural levee forest as well as forested wetlands and freshwater marsh fund within the Jean Lafitte National Historic Park. This habitat supports a variety of commercially and recreationally harvested aquatic and terrestrial species. A number of crude oil and natural gas pipelines traverse this area, which also contains the Bayou Segnette and Crown Point Oil Fields, as well as the Barataria Salt Dome.

5.3.2.2.4 Analysis of Human-Wildlife Proximity

Odds ratios measured the proportion of minority population in the blocks within a half-mile of potentially impacted wildlife habitat (Table 31). This analysis has revealed that there is an unequal social distribution of potentially impacted wildlife and fishery habitat in Jefferson Parish. As in Lafourche Parish, the most equitable distribution is seen around the potentially impacted freshwater fisheries of the parish. Minority residents are no more likely to live in proximity to potentially impacted fisheries than anywhere else in the parish. This is likely due to the fact that the primary areas of freshwater fish habitat are in the Mississippi River, and much of the shoreline of the river on the west bank of Jefferson parish is commercial and industrial property.

The African American population is more likely to be found living in proximity to both potentially impacted hunting and potentially impacted trapping land. This is largely due to the more dense population clusters found in the more industrialized northern portion of Jefferson Parish’s west bank. These areas include portions of Avondale and Waggaman, which lie along
Table 31 Odds Ratio Values of Potentially Impacted Wildlife Habitat in Jefferson Parish, Louisiana with Census Block Race Variables: White, African American, Native American, Asian, and Hispanic

<table>
<thead>
<tr>
<th>Habitat Type</th>
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<th>Native American</th>
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<tr>
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<td>.000*</td>
<td>.578</td>
<td>.000*</td>
<td>.516</td>
</tr>
</tbody>
</table>

* Statistically significant at 99% confidence level
¹Sample consists all census blocks within 0.5 miles of commonly hunted wildlife habitat potentially impacted by onshore oil-related development (n = 221)
²Sample consists all census blocks within 0.5 miles of commonly trapped mammal habitat potentially impacted by onshore oil-related development (n = 341)
³Sample consists all census blocks within 0.5 miles of freshwater fish habitat potentially impacted by onshore oil-related development (n = 78)
the urban-rural fringe, and have many clusters of high African American census blocks, as well as more densely populated areas along the southern portion of the Harvey canal, toward Estelle. The Native American population is only about 50 percent as likely to reside in proximity to potentially impacted wildlife habitat as anywhere else in Jefferson Parish, while the Asian and Hispanic populations are in many cases less than 10 percent as likely to reside in proximity. These numbers reflect the concentration of the Asian and Hispanic populations within the highly urbanized centers of Jefferson Parish.

5.3.2.3 Saint Bernard Parish

Saint Bernard Parish is entirely within the Louisiana Coastal Zone. It covers approximately 1,327,300 acres, 80 percent of which is water. Of the remainder, 18 percent is wetland and only 2 percent is developed (Wicker et al. 1982). In all, there are 22 management units within Saint Bernard Parish. I have identified four areas within Saint Bernard Parish that contain eight clusters of potentially impacted wildlife habitat. Four of these clusters are potential habitat for commonly hunted fauna and cover approximately 6,410 acres of land (Figure 62). The other four are potential habitat for commonly trapped mammals and cover 6,341 acres (Figure 63). The clusters of commonly hunted and trapped faunal habitat are in four areas, one located entirely on the urbanized levee in Chalmette, one in the Central Wetlands Environmental Management Unit across the Forty Arpent Canal from Chalmette and Meraux, one around Bayou Terre Aux Boeufs in Toca and Kenilworth, which extends beyond the semi-urban management unit into the Central Wetlands, and the final location around the La Loutre Wetlands Environmental Management Unit just below the Mississippi River Gulf Outlet (MRGO) spoil bank near Yscloskey. These same locations, with the exception of the Toca and Kenilworth area, also contain the parish’s most at-risk freshwater fisheries (Figure 64; Figure 65).
Figure 62 Locations of Potentially Impacted Hunting Zones in Saint Bernard Parish, Louisiana
Figure 63 Locations of Potentially Impacted Trapping Zones in Saint Bernard Parish, Louisiana
Figure 64 Locations of Potentially Impacted Fishing Zones in Saint Bernard Parish, Louisiana
Figure 65 Coast 2050 Region 1 and 2 Mapping Unit Boundaries in Saint Bernard Parish, Louisiana
5.3.2.3.1 Chalmette
The potentially impacted wildlife area in Chalmette is located on the Chalmette National Battlefield, part of the Jean Lafitte National Park, located six miles from the city of New Orleans. Although selected wildlife species may inhabit the National Park and potentially use some of the land as a breeding area, this area clearly is not a potential hunting or trapping area.

5.3.2.3.2 Central Wetlands
The Central Wetlands, which extend from the Forty Arpent Canal at the edge of the urban and semi-urban units of Saint Bernard Parish up to the spoil banks of the MRGO, is a vast region of greatly modified marshland. Construction of the MRGO greatly altered the hydrology of the unit in 1963. In addition, the salinity of the marsh has increased dramatically since this time, changing them from fresh to slightly brackish wetlands.

These environmental changes brought about notable decreases in the population of commonly hunted and trapped fauna, as sawgrass marshes and cypress swamps, important for the production of species such as muskrat, mink, raccoon, white-tailed deer, and waterfowl, died (Wicker et al. 1982). Despite the increase in water salinities, a number of waterfowl still winter in this unit. Many of the shallow, brackish ponds found in the Central Wetlands, formed by the breakup of larger wetlands, are important wintering grounds for large numbers of waterfowl species (Wicker et al. 1982).

5.3.2.3.3 La Loutre Wetland
The La Loutre Wetlands encompass the area between the Bayou La Loutre natural levees and the MRGO spoil banks. Since the construction of the MRGO, the area has become increasingly brackish as the channel cut direct water exchange between the wetland area and Lake Borgne, located beyond the MRGO to the east. Despite the deterioration of the unit, the
close proximity of the wetlands to the semi-urbanized levee makes this an important wildlife resource area in Saint Bernard Parish. Nutria, muskrat, and raccoon remain important faunal species in the unit.

**5.3.2.3.4 Analysis of Human-Wildlife Proximity**

The contingency analysis has revealed that the social distribution of potentially impacted wildlife and fishery habitat in Lafourche Parish does not differentially impact minority residents (Table 32). In fact, only the white population in Saint Bernard Parish is statistically more likely to found living in proximity to potentially impacted faunal habitat.

The African American population is the least likely minority group to be found living in proximity to all potentially impacted wildlife habitat. Given the results of the hazards analysis finding that the African American population resides in populated centers away from both the refining districts and the gas processing plants, these results are hardly surprising. Violet, where most of the parish’s African American population resides, is located along the urban levee of the parish, where wildlife habitat diversity is the lowest. Similarly, because most of the refining-related industries in Saint Bernard Parish are concentrated both to the east and west of Violet, the community has far fewer industries and a less significant risk surface. As we found in Jefferson Parish, the Native American population is only about 50 percent as likely to reside in proximity to potentially impacted wildlife habitat, while the Asian and Hispanic populations are again less than 10 percent as likely.

**5.4 Conclusions**

Environmental justice guidelines clearly state that federal agencies must consider the impacts of proposed actions on wildlife and fisheries upon which low-income and minority
Table 32 Odds Ratio Values of Potentially Impacted Wildlife Habitat in Saint Bernard Parish, Louisiana with Census Block Race Variables: White, African American, Native American, Asian, and Hispanic

<table>
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<td>.000*</td>
<td>.097</td>
<td>.000*</td>
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* Statistically significant at 99% confidence level
\(^1\)Sample consists all census blocks within 0.5 miles of commonly hunted wildlife habitat potentially impacted by oil refining-related development (\(n = 239\))
\(^2\)Sample consists all census blocks within 0.5 miles of commonly trapped mammal habitat potentially impacted by oil refining-related development (\(n = 230\))
populations depend. In fact, CEQ takes this mandate one step further, stating that anywhere agency actions may impact wildlife and fisheries, there exists the potential for environmental justice impacts, regardless of actual consumption. This raises several practical issues that are relevant to the wider environmental justice debate.

First, the regulations do not clearly define a methodology for identifying impacted areas. Building on a methodology used in previous research (Hemmerling and Colten 2004), the research develops a model used to identify areas of high wildlife diversity, focusing on those animals commonly fished, hunted, and trapped. When this model is examined in conjunction with a similarly developed industrial hazards model, we are able to identify “hot-spots” where wildlife populations are most at risk from industrial development.

Second, it is implied in the environmental justice guidelines that researchers need to scope any potentially impacted communities. Yet, it is not entirely clear how these communities are to be identified. In most subsistence literature, there is a clear focus on Native Americans and reservation lands. In these cases, the community is defined by the boundaries of the reservation. Yet, many Native Americans do not reside on reservations. Similarly, other racial and ethnic groups do not reside in homogenous communities.

In the case of Lafourche Parish, for example, the Houma Indians are the dominant Native American group. However, the Houma are not federally recognized, nor do they live on a reservation. Instead, the Houma live in small pockets throughout the parish. Similarly, there are clusters of Asians, Hispanics, and African Americans scattered across the parish. With the model developed in this research, I am able to identify those pockets of minority populations that live in close proximity to potentially impacted wildlife and fishery areas. By doing so, the analysis identifies areas with the greatest potential for environmental justice impacts, as defined by CEQ.
It is important to note that minority groups are often disproportionately affected in ways not often acknowledged or even understood. A more inclusive environmental justice agenda needs to acknowledge and protect the health and safety of the ecosystem upon which a wide variety of people depend for subsistence, traditional, cultural, and religious purposes. This research, by identifying critical areas where minority groups may be exposed to multiple risks through consumption of potentially contaminated aquatic and terrestrial wildlife, provides but one example of how environmental justice research is able to move beyond the traditional residential exposure model towards a more place-specific model that includes the social and cultural context.
CHAPTER 6 – PROCESS-BASED ENVIRONMENTAL EQUITY AND THE DEVELOPMENT OF THE OIL INDUSTRY IN SOUTHEAST LOUISIANA

This research has shown that certain socioeconomically disadvantaged groups now face disproportionate risks due to the presence of the oil industry and its associated infrastructure in southeast Louisiana. Outcome-based analysis such as this may result in a determination of environmental inequity but not overt, or even subtle, discrimination. Most analyses are similarly cross-sectional, linking the location of polluting sites to population demographics for one period of time. They are thus outcome-based and can therefore only evaluate environmental equity. In this dissertation, I consider a process-based analysis to be the natural extension of finding inequity in an outcome-based analysis (Talih and Fricker 2002).

In this chapter, I develop a systematic process-based methodology to reveal the formation of environmental inequity. Previous research into the socio-historical foundations of environmental inequity has explored this in a number of ways. The most common method involves analyzing the demographics of the communities at the time in which facilities commenced operation and tracing the socioeconomic shifts that followed (See, for example, Mitchell et al. 1999). This method has been critiqued for being “markedly reductionistic” in that it simplifies the question of causal dynamics to a chicken-or-egg dichotomy (Szasz and Meuser 2000). Like all forms of stratification, environmental inequalities are relationships that are constituted through a process of continuous change that involves negotiation and often conflict among multiple stakeholders (Pellow 2000). A view of environmental inequity formation that fails to take into account the complex interplay of social forces and the dynamics of neighborhood change would provide researchers and analysts with an incomplete understanding of the dynamics and causation of environmental equity.
Just as a finding of present-day environmental inequity does not provide evidence of discrimination, an historical lack of association between minority population and facility siting does not demonstrate a lack of discrimination (Talih and Fricker 2002). To begin to understand the causative factors of environmental inequity, it is necessary to move beyond process-based analyses that focus purely on the socioeconomic characteristics of potentially impacted populations and toward a more dynamic model that relies on various causal factors and mechanisms that may have contributed to the present-day landscapes of inequality. This includes processes such as industrialization, urbanization, migration, demographic shifts, and housing developments, as well as institutional forces (Frazier et al. 2003). In doing so, I do not intend to underemphasize the role that race and class play in the siting process. In fact, to the contrary, race and class, are vital components of neighborhood dynamics.

The first half of the chapter will examine the historical and geographical evolution of the oil industry in southeast Louisiana. I identify locations of significant oil-related developments and determine the proximity of minority populations to these developments. In the second half of the chapter, I use spatial analytical tools to examine the forces shaping residential patterns and industrial location in southeast Louisiana. Finally, the chapter concludes with a discussion of several theories of environmental inequity formation and analyzes each of the three case study parishes in terms of these theories.

6.1 Historical and Spatial Evolution of the Oil Industry in Southeast Louisiana

The 1935 discovery of oil at the Lafitte Field in southern Jefferson Parish marked one of the earliest significant discoveries in southeast Louisiana. The groundwork for this discovery was laid in the early decades of the twentieth century by a series of innovations and discoveries that allowed drillers to move into the marshlands of Louisiana’s coastal zone. Although the first
major discovery of oil in Louisiana was the Jennings Field in southwest Louisiana, struck in 1901, the majority of early developments were in north Louisiana, where the fields were easily accessible (Lindstedt et al. 1991). Development in one of these fields, Caddo Lake, would mark the first successful technological adaptation to the aquatic environment in Louisiana, when overwater drilling occurred in 1910. In order to drill and produce without direct connection to the land, oil companies constructed platforms on pilings driven into the lake bottom and barged drilling equipment to the site (Gramling 1996). Adaptations of this technology would prove vital when oil and gas exploration and drilling moved into the coastal fringe of Louisiana.

6.1.1 Early Developments in Southeast Louisiana, Pre-1930

The early years of the twentieth century saw a number of advancements that helped develop southeast Louisiana into a prime oil-producing region, decades before oil companies discovered the first productive onshore wells in the region. Saint Bernard Parish, for example, had refineries operating within its borders prior to the onshore oil boom that would begin in the 1930s. The Sinclair Refining Company had an early refinery in Meraux (then known as Merauxville) that would refine crude oil shipped via tanker from Venezuela. Meraux at the time was largely woods and prairies, though populated enough that residents could petition the local police jury in Chalmette to declare the refinery a public nuisance in 1925, due to the release of “nauseous gasses and fumes…which are unhealthful and make living conditions very uncomfortable and unbearable” (Louisiana Historical Records Survey 1941). Local residents also claimed that these fumes and gasses “scorch and burn all vegetation” making their crops unfit for market. Furthermore, residents claimed that the refinery had released waste oil and asphalt into neighboring ditches, which in addition to presenting a tremendous fire hazard, would
ultimately make the adjacent woodlands and prairies unfit for future land reclamation (Louisiana Historical Records Survey 1941).

The Chalmette oil refinery also came on line in the 1920s (Figure 66). The property was first leased on January 1, 1920 to the Pelican Oil Refining Company for a period of ten years. Before Pelican developed the land, they transferred the lease to the Chalmette Oil and Refining Company. By the end of the 1920s, both refineries were in operation in Saint Bernard Parish, with the refined oil and gasoline from Sinclair transported via pipeline to the Chalmette refinery where the Southern Railway had a terminal (Louisiana Historical Records Survey 1941). Although the Sinclair Refinery would ultimately shut down, the Chalmette refinery would continue, though various ownership changes continue to operate until the present day.

Although no census data is available for census subdivisions in 1920, overall, there is a decline in the African American population for Saint Bernard Parish between 1920 and 1930 from 32.1 percent to 20.5 percent. Though many of the jury wards in the parish had slightly above averages of African Americans, only the more rural Sixth Ward, containing the communities of Saint Bernard, Toca, and Kenilworth, had significantly higher numbers (Figure 67). The white population, on the other hand was significantly more likely to reside in the Arabi and the First Ward, which bordered the Ninth Ward of New Orleans, at that time an ethnically diverse working-class neighborhood (Wells 2004). In addition, there were slightly greater proportions of whites in Chalmette and the Third Ward by 1930, while in Meraux and the Fourth Ward, there was a slightly higher African American population, a pattern that would persist throughout the century, although later more refined census procedures would reveal that the Fourth Ward communities of Meraux tends to be largely white, while the downriver areas of the Fourth Ward, such as Myrtle Grove, tend to be largely African American.
Figure 66 Areas of Historical Refinery Development in Saint Bernard Parish, Louisiana, 1937
Figure 67 Wards with Significant African American Population, 1930, St Bernard Parish, Louisiana
Jefferson Parish was also experiencing some initial oil-related growth prior to the discovery of the large oil fields during the 1930s. During the 1920s, the Jefferson Parish Oil Commission granted a number of permits and petitions to construct petroleum bulk storage tanks and facilities. Oil companies constructed these facilities along both banks of the Mississippi River and used them to store product before they barged or shipped it to the terminals. In 1925, for example both the Gulf Refining Company and Mexican Petroleum Oil Company requested permits to erect oil storage tanks in Jefferson Parish. The Gulf Refining Company had an existing property in Gretna, on the west bank, and was granted permission to erect and operate a bulk distributing oil station and gasoline storage tanks on their property in the Seventh Ward. In 1928, the Gulf Refining Company requested an additional permit to erect an additional 80,000-barrel oil tank between Ninth and Tenth Streets in Gretna. This same year, the Oil Commission granted an application for the construction of a small oil refinery and crude oil storage depot, again in the Seventh Ward, “provided that it did not increase the insurance rates on the property in the vicinity, and that the owner of the refinery would use the most modern methods and machinery made, to eliminate as much as possible the odor that emanates from said plant” (Louisiana Historical Records Survey 1939). As the decade closed, other companies applied for additional permits. In 1929, for example, the International Lubricant Corporation applied for a permit to erect an oil storage tank on the east bank of Jefferson Parish.

The changes of the industrial landscape throughout the 1920s coincided with a number of demographic shifts in Jefferson Parish. As we saw in Saint Bernard Parish, the proportion of African American residents actually sharply declined in the period between 1920 and 1930, from 5.9 percent to 3.3 percent. By the time of the 1930 census, when the U.S. Census Bureau broke the population down by parish subdivisions, we find that the African American population is
slightly more likely to be found residing in the wards along the Mississippi River where the Oil
Commission had approved construction of several petroleum bulk storage facilities (Figure 68).
Note, however, that the Fifth Ward, with the highest concentrations of African Americans in
Jefferson Parish, was not developed in this early stage of storage facility construction.

With the initial development of the offshore industry more than a decade away,
Lafourche Parish, in the years leading up to the discovery of large oil fields in southeast
Louisiana, relied principally on the processing of food and food products, particularly sugar,
molasses, and seafood (Louisiana State University 1949b). Despite the presence of a large
fishing fleet, the shipbuilding industry, which would come to play an important part in the
economy of Lafourche Parish, did not exist in the early years of the oil industry in Louisiana.
Communities such as Larose, which would come to dominate the shipbuilding industry in
Lafourche Parish, were not even in existence at this time. As of 1926 only a handful of home
dotted the banks of Bayou Lafourche at the juncture of the Harang Canal, the site of present-day
Larose (Figure 69). However, just a couple of years later, following the construction of the
Intracoastal Waterway through the channel of the Harang Canal, the town of Larose began to
develop, spreading along Bayou Lafourche and the Waterway, setting the stage for the
development of the shipping industry in the decades to come (Figure 70).

6.1.2 Discovery of Oil in Southeast Louisiana, 1930-1940

Although technological innovation made oil field development in the marshes of south
Louisiana possible, it took government intervention to make it economical. In 1933, the United
States government began the prorationing program. The idea behind prorationing was that all
producers would cut their production and ration out their output, with each producer maintaining
their proportion of the total output (Gramling 1996). When U.S. Secretary of the Interior Harold
Figure 68 Wards with Significant African American Population, 1930, Jefferson Parish, Louisiana
Figure 69 Areas of Historical Shipping Development in Larose, Lafourche Parish, Louisiana, 1926
Figure 70 Areas of Historical Shipping Development in Larose, Lafourche Parish, Louisiana, 1932
Ickes set southern Louisiana’s proration allotment at 44,528 barrels daily, nearly double that of northern Louisiana, thousands of oil field workers poured into the region, setting off an oil boom that would continue for decades to come (Franks and Lambert 1982).

This same year, the Texas Company, using geophysical instruments developed during World War I to detect the presence of hostile vessels, determined that land it held approximately 20 miles south of Gretna in the marshy Barataria region of Jefferson Parish contained a large salt dome, which likely served as a trap for large quantities of oil (Dabney 1940). The company brought a submersible drilling barge through newly dug canals and began to develop the site that would ultimately become the Lafitte field. In 1935, the company struck oil as well as large quantities of natural gas. In order to process the natural gas, it constructed a 15,000-gallon natural gas absorption plant in the Lafitte Field, the first such plant in southeast Louisiana. A 10-inch gas pipeline moved the processed gas from the plant to the Freeport Sulphur Company in Plaquemines Parish. At the time, this was the only commercial use of natural gas from a southeast Louisiana field (Baton Rouge Oil Scouts Association; BROSA 1938).

The Lafitte oil and gas field, as well as the natural gas processing plant, were near a fishing village of the same name, in the largely rural Sixth Ward of Jefferson Parish. Over 60 percent of the non-African American minority residents in Jefferson Parish resided in this ward (Figure 71). According to the 1930 census, the majority of the non-African American minority population in Jefferson Parish was Native American. In fact, Jefferson Parish was second only to Terrebonne Parish in the number of Native Americans residents. The Barataria region of central Jefferson Parish was traditionally home to large Houma and Chitimacha Indian populations, many of whom still resided in the area. The number of Native Americans found in Jefferson Parish would drop dramatically between 1930 and 1940. It is difficult to ascertain
Figure 71 Wards with Significant Non-African American Population, 1940, Jefferson Parish, Louisiana
whether this drop was due to changes in the enumeration methods used by the U.S. Census Bureau or whether there was a significant outmigration by Houma residents. The latter is suggested by a concurrent drastic rise in Native American population in neighboring Lafourche Parish.

This region also contained a number of small fishing and shrimping villages settled by Asian immigrants. Two such shrimping communities include Manila Village settled by the Philippine and Bassa Bassa settled by the Chinese (Louisiana State University 1949a). During the late 1930s, a number of conflicts would develop between residents of the Sixth Ward and the oil companies. First, local fishermen charged the oil companies with killing off fish and oysters with the dynamite they used in seismographic work (Conner 1977). The Louisiana Department of Conservation, created in 1916, was the agency charged with enforcing all statewide laws involving natural resource use and development on land and water. After researching the issue, the agency formulated a set of rules and regulations that recommended the use of floating charges. Shrimpers later challenged this process on the grounds that the resultant spoil banks and trenches on the water bottoms were damaging their shrimp trawls. The guidelines were then changed, requiring oil companies to explode dynamite in holes drilled to depths of 100 to 200 feet (Conner 1977). This represented the first instance of state governmental regulation in the Louisiana coastal zone.

Residents of the parish also charged that the oil companies did not use local labor or businesses in the oil fields. In 1936, residents of Jefferson Parish filed a complaint with the Jefferson Parish Police Jury stating that the Texas Oil Company employed a negligible number of local residents compared to the number of people in that area who were unemployed. The Police Jury also noted that all machine and boiler work associated with operations in the Lafitte
Field “have been given to firms and individuals who are non-residents of the Parish of Jefferson, whilst citizens of this Parish, who have shops fully equipped and able to perform any kind of boiler or machine work, are not given any consideration whatsoever” (Louisiana Historical Records Survey 1939). The Police Jury, in response, made a resolution requesting that the Texas Oil Company show some cooperation and consideration for these issues, just as the Police Jury “has not hesitated in the past, in granting the Texas Oil Company rights and privileges to facilitate their operations.” Ultimately, the oil companies did begin to use many of the local machine shops, resulting in increased industrialization in many of the communities on the northern portion of the Parish’s west bank.

The developments at Lafitte Field, as well as the Barataria and Crown Point fields in the late 1930s, would significantly alter the industrial landscape of Jefferson Parish, not only in the Sixth Ward where the fields were located, but all across the parish (Figure 72). In particular, the industrial areas along the Mississippi River greatly expanded following the discovery of oil in the region. From Gretna to Avondale, through the towns of Harvey, Marrero, and Westwego, the west bank of the Mississippi River, then as today, was an “uninterrupted line of warehouses, manufacturing plants, packing houses, and distilleries” (Louisiana State University 1949a). The addition of a number of smaller oil-related businesses dealing in products such as drilling muds and oil field machinery sprang up in the area, especially along the Harvey Canal.

The Harvey Canal, perhaps more than any other landscape feature, served as a focal point for Jefferson Parish’s industrial development. Fishermen and hunters had long used the canal to drive their boats to the New Orleans riverfront. In 1907, the Army Corps of Engineers constructed a brick and wood lock which connected the canal to the Mississippi River (Dabney 1960). In 1933, the Corps replaced this lock with a larger steel and concrete lock, using the
Figure 72 Historical Development of Onshore Oil Fields, Jefferson Parish, Louisiana
Harvey Canal to connect the Mississippi River with the Gulf Intracoastal Waterway. Prior to the discovery of oil in Jefferson Parish, three businesses had operations on the canal, employing 50 people. By 1940, twenty businesses were active on the canal, employing some 600 people (Dabney 1940).

These oil field supply industries represent the upstream portion of the oil industry. The downstream segment primarily involve the transportation of the product from the oil field to the production outlets. Shortly after the discovery of oil and gas at Lafitte Field, the Texas Company constructed two pipelines in Jefferson Parish, each approximately 25 miles in length. The first, a 6-inch line constructed in 1935, moved crude oil from the field to the company’s Amesville Terminal on the Mississippi River in Marrero (Figure 73) (BROSA 1936). By 1937, increased production forced the company to add an additional 8-inch line. The Amesville terminal also received product from other oil fields in the region, such as the Paradis Field in nearby Saint Charles Parish. From Amesville, refiners or brokers purchased the crude oil and shipped it via tanker to various ports in the region.

While some oil companies proposed large pipeline projects during the early years of the oil industry in southeast Louisiana, the fact was that the handling and shipping of oil by barges and tankers proved too cheap and convenient to warrant the costs at the time. Most producing fields in southeast Louisiana are in close proximity to a veritable maze of navigable interconnecting waterways which afford an easy inexpensive method of transporting crude from producing areas to storage, refineries, tanker terminals and loading racks. Most of the pipeline laid in the early years of the oil industry moved oil from the wells to loading docks in the immediate vicinity of the fields, where it could be transported by barge. Thus, when the California Company discovered the Barataria Field in 1939, it barged product to Westwego, for storage in Sun Oil Company tanks (Figure 74) (BROSA 1940).
Figure 73 Areas of Historical Petroleum Storage Development in Marrero, Jefferson Parish, Louisiana, 1935
Figure 74 Areas of Historical Petroleum Storage Development in Westwego, Jefferson Parish, Louisiana, 1939
While the majority of the extraction activities took place in the sparsely populated wetlands, most of the storage and transportation activities centered in the more populated northern portion of the west bank. Jefferson Parish’s Fourth Ward, an area that includes Westwego and Marrero, contained a large number of the early terminals for the Lafitte and Barataria fields, for example. By 1940, Jefferson Parish’s west bank had some 49 petroleum bulk storage tanks with a capacity of approximately 2,367,000 barrels. Although most of these storage tank facilities sited in the Fourth Ward, Standard Oil Company’s facility at the Avondale Terminal, located in the Fifth Ward, contained the majority, by volume, of this storage capacity (Figure 75).

Prior to the discovery of oil at Lafitte field, one half of the six wards on Jefferson Parish’s west bank had African American population concentrations above the parish averages. The most significant concentration of African Americans resided in the Fifth Ward, which contained the communities of Waggaman and Avondale. The First and Second Wards, which included the community of Gretna, contained smaller African American population concentrations. Interestingly, the Third and Fourth Wards, the locations of the Harvey Canal and the tanker terminals in Marrero and Westwego, had significantly lower concentrations of African American population. By the time of the 1940 census, very little had changed in terms of minority population concentrations, although the Third Ward, including the area around the Harvey Canal, was slightly above the parish average in terms of African American population.

6.1.3 World War II and the Growth of the Southeast Louisiana’s Oil Industry, 1940-1960

A number of external factors changed the complexion of the oil industry in Louisiana during the 1940s. Chief among these was the United States’ entry into World War II. Prior to the war, barging proved to be the most inexpensive and efficient means of oil
Figure 75 Areas of Historical Petroleum Storage Development in Avondale, Jefferson Parish, Louisiana, 1940
transportation, since most of the producing fields in South Louisiana were in close proximity to a navigable canal or waterway. Oil to be sold to eastern and northern markets could be barged from producing fields to tanker terminals along the Mississippi River. It had been common practice during the early years of the oil industry to transport oil produced in South Louisiana by tanker to the Port Arthur and Houston areas for refining and then transported back to the New Orleans area for shipment to eastern and northern markets (BROSA 1943).

The heavy demand upon barging and vessel facilities, together with outside submarine menace in the Gulf of Mexico, forced the government to step in and regulate barge transportation. By June 1942 the barging facility situation in South Louisiana had become so acute that a government subcommittee on barge movements recommended that all westerly movements be discontinued. The committee proceeded to mark off mile posts of 100 miles along the Gulf Intracoastal Waterway, beginning at New Orleans, Mile Post 100 being at Morgan City, Mile Post 200 on the Vermillion and Cameron Parish line, and Mile Post 300 at Port Arthur, Texas. The committee ruled that oil produced east of Mile Post 200 could not be barged west of that mile post and that oil produced between Mile Post 200 and Mile Post 300 could not be moved west of Mile Post 300 (BROSA 1943).

This ruling had several important impacts on Louisiana’s oil industry. First, it forced many refinery operators to open new crude sources close to their plants. Two additional refineries would come online in the study area during the 1940s. The first was located in Saint Bernard Parish, in Meraux, the site of the Sinclair Refinery in the 1920s (Figure 76). Throughout the 1940s, numerous attempts were made to operate a refinery in Meraux. In 1940, General Oil would run the refinery, though it would cease production in September of 1941. It sold the property to the Farm Bureau Co-Op Association in 1943, which would operate the refinery until 1945, when production would again be shut down. Beginning in September 1948,
Gilcrease Oil took over the refinery, which would again cease operation in March 1949. Finally, in 1953, Ingram Products took over operations of the refinery, which went online in March of 1954. From this point forward, the refinery continuously operation in Meraux, though the Murphy Oil Company would later acquire Ingram Oil and the Meraux refinery in 1963. As the USGS quadrangle shows, this site where the Murphy refinery and its predecessors was still largely rural, much as it was in the 1930s (Figure 76). The neighborhood bordering the Chalmette Refinery to the north has begun expanding at this time, with a number of neighborhoods developing off of the main arterials crossing the area.

The second southeast Louisiana refinery to come online was in Marrero, on Jefferson Parish’s west bank. The Orleans Refinery, later named Clarks Super Gas, Clarks Oil and Refining, and Petco, began operation in 1941 and ran continuously until 1958. The refinery permanently shut down in 1963.

In addition to stimulating the development of new crude sources and refinery growth, the ban on east-west barge trafficking also triggered pipeline construction, as oil companies sought ways to continue to use their own refineries to process petroleum extracted in South Louisiana. Throughout the 1940s, oil production in the inland and coastal zones of Louisiana increased rapidly, doubling with each succeeding decade until the end of the 1960s (See Figure 72) (Lindstedt et al. 1991). During this time, Westwego, Marrero, and Avondale in Jefferson Parish served as primary production outlets for many of the oil fields of southeast Louisiana. In between and around the tank farms and storage facilities that dotted the landscape along the Mississippi River, residential development began to occur at ever increasing rates. In some cases, the residential communities directly abutted the petroleum storage sites (Figure 77 and Figure 78). Other communities along the Mississippi River still managed to retain some buffer
Figure 76 Areas of Historical Refinery Development in Saint Bernard Parish, Louisiana, 1951
Figure 77 Areas of Historical Petroleum Storage Development in Marrero, Jefferson Parish, Louisiana, 1951
Figure 78 Areas of Historical Petroleum Storage Development in Westwego, Jefferson Parish, Louisiana, 1951
between development and the tank farms, as in Waggaman and Avondale, where the African American population tended to cluster (Figure 79 and Figure 80). Despite these increases in oil production, the Baton Rouge Oil Scouts Association reported that the levels of both exploration and discovery fell markedly during this period (BROSA 1941). By 1945, perhaps in response to the decline in new discoveries, geophysical prospecting began expanding steadily outward into the Gulf of Mexico. In May of 1946, the Magnolia Petroleum Company began work on a platform in the Gulf of Mexico approximately ten miles southeast of Terrebonne Parish (BROSA 1946). This earliest attempt, on what are now federal waters, used local expertise and vessels (primarily shrimp boats) for transportation of personnel and supplies to the drill site (Gramling 1996). Though the Magnolia well turned out to be dry, Kerr-McGee utilized the same drilling technology to prospect in two leases located in the Ship Shoal area, located fifty-four miles off the coast of Terrebonne Parish, well out of sight of land (Franks and Lambert 1982). The discovery of oil on Ship Shoal block 32 in November of 1947 would dramatically alter the face of the Louisiana oil industry.

The offshore oil industry needed a network of onshore support facilities to be able to operate in the Gulf of Mexico. At the time it was impractical to build production platforms in place in the Gulf and consequently companies had to fabricate entire production platforms on land and set them in place offshore (Gramling 1996). In the years following the discovery of offshore oil, a number of fabrication yards dedicated to the construction of offshore oil platforms opened in Louisiana. In addition, the Ship Shoal discovery set off a boom for Louisiana shipyards. In the late nineteenth century and through the first four decades of the twentieth, Louisiana shipbuilders relied primarily on the seafood industry. Shrimpboat construction was often a backyard industry, with vessels frequently built following designs passed down from one
Figure 79 Wards with Significant African American Population, 1960, Jefferson Parish, Louisiana
Figure 80 Areas of Historical Petroleum Storage Development in Avondale, Jefferson Parish, Louisiana, 1951
generation to the next. The offshore oil industry would require much larger vehicles to transport crews and supplies to the drilling platforms and to withstand the waves in the Gulf of Mexico. Consequently, large shipyards rather than backyard operations supplied vessels for the offshore industry.

Because of its proximity to the offshore oil fields, Lafourche Parish would quickly become an important site for onshore support infrastructure, particularly boat and ship building and repairing. During the 1940s and 1950s, five shipyards began operation in a number of sites along Bayou Lafourche and the Intracoastal Waterway in the southern portion of Lafourche Parish. During this time period, south Louisiana’s population grew steadily and shifted from remote rural areas in the marshes to more densely settled communities where employment with the petroleum-related industries has been available (Davis and Place 1983). Land for residential, commercial, and community use was at a premium in the coastal zone, where dry land suitable for construction is limited. Petroleum related industries, such as supply bases, shipyards, ports, platform fabrication yards, gas processing plants, and refineries generally require from one to over 1,000 acres of land for construction and operation (Lindstedt et al. 1991). Thus, when it came time for facilities to site in the coastal zone, they often selected small communities such as Golden Meadow, Toca, and Yscloskey (Figure 81; Figure 82; Figure 83).

Prior to the beginning of offshore oil development, the seafood industry drove Lafourche Parish’s economy, although a number of oil fields were discovered there in the 1930s. The 1940 census established the residential minority pattern that we see in Lafourche Parish today. The African American population resides in the jury wards north of the Intracoastal Waterway, with especially high concentrations around Thibodaux and Raceland (Figure 84), while the Native American population is highly concentrated in tenth ward, the southernmost jury ward in the
Figure 81 Areas of Historical Shipyard Development in Golden Meadow, Lafourche Parish, Louisiana, 1944
Figure 82 Areas of Historical Gas Processing in Toca, Saint Bernard Parish, Louisiana, 1951
Figure 83 Areas of Historical Gas Processing in Yscloskey, Saint Bernard Parish, Louisiana, 1957
Figure 84 Wards with Significant African American Population, 1940, Lafourche Parish, Louisiana
parish (Figure 85). By 1960, we see that the Native American population has migrated northward, settling in greater numbers in the wetland to the west of Bayou Lafourche, in the vicinity of Grandbois (Figure 86).

6.1.4 The Development of the Offshore Oil Industry, 1960-1990

The offshore oil industry rapidly expanded during the 1960s and early 1970s, resulting in high levels of immigration and population growth in traditional settlements that had become staging areas for offshore activities, such as Larose and Golden Meadow in Lafourche Parish (Figure 87; Figure 88). The population growth in these communities placed strains on existing transportation networks, community infrastructures, and the delivery of social services (Gramling 1996). By the mid-1970s portions of coastal Louisiana exhibited many of the characteristic stresses and strains associated with the classic boom town (Gramling 1996).

After several decades of growth, however, oil production in coastal Louisiana began to peak in 1968, when more than one billion barrels were produced in the inland, coastal, and OCS regions combined. Production continued at levels above one billion barrels for four more years, peaking in 1971 at 1.2 billion barrels (Lindstedt et al. 1991). Likewise, the production of natural gas peaked in 1970, with all three regions combined producing ten trillion cubic feet of gas. By 1973, the OCS surpassed the Louisiana coastal zone as the dominant oil-producing region in the state. Likewise, natural gas production reached its peak in the inland and coastal zones in 1970 while production in the OCS continued to rise until peak natural gas production was reached in 1980 (Lindstedt et al. 1991). A dramatic rise in worldwide oil prices during the 1970s had two predictable results. First, oil producers sought to take advantage of the higher prices by increasing production. Second, there was a drop in consumption as consumers sought ways to conserve gas. U.S. demand for petroleum products began to fall in the late 1970s, resulting in a
Figure 85 Wards with Significant Non-African American Minority Population, 1940, Lafourche Parish, Louisiana
Figure 86 Wards with Significant Non-African American Minority Population, 1960, Lafourche Parish, Louisiana
Figure 87 Areas of Historical Shipping Development in Larose, Lafourche Parish, Louisiana, 1963
Figure 88 Areas of Historical Shipping Development in Golden Meadow, Lafourche Parish, Louisiana, 1964
crash in oil prices in the mid-1980s (Gramling 1996). As a result of this bust, unemployment rates in coastal Louisiana skyrocketed, and many residents left the area to seek out new employment. This marked a period of time in which much of the onshore support network began to be disassembled.

6.1.5 Deepwater Oil Production in the Gulf of Mexico, 1990-Present

The last decade of the twentieth century and the first years of the twenty-first was a period of recovery for the Louisiana oil and gas industries, following the dramatic bust of the 1980s. The increasing production since 1990 is primarily the result of expanding activities in the deepwater Gulf of Mexico, defined here as production in more than 1,000 feet of water (Hughes et al. 2001). Development of new platform technology made the move into the deepwater Gulf possible. By 2002, there were approximately 7,400 active leases in the Gulf of Mexico, 54 percent of which are in deepwater (Baud et al. 2002).

Deepwater production began in 1979 with Shell Oil Company’s Cognac Field. Despite the success of the Cognac Field, it would be another five years before the next deepwater field went online. Nearly a decade later, in 1992, only five deepwater fields were in production. Since that time, however, deepwater production has continued to grow at an ever-increasing rate so that, by the end of 2001, there were fifty-one fields in production in the deepwater Gulf. Over the ten-year period from 1992 to 2001, deepwater oil production rose over 800 percent, while deepwater gas production increased nearly 1,500 percent (Baud et al. 2002).

A number of factors have contributed to this rejuvenation of oil and gas activities in the Gulf of Mexico. First, new exploration technologies have increased discoveries on the deepwater shelf of the Gulf of Mexico in recent years. Second, new and improved technologies have been developed in recent years that have allowed for the extension of conventional oil
fields into deepwater (Hughes et al. 2001). Finally, the passage of the OCS Deep Water Royalty Relief Act (DWRRA) in 1995 has had a significant impact on deepwater Gulf of Mexico activities. This legislation provides a number of economic incentives for operators to develop fields in water depths greater than 656 feet, including the automatic suspension of federal royalty payments for the initial volumes of oil or gas produced. This initial volume is graded, with deeper oil fields receiving higher royalty relief volumes (Baud et al. 2002). The DWRRA encouraged extensive leasing in the deepwater Gulf of Mexico and allowed oil companies to spend more money on exploration and discovery in the deepwater Gulf. In 1999, deepwater oil production surpassed shallow-water production and now approaches the high shallow-water mark established in 1971.

As deepwater production continues to expand, the onshore support infrastructure will continue to see increased activity as well. Some 600 offshore oil platforms are within a forty-mile radius of Port Fourchon, a land based support terminal for the offshore oil and gas industry in the Central Gulf of Mexico. Further development of OCS activity and Port Fourchon will markedly affect Lafourche Parish. Rapid increases in parish employment, which began in 1995, have been concentrated in water transportation and shipbuilding (Hughes et al. 2001). The final large infrastructure facility was completed in 1998, when the Larose Gas Processing plant went online.

6.1.6 Summary of Residential and Industrial Development

By 1990, industry had already constructed most of the petroleum-related infrastructure in place today. We have seen that, in some cases, this infrastructure developed in existing communities. This was the case, for example in Larose and Golden Meadow, in Lafourche Parish. As the previous section has shown, both of these communities were in existence well
before the shipyards were constructed. In the case of Golden Meadow, the impacts of the oil industry are extremely evident, from the extensive channelization of the wetlands to the west to the development of the shipyards along Bayou Lafourche to the east (Figure 89). The census data shows that, in the case of Larose, the minority populations moved in after the shipyards were built, while in Golden Meadow, the Native American population was present before the shipyards. Similarly, we saw that large gas processing plants were built in Toca and Yscloskey, communities that likely had large Isleño populations at the time of construction. Today, these small communities still live in close proximity to the plants (Figure 90; Figure 91).

In many cases, especially in the larger, more urban areas, we see that the population has tended to develop and grow around the industry. This is definitely the case in Chalmette and Meraux, communities that have expanded their limits right up to the boundary of the local refineries (Figure 92). At the same time, the refineries have continued to expand as well. In both cases additional tank storage was added on and, in the case of the Chalmette Refinery, operators constructed a gas processing plant on-site.

Finally, in much the same way that the population began to develop around the refineries in Saint Bernard Parish, so too did the populations grow up around the oil and gas storage facilities on the west bank of Jefferson Parish. The communities of Harvey, Marrero, and Westwego have long been home to numerous tank farms and petroleum storage depots. Even today, these facilities continue to operate in the midst of the heavy urbanization that sprang up around them (Figure 93). Even one of the final communities to develop, Avondale, has built up around the industry. Interestingly, one of the largest tank farms operating in the early years of the oil industry in Jefferson Parish, shut down and is now the site of the residential community of Avondale (Figure 94).
Figure 89 Areas of Historical Shipping Development in Golden Meadow, Lafourche Parish, Louisiana, 1990
Figure 90 Areas of Historical Gas Processing in Toca, Saint Bernard Parish, Louisiana, 1989
Figure 91 Areas of Historical Gas Processing in Yscloskey, Saint Bernard Parish, Louisiana, 1989
Figure 92 Areas of Historical Refinery Development in Saint Bernard Parish, Louisiana, 1989
Figure 93 Areas of Historical Petroleum Storage Development in Jefferson Parish, Louisiana, 1990
Figure 94 Areas of Historical Petroleum Storage Development in Avondale, Jefferson Parish, Louisiana, 1990
All of this raises the question of how and why environmental inequities may form. Clearly, from a historical perspective, there is no one simple answer. In some cases industry does in fact site where minority or low-income persons are residing. In other cases we see that people are moving closer to industry. The next section will explore the question of how environmental inequities may form.

6.2 Theories of Environmental Inequity Formation

This portion of the research takes a historical perspective on environmental equity. Much current research into environmental justice focuses on present-day instances of environmental equity without focusing on the historical processes that created the inequities in the first place. Even when researchers have examined environmental justice historically, they have tended to focus on establishing a baseline situation and determining whether the facility or the minority community was sited first. While valuable in its own right, this type of approach does not get to the root of environmental inequity formation. Laura Pulido has described how a strict focus on facility siting provides an inadequate understanding by separating larger sociospatial processes from explanations of environmental inequity formation. It is important that any process-based analysis of environmental equity include “careful consideration of residential patterns, land use, and industrial development” (Pulido 2000). A number of useful theories can be incorporated into environmental equity analyses. This can be divided into two broad categories, economic and sociospatial.

6.2.1 Economic Theories of Environmental Inequity

There are many inherent difficulties in proving that environmental inequities are the result of direct intentional discrimination. Most facility owners would readily argue that
economics drive siting decisions. The Louisiana Chemical Association, for example, in a report to the Louisiana Advisory Committee of the United States Commission on Civil Rights, made clear that its members base their siting decisions on a number of factors, among them abundant land to site large-capacity operations, the proximity to deep water ports and rail transportation, access to natural resources and gas pipelines, and the presence of a neighboring plant to supply chemical feedstocks (Louisiana Chemical Association 1992). It clearly states that companies have in no case targeted minority communities for facility siting and that this concern “does not square with the economic and logistic realities that must be faced in the site selection process” (Louisiana Chemical Association 1992). Yet, by ignoring the socioeconomic status of the host neighborhood, industry may have, in fact, intensified existing disparities in the distribution of polluting industries through indirect processes associated with racism and classism.

To test these arguments, we first must explore the economics of environmental inequity formation. The most controversial claim made by some environmental justice advocates is that industry specifically targeted minority and low-income communities because of their socioeconomic status. Economic theory offers three distinct explanations for the genesis of such environmental racism (Hamilton 1995). The first explanation is that some form of pure discrimination has occurred, whereby facility owners trade off profits for prejudice. While few advocates believe such overt racial hostility is the cause of existing environmental inequities, many believe that industry has targeted minority and low-income communities because they lack the political power and technical knowledge to resist the siting of facilities in their neighborhood (Daniels and Friedman 1999).

Another explanation is that a facility will locate where it does the least amount of damage because this is where the potential compensation would be least. The siting industry would take
into account factors such as the number of people potentially impacted by the industry, their incomes, and the property values of the surrounding neighborhood when determining the costs of it externalities. According to this theory, industry operates under the assumption that low incomes and education are related to low willingness to pay for the environment and low expected damages in liability cases. When these variables are in turn associated with race, polluting industries may choose to locate in minority areas because compensation demands and expected liabilities from operation are lower there (Hamilton 1995).

Finally, the theory of collective action states that communities with high political participation are more likely to mount collective action efforts to either stop the siting of certain facilities or to force the industry to internalize its externalities. Such efforts require a mobilized population with a vested interest in the community. Previous research has shown that political mobilization is closely associated with home ownership. The higher the value of owner-occupied housing, the greater the stake in the community, and the more likely a high level of mobilization will occur (Lester et al. 2001). Therefore, in theory, if minority and low-income communities were segregated in run-down neighborhoods with rental properties, they would be less likely to mount collective action efforts. Industry may choose to locate in these neighborhoods because that is where the expressed opposition is the least (Hamilton 1995).

6.2.2 Theories of Neighborhood Change and Environmental Justice

Clearly, there is a spatial dimension to all forms of neighborhood change. Spatial processes have been one of the major driving forces shaping the demographic, social, and economic landscape (Liu 1997). Contemporary patterns of residential segregation, for example, developed from neighborhood patterns evolved during earlier growth phases (Knox 1994). The presence or absence of potentially hazardous facilities influences some residential segregation
models, while having no impact on others. Both the classical invasion-succession and neighborhood life-cycle models, for example, are not directly impacted by the presence of potentially hazardous facilities, whereas the push-pull model and the institutional theory of neighborhood change rely intrinsically on the siting of potentially hazardous facilities.

The notion that the proportion of minority residents in a predominantly white neighborhood would gradually increase until a “tipping point” is reached characterizes the classical invasion-succession model, perhaps best characterized by the process of white flight. Beyond the tipping point, the non-minority residents of the neighborhood begin to move out, presumably in response to the influx of minority residents. This model implies that minority residents could move into areas with or without potentially hazardous sites and suggests that the postsiting decline in neighborhoods hosting potentially hazardous facilities might be the result of minority expansion, which had started before siting (Liu 1997).

The neighborhood life cycle model suggests that communities go through natural cycles of development, transition, aging, decay, and renewal (Talih and Fricker 2002). Through this life cycle, we would expect the housing characteristics to decline and socioeconomic status becomes successively lower. This model suggests that population density and the age of the housing stock are the two most important community characteristics that determine neighborhood change. Again, as in the invasion-succession model, the presence or absence of potentially hazardous facilities is not a necessary condition for this decline process, although it has been suggested that the presence of such facilities may accelerate the decline process (Liu 1997).

Unlike the previous two models of neighborhood change, the push-pull model assumes that some externality such as the siting of potentially hazardous facilities pushes out more affluent residents and draws in less-affluent residents. While many other factors play into
mobility decisions, the increased concern with environmental risks may be influential in shaping internal migration patterns. Population would be expected to flow away from areas that pose high levels of environmental risk, and toward those characterized by low risk levels, net of the other contextual factors associated with migration streams (Hunter 1998). However, migration is rarely even, and strong associations between race and pollution may arise through the Tiebout process. Through this process, residents who place a high value on the environment and have access to the resources may leave the community. The residents that remain or move in may be low-income, minority residents who lack the resources to purchase a higher level of environmental amenities (Hamilton 1995; Colten 2001). Thus, the siting of a potentially hazardous facility may in fact serve as a catalyst for the segregation of the surrounding neighborhood, despite the fact that the neighborhood may have been neither low-income nor minority at the time of the siting.

In addition to operating through neighborhood desirability, the push-pull model may also operate through changes in neighborhood economics, especially property values (Talih and Fricker 2002). A facility may locate in a given area, causing the environment to deteriorate, making the neighborhood less desirable, thereby decreasing the neighborhood’s property value. This makes housing more available to lower income households and less attractive to higher income households, ultimately making the neighborhood poorer than it was before the facility siting (Been 1994).

Finally, the institutional theory of neighborhood change suggests that institutions such as banks, insurance companies, or universities play a very important role in the neighborhood change. This theory implies that the presence of potentially hazardous facilities does not necessarily lead to neighborhood decline. In fact, such institutions may dramatically impact the
local economic structure for better or for worse, often affecting the direction in which the surrounding neighborhoods will develop (Liu 1997). In some cases, facilities may be attracted to neighborhoods that are in the aging or declining stage of the neighborhood life cycle, altering the socioeconomic status of the neighborhoods. In some cases, socioeconomic status might increase following the siting of the facility, or the neighborhood may continue to decline. Thus, according to the institutional theory, the siting of potentially hazardous facilities many not necessarily be the cause of neighborhood decline, but could in fact be the result of neighborhood decline (Talih and Fricker 2002).

6.3 Minority Population Change and the Siting of Oil-Related Infrastructure in Southeast Louisiana

6.3.1 Saint Bernard Parish

In Saint Bernard Parish, the first of the study area parishes to exhibit significant oil-related development, the African American population hovered just below the state average for the first decades of the twentieth century, dropping from 43.67 percent in 1900 to 32.15 percent in 1920. The development of the oil refineries in Chalmette and Meraux in the 1920s would dramatically alter the population demographics in Saint Bernard Parish, with the white population rising significantly in the years following facility siting and African American population either holding steady or dropping. Though we have no census data for either Chalmette or Meraux, the ward data suggests that the overall parish pattern holds for each of these communities. In 1930, the Third Ward, containing Chalmette, had only 18.99 percent African American, significantly below both the parish and state averages. This number would continue to drop in the coming decades until, by the 1960s, the African American population in the Third Ward numbered well under 1 percent of the total population. Chalmette itself only
appeared in one census prior to 1980. In 1950, the census enumerated a total of five African Americans out of a total of 1,695 residents in Chalmette, again well less than 1 percent of the total population. This pattern holds for the Fourth Ward as well, although not as dramatically, at least not on the surface. At the start of the 1930s, the rural inhabitants of the Fourth Ward made up over 60 percent of the total population compared to just over 14 percent in the Third Ward. The proportion African American at the time comprised 28.01 percent – above the parish average and below the state average. Over the course of the 1930s, the percentage African American in the Fourth Ward rose to 31.31 percent, even as the parish average dropped to under 20 percent. Later censuses would show that Meraux, bordering Chalmette on the east, contained most of the ward’s white population, while the ward’s African American population largely resides to the east, on the border of the Fifth Ward, which contains the communities of Violet and Poydras. While this pattern may have been in place in the first half of the twentieth century as well, this cannot be conclusively stated based on the available census data.

By the mid-1930s, the Meraux refinery had shut down, which may explain, in part, the lack of urbanization in the Fourth Ward, compared to the neighboring Third Ward. However, the attempts to reestablish the refinery site throughout the 1940s and the successful development of the site in the early 1950s had the same effect on the population of the Fourth Ward as the siting of the Chalmette Refinery had on the Third Ward. The proportion African American would drop dramatically from a high of 31.31 percent in 1940, when the General Oil Company brought the refinery online to 11.59 percent by the end of the 1960s, the decade when the Murphy Oil Company took over the refinery.
6.3.2 Jefferson Parish

In Jefferson Parish, the potential for onshore oil-related environmental inequity becomes evident in one of two areas. The first is the location of the oil fields and the second is the siting of the support infrastructure, particularly the petroleum bulk storage facilities. The rural areas and marshlands of southern Jefferson Parish contain the majority of the oil fields while the more developed portions of the west bank along the Mississippi River are home to the large bulk storage facilities.

The Sixth Ward contains the Barataria region, including the Lafitte and Barataria oil fields, which both came online in the late 1930s. In 1940, 71 of the parish’s 118 non-African American minority residents, over 60 percent, resided in the Sixth Ward. The lack of census data for communities in the Sixth Ward makes it difficult to draw any conclusions whether these residents resided in proximity to the oil fields or not. We do know that the majority of the population lived in developed areas, with only 2 percent of the population residing in rural areas. As the oil field development in the Barataria region took place in rural areas, it is likely that few residents of the parish resided in close proximity to the fields.

The wards that contained the largest number of petroleum bulk storage facilities, the fourth and fifth, showed vast differences in minority proportions in the years prior to the arrival of the oil industry. The Fourth Ward, containing Marrero and Westwego, had only 18.75 percent African American in 1930, below both the state and parish averages. The Fifth Ward, containing Avondale, contained 40.04 percent African American in 1930, slightly higher than the state average and well above the parish average. Note that it is difficult to make any definitive conclusions based on this early data, given the relatively large wards. The relatively large unit of analysis available in the 1930 census may mask significant pockets of minority residents.
There are distinct differences in the character of each of these wards. In 1930, the Fourth Ward was almost entirely urbanized, with the U.S. Census Bureau classifying only 7.34 percent of the 11,345 residents as rural. This stands in sharp contrast to the demographics of the Fifth Ward, which contained less than a thousand residents, 35.72 percent of which were rural. However, by 1940, the population in each of these jury wards was becoming increasingly urban. The percentage rural would drop nearly 10 percent in the Fifth Ward down to 25.61 percent in the years between 1930 and 1940, while the proportion rural in the Fourth Ward would drop down to 5.27 percent.

In 1940, the Orleans Refinery (later Clarks Refinery) opened in Marrero in the Fourth Ward. At the time, the proportion African American in the Fourth Ward was below both the parish and state averages. By the time the refinery recorded its last run of petroleum in 1958, the Fourth Ward had 21.28 percent African American, compared to the parish average of 15.15 percent. While there is no census data for Marrero itself for the period of time in which the refinery operated, in 1980 the proportion African American in Marrero was 31.54 percent compared to the parish average of 13.86 percent. It would appear that the presence of this refinery might have created a push-pull effect in the Fourth Ward, though without earlier community-level data, this cannot be stated conclusively.

6.3.3 Lafourche Parish

When Kerr-McGee struck oil in the Gulf of Mexico in 1947, Louisiana shipyards boomed as companies sought to supply vessels necessary to transport both crew and supplies to the offshore drilling platforms. In Lafourche Parish, four new shipyards began operation in the latter half of the 1940s. Two of these found sites in Lafourche Parish’s southernmost ward, with a third sited on the western border. The tenth ward includes Port Fourchon as well as the
communities of Leeville, Golden Meadow, Galliano, Cut Off, and part of Larose. In 1940, the
tenth ward was home to all but one of the parish’s non-African American minority population of 321. Of this total, the U.S. Census Bureau has identified 319 as Native American.

This data would seem to suggest that the siting of shipyards in the 1940s disproportionately impacted the Native American population of Lafourche Parish. However, caution should be exercised in drawing such a conclusion. The tenth was by far the largest ward in Lafourche Parish and 38.36 percent of its 38,615 persons resided in rural areas away from the towns with the shipyards. The 1950 census, which included data for both Larose and Golden Meadow, verifies that the Native American population at that time was still largely rural. In 1950, the number of Native Americans in Lafourche Parish had grown to 435. Of this total, only six lived in Larose and none in Golden Meadow. No significant Native American influx into these communities appears until the 1980. By this point, all three of the shipyards sited in Larose were already in operation, as well as two of the three in Golden Meadow. The third shipyard to locate in Golden Meadow began operation in 1983, at a time when the community was already disproportionately Native American.

6.4 Statistical Analysis of Environmental Equity Dynamics

By examining the demographic characteristics of the host ward at the time of facility siting, this research determines whether low-income and minority neighborhoods received a disproportionate share of potentially hazardous facilities relative to the rest of the population. This serves as a benchmark with which to compare the present day neighborhood composition. It does not, however, allow us to establish a causal link between the presence of oil-related infrastructure and the change in neighborhood characteristics. The presence or absence of
potentially hazardous facilities is neither a necessary nor sufficient condition for neighborhood changes (Liu 1997).

The results suggest that areas undergoing industrial development generally exhibit fairly rapid population expansions. In many cases, over time, the minority proportion in these areas has increased. The several theories of environmental equity formation offer varying explanations as to how and why areas might become increasingly poor and minority. This portion of the analysis determines which of these theories best explains the presence of environmental injustice in certain areas of southeast Louisiana. Using multiple regression analysis, we test which factors most influence population migration into census tracts within the study area.

The 2000 census question regarding place of residence in 1995 is the source of the migration data used to calculate the dependant variables in this analysis (Hunter 1998). A number of sources, particularly U.S. Census Bureau 1990 data, U.S. Geological Survey 1990 land use and land cover data, and USEPA 1996 air release data, served as source data for the independent variables. This data establishes the initial conditions within each census tract. Migration analysis assumes that residents respond to these factors by moving in or out of certain areas. Ultimately, population migration shows environmental equity and justice formation as a more dynamic process. It should be noted that this analysis specifically examines in-migration patterns – those factors that draw persons into an area and not those that drive them out. This approach assumes that populations are not drawn to particular regions because they are hazardous. It is important, however, to consider that populations may be drawn to potentially hazardous areas because of employment opportunities and real estate values.
In order to determine what is driving migration patterns in the three study area parishes, I first ran a regression for the total population, then by individual minority groups. This allows me to isolate different potential motives for individuals moving into particular areas. This step uses surrogate categories to define specific social and economic variables. For example, it would be a mischaracterization to say that a particular population group moves into an area because the house values are high. It would likely be more accurate to say that people tend to want to live in nicer neighborhoods where the housing stock tends to be more valuable. Conversely, we cannot assume that a migration shift into an area with lower house values represents downward mobility (i.e. a desire to live in a run-down area). Rather, we can likely say that these people move into the area because houses and rents are affordable. A significant finding that individuals move into areas with his/her own race or ethnicity could contradict this.

I selected a number of variables based on their ability to best model the different theories of environmental equity formation. For example, white migration into more segregated white neighborhoods with minorities moving into more integrated areas is characteristic of invasion-succession. If the white population is decreasing in terms of raw numbers, then we have a situation with white flight. If both the African American and white populations are increasing, we can assume that market dynamics are important in this area. Because we are using regression analysis, economic factors such as house value, median rent, and income are controlled. In the case of pure invasion-succession, the racial characteristics should change first and not economic status.

A general movement to or from older densely populated neighborhoods typifies the neighborhood life-cycle model. As the age of the housing stock increases, we would expect to see resultant changes in the demographic makeup of the community. As the neighborhoods ages,
the quality of the housing stock declines, values and rents decrease, and low income and minority residents move in. Of course, the regression analysis controls for house value. This is important in particular areas of southeast Louisiana, especially in historic neighborhoods. We would expect total migration to be away from these older, densely populated areas. However, minorities more likely would be drawn to such neighborhoods, whereas the white population would tend to move into newer houses.

Movement between neighborhoods of contrasting desirability characterizes the push-pull model. Areas with a high percentage of industrialization would serve as a push force, resulting in total migration into surrounding areas with low industrialization. Assuming that property values in industrial areas are lower, less affluent residents tend to live in these areas. Under the push-pull model, minority residents are more likely to move into areas with low property values, whereas whites are more likely to move into areas with high property values. However, these hypotheses do not consider the percentage of residents employed in manufacturing. Blue-collar working class residents of any race might move into more industrial areas because of the nearness to manufacturing employment. In fact, previous research has suggested that the migrations of working-age people into a region comprising one or several parishes may be interpreted as a sign of regional growth and employment growth of the industries within the region (Shanafelt 1977). Finally, this analysis examined environmental conditions within each parish during the mid-1990s. For this, I used data on the release of common air pollutants. Air emissions, including smoke and other forms of particulate matter, represent the most visible form of pollution, and would likely have the most immediate effect on decisions to move into an area. Previous research has demonstrated that the level of air pollutants demonstrates the strongest relationship with county level migration patterns (Hunter 1998).
Table 33 Results of Stepwise Multiple Regression Analysis for Lafourche, Jefferson, and Saint Bernard Parishes, Louisiana with Census Tract In-Migration as the Dependent Variable

<table>
<thead>
<tr>
<th>Census Tract Characteristics</th>
<th>Overall Population</th>
<th>White</th>
<th>African American</th>
<th>Native American</th>
<th>Asian</th>
<th>Hispanic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Segregated Minority Neighborhoods</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>-0.227</td>
<td>+0.255</td>
<td>+0.825</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Native American</td>
<td>n.s.</td>
<td>+0.118</td>
<td>-</td>
<td>+0.376</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Asian</td>
<td>n.s.</td>
<td>+0.124</td>
<td>-</td>
<td>-</td>
<td>+0.337</td>
<td>-</td>
</tr>
<tr>
<td>Hispanic</td>
<td>n.s.</td>
<td>+0.255</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+0.521</td>
</tr>
<tr>
<td><strong>Segregated Minority and Segregated White Neighborhoods</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Native American</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Asian</td>
<td>n.s.</td>
<td>n.s.</td>
<td>-</td>
<td>-</td>
<td>n.s.</td>
<td>-</td>
</tr>
<tr>
<td>Hispanic</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>-</td>
<td>-</td>
<td>+0.270</td>
</tr>
<tr>
<td><strong>Neighborhood Characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age of Housing Stock</td>
<td>-0.332</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>-0.024</td>
<td>n.s.</td>
</tr>
<tr>
<td>Median House Value</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>-0.112</td>
<td>+0.147</td>
<td>n.s.</td>
</tr>
<tr>
<td>Median Rent</td>
<td>-0.320</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>+0.215</td>
</tr>
<tr>
<td>Percent Industrial Land Use</td>
<td>+0.473</td>
<td>-0.104</td>
<td>+0.088</td>
<td>n.s.</td>
<td>+0.179</td>
<td>n.s.</td>
</tr>
<tr>
<td>Population Density</td>
<td>-0.436</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>+0.263</td>
</tr>
<tr>
<td><strong>Occupational Characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employed in the Same Town</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Percent Employed in the Oil Industry</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>-0.036</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Percent Employed in the Manufacturing Industry</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Total Travel Time to Work</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>+0.147</td>
<td>n.s.</td>
</tr>
<tr>
<td><strong>Environmental Characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tons of Air Pollutants</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
</tbody>
</table>

Finally, to test for effects related to the institutional theory of neighborhood change, the analysis has to establish that some other factor was already in play when the facility sited there. For example, the neighborhood may have already been in decline or property values may have been dropping prior to industrial siting. Some institutional change (positive or negative) occurs and a reversal in this established dynamic follows.

6.4.1 Regional Migration Patterns

The initial portion of the analysis looked at the migration rates within all three of the case study parishes, Lafourche, Jefferson, and Saint Bernard. By using the stepwise multivariate analysis, I formulated a regression model using the standardized coefficients (Table 33). The migration of population into census tract in the three-parish study area is correlates positively with population density and the percentage of the land in industrial usage. It is also correlates positively with lower rents. In other words, people appear to be moving into densely populated, largely industrial areas where the costs of rent are lower. In addition, people tend to be moving into newer housing. Finally, it would appear that people are moving into areas where the white population and the African American population are more integrated. This is not related to any of the employment factors. In other words, people do not appear to moving to live closer to their jobs, at least not at the regional level. Finally, overall there is a slight non-significant positive correlation between the level of air emissions within the census tract and the movement of the population into that tract, suggesting that environmental factors are not important in terms of the overall migration of population within the region.

When these population patterns are broken down by race, we see quite different patterns emerge. The white population, especially, occupies segregated areas away from industrial land. This contrasts with the African American population, which, when examined over the entire
region, moves into areas that are more industrial and already have a fairly segregated African American population. These areas also tend to have lower house values.

Like the African American population, the Asian population appears to be more likely to move into segregated Asian neighborhoods as well as census tracts with higher levels of industrial land uses. Unlike the African American population, however, the Asian population tends to move into tracts that, although more industrial, have higher value and newer housing.

Like the white, Asian and African American populations, Hispanics in southeast Louisiana tend to move into neighborhoods that are highly segregated. Furthermore, the regression model shows a positive correlation between neighborhood in-migration and absolute levels of Hispanic/White segregation. This suggests that in addition to moving into areas with large numbers of Hispanic residents, some Hispanics may be moving into areas with highly segregated white populations. In addition, many Hispanics tend to be moving into areas with higher rents.

Interestingly, none of the racial or ethnic groups examined thus far appear to migrate into census tracts where higher proportions of residents live close to their jobs. Similarly, although both the African American and Asian populations tend to move into areas with higher percentages of industrial land use, none of the groups examined thus far are moving into tracts where larger numbers of residents work in either manufacturing or in the oil industry. This would seem to support the contention that market dynamics are the driving force behind many of the migration patterns found in the three-parish study area (Been 1994).

Of all the minority groups, only the Native American population generally moves into census tracts where a large portion of the population works in the oil industry. The Native American population also appears to be migrating into areas that are farther from their place of
employment, at least in terms of travel time to work. What all of this suggests is that the Native American population has tended to migrate into Native American communities where a large number of people are employed by the oil industry. These communities also tend to be farther from the actual employment sites.

In general, migration of a population within a parish represents upward economic mobility into better housing or into more desirable areas of the parish. Migrations from one parish to another can either reflect the lack of opportunity in some parishes or more economic opportunities in other parishes or a combination of the two, which is usually the case (Shanafelt 1977). This would provide some evidence of the push-pull model of population mobility.

When examined in total, within-parish migration follows the expected trend. People who migrate to other areas in the parish tend to move away from their work. Likewise, the areas they move into are generally less industrial and have lower overall air pollution. Finally, the areas which people have migrated into have lower population densities as well as lower house values.

Migrations from outside the three parishes show an opposite trend. People from outside these parishes have tended to move into newer housing built in more industrial areas. Interestingly, the data suggests that destinations for out-of-parish migrants have lower percentages of residents who work in the manufacturing industry, suggesting that these migrants are not seeking neighborhoods that one would traditionally consider as “blue-collar.” Overall, the data suggest a general movement towards newer neighborhoods in industrialized areas. We see very little movement, for example, into areas dominated by wetlands and marshland, where the Native American populations have traditionally settled.
6.4.2 Lafourche Parish Migration Patterns

The next portion of the analysis involved looking at the migration rates within each parish. To begin, I looked at Lafourche Parish, which has become the center of the offshore oil industry in southeast Louisiana. Again, using stepwise multivariate analysis, I obtained a regression model using the standardized coefficients (Table 34). In Lafourche Parish, overall migration is positively correlated with the ability to work in the same place that one lives. In addition, there is a slight positive correlation between the age of the housing stock, though not significant to the 95 percent confidence level. These results suggest that people are moving into older housing close to their jobs. When the analysis includes the percentage of the population employed in manufacturing as a factor, the model does not change. This further suggests that in Lafourche Parish people engaged in manufacturing jobs, such as shipbuilding, are not moving into more blue-collar type neighborhoods.

When broken down racially, different patterns emerge. The white population has not migrated into the urban areas in Thibodaux, instead they moved into the more rural area east of Thibodaux, as well as the area between Larose and Lockport (Figure 95). Over 60 percent of the variability in this migration can be explained by the degree of segregation between the African American and white populations. The African American and Asian populations in Lafourche Parish had similar in-migration patterns. Significantly, the Asian and African American populations each settled in tracts in Thibodaux as well as the area between Thibodaux and Raceland, areas that the white population tended to avoid (Figure 96 and Figure 97). These results all suggest that in Lafourche Parish, the white, African American, and Asian populations all sought out census tracts with higher segregation levels. In other words, when the analysis controls for all other factors, including house values, proximity to jobs, and the quality
Table 34 Results of Stepwise Multiple Regression Analysis for Lafourche Parish, Louisiana with Census Tract In-Migration as the Dependant Variable

<table>
<thead>
<tr>
<th>Census Tract Characteristics</th>
<th>Overall Population</th>
<th>White</th>
<th>African American</th>
<th>Native American</th>
<th>Asian</th>
<th>Hispanic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Segregated Minority Neighborhoods</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>n.s.</td>
<td>+0.790</td>
<td>+0.845</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Native American</td>
<td>n.s.</td>
<td>n.s.</td>
<td>-</td>
<td>n.s.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Asian</td>
<td>n.s.</td>
<td>n.s.</td>
<td>-</td>
<td>-</td>
<td>+0.483</td>
<td>-</td>
</tr>
<tr>
<td>Hispanic</td>
<td>n.s.</td>
<td>n.s.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>n.s.</td>
</tr>
<tr>
<td>Segregated Minority and Segregated White Neighborhoods</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Native American</td>
<td>n.s.</td>
<td>n.s.</td>
<td>-</td>
<td>n.s.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Asian</td>
<td>n.s.</td>
<td>n.s.</td>
<td>-</td>
<td>-</td>
<td>n.s.</td>
<td>-</td>
</tr>
<tr>
<td>Hispanic</td>
<td>n.s.</td>
<td>n.s.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>n.s.</td>
</tr>
<tr>
<td>Neighborhood Characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age of Housing Stock</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Median House Value</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Median Rent</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Percent Industrial Land Use</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Population Density</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Occupational Characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employed in the Same Town</td>
<td>+0.760</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Percent Employed in the Oil Industry</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>+0.641</td>
<td>n.s.</td>
<td>+0.667</td>
</tr>
<tr>
<td>Percent Employed in the Manufacturing Industry</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Total Travel Time to Work</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Environmental Characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tons of Air Pollutants</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
</tbody>
</table>

Figure 95 Migration Patterns of the White Population, 1995-2000, Lafourche Parish, Louisiana
Figure 96 Migration Patterns of the Asian Population, 1995-2000, Lafourche Parish, Louisiana
Figure 97: Migration Patterns of the African American Population, 1995-2000, Lafourche Parish, Louisiana
of air, these populations each primarily sought out areas where they were segregated from either the African American population, in the case of the white population, or from the white population, in the case of Asians and African Americans. In the case of African American population migration, this one factor accounted for over 71 percent of the total variability.

Very different patterns emerge with the Native American and Hispanic populations. Each group significantly sought out areas south of the Gulf Intracoastal Waterway, which runs through Larose (Figure 98 and Figure 99). The Hispanic population migrated into Larose, while the Native American population migrated into the areas further south, including Cutoff and locations on the eastern bank of Bayou Lafourche. These are largely census tracts where larger proportions of residents find employment in the oil industry.

6.4.3 Jefferson Parish Migration Patterns

Jefferson Parish, historically, was the center of early oil development in southeast Louisiana. Oil-related development in the area centered around two principal areas, both on the west bank of the Mississippi River. The first was the oil fields. Early on, the vast majority of oil field development centered in the Barataria Region of the parish, especially in the vicinity of Lafitte and Barataria, in the oil fields of the same names. During this time, the more industrialized communities along the west bank of the Mississippi River were the locations of many of the support industries, particularly the petroleum bulk storage facilities. Only later would oil fields such as the Westwego, Avondale, and Bayou Segnette fields be developed in the more northerly portion of the West Bank. At the same time that oil-related industries were expanding on the West Bank, the East Bank communities, such as Kenner and Metairie, were developing into suburban residential communities, largely populated by residents of New Orleans.
Migration Patterns of the Native American Population, 1995-2000
Lafourche Parish, Louisiana

Figure 98 Migration Patterns of the Native American Population, 1995-2000, Lafourche Parish, Louisiana
Figure 99 Migration Patterns of the Hispanic Population, 1995-2000, Lafourche Parish, Louisiana
In this portion of the analysis, I first examine the migration patterns for Jefferson Parish as a whole, then we divide the parish into census tracts on the east bank and those on the west bank of the Mississippi River. I would expect to find very different reasons for settling in each of these areas that would be quite different from the parish as a whole. Once again stepwise multivariate analysis enables a modeling of in-migration into the census tracts. Results for the parish population as a whole are almost identical those found in the model developed for the three-parish study area, likely due to the large total population of Jefferson Parish (Table 35). The primary difference is that in Jefferson Parish, contrary to the entire region, people are moving into more densely populated areas. Another difference is that in Jefferson Parish, populations are migrating into census tracts with low levels of absolute segregation between the African American population and the white population, suggesting that in Jefferson Parish as a whole, there has been a tendency to migrate into more integrated census tracts.

The white population, however, moves into census tracts where they are largely segregated from the African American and Hispanic populations, though they generally have moved into areas with higher levels of Native Americans. It would thus appear that the white population has moved away from the more industrialized areas of the parish into areas where the Native American population had resided, suggestive of a move into the more rural areas of the parish (Figure 100). The map of white migration shows this, to some extent. Although the primary areas into which the white population has moved are in the census tracts along the lakefront in northern Jefferson Parish and the Harahan/Elmwood district, across the Mississippi River from the communities of Waggaman and Avondale, there is also a significant level of in-migration into the census tract containing the rural communities of Lafitte, Jean Lafitte, and Barataria. The regression analysis indicates that the census tracts the white population is moving
Table 35 Results of Stepwise Multiple Regression Analysis for Jefferson Parish, Louisiana with Census Tract In-Migration as the Dependant Variable

<table>
<thead>
<tr>
<th>Census Tract Characteristics</th>
<th>Overall Population</th>
<th>White</th>
<th>African American</th>
<th>Native American</th>
<th>Asian</th>
<th>Hispanic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Segregated Minority Neighborhoods</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>n.s.</td>
<td>+0.998</td>
<td>+0.803</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Native American</td>
<td>n.s.</td>
<td>-0.112</td>
<td></td>
<td>n.s.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Asian</td>
<td>n.s.</td>
<td>n.s.</td>
<td>-</td>
<td>+0.325</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>n.s.</td>
<td>+0.241</td>
<td></td>
<td>-</td>
<td>-</td>
<td>+0.480</td>
</tr>
<tr>
<td><strong>Segregated Minority and Segregated White Neighborhoods</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>-0.239</td>
<td>+0.246</td>
<td>n.s.</td>
<td>n.s.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Native American</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Asian</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>+0.296</td>
</tr>
<tr>
<td><strong>Neighborhood Characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age of Housing Stock</td>
<td>-0.242</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>-0.216</td>
</tr>
<tr>
<td>Median House Value</td>
<td>n.s.</td>
<td>n.s.</td>
<td>-0.137</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Median Rent</td>
<td>-0.273</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>+0.188</td>
</tr>
<tr>
<td>Percent Industrial Land Use</td>
<td>+0.537</td>
<td>-0.114</td>
<td>+0.086</td>
<td>n.s.</td>
<td>+0.196</td>
<td>n.s.</td>
</tr>
<tr>
<td>Population Density</td>
<td>+0.385</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>+0.317</td>
</tr>
<tr>
<td><strong>Occupational Characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employed in the Same Town</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Percent Employed in the Oil Industry</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Percent Employed in the Manufacturing Industry</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Total Travel Time to Work</td>
<td>n.s.</td>
<td>-0.115</td>
<td></td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td><strong>Environmental Characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tons of Air Pollutants</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
</tbody>
</table>

Figure 100 Migration Patterns of the White Population, 1995-2000, Jefferson Parish, Louisiana
into also have shorter travel times between the home and workplace, indicating that these census tracts are either in proximity to the places of employment or closer to convenient transportation routes.

The African American population, on the other hand, shows a propensity to move into more industrialized areas where the house values are lower. These communities largely are located in the industrial districts of the West Bank as well as along the Airline Highway on the East Bank (Figure 101). The African Americans living in these areas are also largely segregated from the white population.

Similarly, the Asian and Hispanic communities have moved into census tracts where they are segregated from the white population. However, the Asian population appears to be moving into more densely populated industrial areas where there is a greater proportion of more recently constructed housing, in contrast to the lower value housing that the African American population in Jefferson Parish has tended to move into. For example, although we see some areas along the lakefront where the Asian population has moved, we also see significant Asian migration into Avondale as well as the census tracts along the Westbank Expressway between Marrero and Westwego (Figure 102). Similarly, the Hispanic community, although they also tend to move into more segregated Hispanic census tracts, generally move into areas where the median contract rents are higher, including areas of the lakefront on the border of Kenner and Metairie, and on the Orleans Parish border on the west bank near Terrytown (Figure 103). The Hispanic population, like the white population, generally avoids those census tracts into which significant numbers of African Americans are moving, such as Waggaman and the southern portion of the Harvey Canal.

In the case of each of these minority groups, it appears that to some extent housing variables are driving the population migrations, whether it is low property values in the case of
Figure 101 Migration Patterns of the African American Population, 1995-2000, Jefferson Parish, Louisiana
Figure 102 Migration Patterns of the Asian Population, 1995-2000, Jefferson Parish, Louisiana
Figure 103 Migration Patterns of the Hispanic Population, 1995-2000, Jefferson Parish, Louisiana
African Americans, newer housing in the case of Asians, or higher quality rental properties in the case of the Hispanic population. Interestingly, these populations also occupy census tracts where they are more segregated from the white population. Contrast this with the results of the regression model for the Native American population in Jefferson Parish which suggests that the Native American population is moving into census tracts where very few residents work in the same town in which they live, including Waggaman and the census tracts south of Marrero, on the boundary of the parish’s industrialized areas (Figure 104). However, there is not a significant relationship between Native American migration patterns and travel time from the residence to the place of employment, meaning that the Native American population may not be moving into census tracts where their jobs are located, but they also may not be significantly altering their travel time to work.

In order to more effectively examine the migration patterns within Jefferson Parish, it is necessary to separate the industrial West Bank from the residential east bank. The analysis suggests that there is a bifurcation of migration patterns between the two banks of the Mississippi River that is masked when examining the migration patterns of the parish as a whole.

6.4.3.1 Jefferson Parish East Bank Migration Patterns

The results of the regression analysis on the total population of the east bank are significantly different than those of the total parish (Table 36). In particular, racial variables do not appear to be significant. The results suggest instead that the primary factor in population migration is population density along with the presence of nearby industry. However, when the research examines the white population alone, a more complex pattern emerges. In the more residential East Bank of Jefferson Parish, the white population tends to avoid census tracts that have high levels of African Americans, Asians, and Hispanics. However, there also appears to
Figure 104 Migration Patterns of the Native American Population, 1995-2000, Jefferson Parish, Louisiana
Table 36  Results of Stepwise Multiple Regression Analysis for the East Bank of Jefferson Parish, Louisiana with Census Tract In-Migration as the Dependant Variable

<table>
<thead>
<tr>
<th>Census Tract Characteristics</th>
<th>Significant Coefficients Determined by Racial Group</th>
<th>Overall Population</th>
<th>White</th>
<th>African American</th>
<th>Native American</th>
<th>Asian</th>
<th>Hispanic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Segregated Minority Neighborhoods</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>n.s.</td>
<td>+0.556</td>
<td>+0.719</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Native American</td>
<td>n.s.</td>
<td>n.s.</td>
<td>-</td>
<td>n.s.</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>n.s.</td>
<td>+0.217</td>
<td>-</td>
<td>-</td>
<td>+0.519</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>n.s.</td>
<td>+0.326</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+0.382</td>
<td></td>
</tr>
<tr>
<td>Segregated Minority and Segregated White Neighborhoods</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>n.s.</td>
<td>-0.201</td>
<td>+0.240</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Native American</td>
<td>n.s.</td>
<td>n.s.</td>
<td>-</td>
<td>n.s.</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>n.s.</td>
<td>+0.181</td>
<td>-</td>
<td>-</td>
<td>n.s.</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>n.s.</td>
<td>n.s.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+0.340</td>
<td></td>
</tr>
<tr>
<td>Neighborhood Characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age of Housing Stock</td>
<td>n.s.</td>
<td>n.s.</td>
<td>-0.085</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>-0.201</td>
</tr>
<tr>
<td>Median House Value</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Median Rent</td>
<td>n.s.</td>
<td>n.s.</td>
<td>-0.105</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Percent Industrial Land Use</td>
<td>+0.775</td>
<td>-0.092</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Population Density</td>
<td>+0.462</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Occupational Characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employed in the Same Town</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Percent Employed in the Oil Industry</td>
<td>n.s.</td>
<td>-0.114</td>
<td>+0.091</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Percent Employed in the Manufacturing Industry</td>
<td>n.s.</td>
<td>-0.201</td>
<td>+0.188</td>
<td>n.s.</td>
<td>-0.229</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Total Travel Time to Work</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Environmental Characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tons of Air Pollutants</td>
<td>n.s.</td>
<td>n.s.</td>
<td>+0.153</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
</tbody>
</table>

be some movement of the white population into more integrated census tracts. In some cases, these results signify that some degree of gentrification might be occurring on the east bank of Jefferson Parish.

In addition to avoiding areas with large concentrations of minority residents, the white population generally avoids “blue-color” neighborhoods where a number of residents are employed in industries such as oil and gas extraction and manufacturing. Similarly, the white population on the east bank generally avoids census tracts where there is considerable industrial land use. Conversely, the African American population has migrated into these more segregated, blue-collar census tracts. The white population has migrated into census tracts that are more integrated, not those with high levels of white segregation while the African American population has tended to avoid these integrated areas, instead moving into areas with significant high segregation levels. This supports the contention that there is some degree of gentrification occurring on the East Bank, with the white population moving into integrated neighborhoods and the African American population moving into segregated African American neighborhoods.

In addition to moving into segregated neighborhoods, the African American population is moving into areas where the median contract rent is significantly lower. These areas also appear to be those with lower air quality levels. This definitely suggests that areas with lower environmental quality do in fact, through market dynamics, become attractive based on low costs to certain minority groups (Been 1994). The fact that much of this housing stock may be newer than houses found elsewhere in the parish may be more indicative of the historical quality of many of the home in the older areas of the parish, such as Old Metairie.

When the analysis examines each of the minority groups (with the exception of the Native American population, which has not migrated into areas of the east bank in any
significant numbers), the degree of segregation from the white population becomes significant. In the case of the Hispanic population, this includes a general avoidance of integrated areas as well. Unlike the African American population, the Asian community on the east bank of Jefferson Parish has significantly avoided moving into manufacturing blue-collar census tracts, though the proportion of the census tract population employed in the oil industry is not significant.

It appears that the forces driving migration patterns on the east bank of Jefferson Parish tend to center on push-pull forces, particularly in terms of choices to reside in proximity to those of the same race or ethnicity. In terms of the white population, there are other factors working as well, particularly a classical invasion-succession pattern that results from the white population moving into census tracts that are becoming integrated, while the African American population is moving into more segregated portions of the parish that have both increased levels of air pollution and lower house values.

6.4.3.2 Jefferson Parish West Bank Migration Patterns

The patterns on the west bank are similar in many ways to those on the east bank in that racial segregation appears to be driving many of the minority migration patterns (Table 37). Overall, however, the migration patterns appear to be driven by occupational characteristics, particularly the residents’ proximity to their workplaces. This would suggest that the total population may not be moving into the same towns in which they are employed, but they are moving into census tracts that are closer to their jobs. When broken down into the white population and the various minority groups, this factor is not significant, however. Only the Hispanic population migration is significantly job-related. The Hispanic population appears to move into census tracts where many residents are employed in that same tract. Interestingly, the
Table 37 Results of Stepwise Multiple Regression Analysis for the West Bank of Jefferson Parish, Louisiana with Census Tract In-Migration as the Dependant Variable

<table>
<thead>
<tr>
<th>Census Tract Characteristics</th>
<th>Segregated Minority Neighborhoods</th>
<th>Segregated Minority and Segregated White Neighborhoods</th>
<th>Neighborhood Characteristics</th>
<th>Occupational Characteristics</th>
<th>Environmental Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Overall Population</td>
<td>White</td>
<td>African American</td>
<td>Native American</td>
<td>Asian</td>
</tr>
<tr>
<td></td>
<td>+1.485</td>
<td>+0.158</td>
<td>-</td>
<td>n.s.</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>n.s.</td>
<td>-0.376</td>
<td>-</td>
<td>n.s.</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>+0.306</td>
<td>+0.182</td>
<td>-</td>
<td>n.s.</td>
<td>-</td>
</tr>
</tbody>
</table>

Significant Coefficients Determined by Racial Group

- *n.s.* indicates not statistically significant.

overall results suggest that most of the population migration on the west bank avoids areas where the Hispanic population tends to be segregated. This would seem to suggest that the Hispanic population will choose housing in closer proximity to their places of employment than the total population, which resides in the surrounding census tracts.

The white population, along with the African American and Asian populations, generally moves into specific census tracts due largely to the degree of segregation present in these tracts. The white population on the west bank of Jefferson Parish, as on the east bank, tends to avoid areas with high levels of African American and Hispanic concentrations. Unlike on the east bank, however, we see that the white population also avoids areas where the African American and white populations are more integrated as well, signified by the higher level of absolute segregation between these populations.

This stands in sharp contrast to the population dynamics of the African American population. The negative value for the absolute levels of segregation between the African American and white populations suggest that there are different processes occurring on the west bank than those found on the east. On the west bank, we find that the white population tends to migrate into areas where they are completely segregated from the African American population. The African American population, conversely, appears to be moving into census tracts that are more integrated. This would, as on the east bank, seem to suggest a classic invasion-succession scenario. On the east bank, this pattern appeared to be one of gentrification, with the white population moving into integrated neighborhoods and the African American population seeking out segregated African American communities. On the west bank, however, this process appears to be one of white flight, with the African American population moving into more integrated census tracts and the white population avoiding these tracts by moving into areas where the white population is more highly segregated.
The migration of the Asian population on the west bank also appears to be largely driven by segregation, in this case by the absolute levels of segregation. That Asian population migrations were driven only by the absolute levels of segregation would seem to imply that Asian population migration has a bimodal distribution, with the population moving into census tracts that contain either segregated white or segregated Asian populations.

6.4.4 Saint Bernard Parish Migration Patterns

Saint Bernard Parish, historically, has had an extremely segregated population, especially in terms of the African American and white populations. Research has indicated that much of the migration into Saint Bernard Parish in the years following World War II, when the courts forced integration of schools, was largely the result of white flight from the Ninth Ward of neighboring New Orleans. This same research has also pointed out that much of this migration of the white population into Saint Bernard Parish was in part due to new jobs in the Kaiser Aluminum Plant and the oil refineries in Chalmette and Meraux, access to inexpensive land, and housing funds for war veterans (Wells 2004). A statistical examination of migration into Saint Bernard Parish reveals that many of these factors continue to drive population movements (Table 38). Analysis reveals that the driving factor in terms of all population groups is the ability to live in the same town in which one works, which tends to be correlated to employment in the oil industry. These locations also have lower contract rents.

Interestingly, the only racial variable that appears to be significant in the overall migration into Saint Bernard Parish census tracts is the percentage Asian. This is possibly explained, to some extent when one looks at the census tracts into which the Asian population has migrated. The Asian population is the only group that has moved in significant numbers into the census tracts containing Meraux with its large oil refinery. This result is highlighted when
Table 38  Results of Stepwise Multiple Regression Analysis for Saint Bernard Parish, Louisiana with Census Tract In-Migration as the Dependant Variable

<table>
<thead>
<tr>
<th>Census Tract Characteristics</th>
<th>Overall Population</th>
<th>White</th>
<th>African American</th>
<th>Native American</th>
<th>Asian</th>
<th>Hispanic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Segregated Minority Neighborhoods</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>n.s.</td>
<td>+0.681</td>
<td>+1.307</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Native American</td>
<td>n.s.</td>
<td>n.s.</td>
<td>-</td>
<td>+0.552</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Asian</td>
<td>+1.426</td>
<td>n.s.</td>
<td>-</td>
<td>-</td>
<td>n.s.</td>
<td>-</td>
</tr>
<tr>
<td>Hispanic</td>
<td>n.s.</td>
<td>n.s.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>n.s.</td>
</tr>
<tr>
<td>Segregated Minority and Segregated White Neighborhoods</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>n.s.</td>
<td>n.s.</td>
<td>+0.696</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Native American</td>
<td>n.s.</td>
<td>+0.180</td>
<td>-</td>
<td>n.s.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Asian</td>
<td>+0.904</td>
<td>n.s.</td>
<td>-</td>
<td>-</td>
<td>n.s.</td>
<td>-</td>
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<tr>
<td>Hispanic</td>
<td>n.s.</td>
<td>n.s.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>n.s.</td>
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<tr>
<td>Neighborhood Characteristics</td>
<td></td>
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<tr>
<td>Age of Housing Stock</td>
<td>n.s.</td>
<td>+0.523</td>
<td>-0.377</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Median House Value</td>
<td>n.s.</td>
<td>n.s.</td>
<td>-0.216</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
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<tr>
<td>Median Rent</td>
<td>-0.410</td>
<td>+0.315</td>
<td></td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Percent Industrial Land Use</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
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<tr>
<td>Population Density</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
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<td>n.s.</td>
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<tr>
<td>Occupational Characteristics</td>
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<tr>
<td>Employed in the Same Town</td>
<td>+0.233</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
</tr>
<tr>
<td>Percent Employed in the Oil Industry</td>
<td>+0.513</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
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<tr>
<td>Percent Employed in the Manufacturing Industry</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>+0.616</td>
<td>n.s.</td>
<td>n.s.</td>
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<tr>
<td>Total Travel Time to Work</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
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<tr>
<td>Environmental Characteristics</td>
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<td></td>
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<tr>
<td>Tons of Air Pollutants</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>n.s.</td>
<td>+0.569</td>
<td>-0.718</td>
</tr>
</tbody>
</table>

examining the results of the regression model for the Asian population. The Asian population cannot be shown to be moving into areas based on the presence or absence of other Asian residents. Housing factors do not appear to be significant, either in terms of house values or rent levels. The regression model accounts for just under one third of the total variability in the migration of the Asian population, however, suggesting that there are other significant variables not accounted for in the regression model that could explain why the Asian population is moving into the Meraux and the census tract downriver (Figure 105). This may include other intangible neighborhood quality factors that are not easily measured. Other possible explanatory variables include segregation from the other minority groups or employment in business sectors other than oil or manufacturing. In any case, the levels of segregation between the Asian population and the white population does not prove to be significant when we examine the regression model for the white population.

The regression model indicates that the white population migrates in significant numbers into census tracts in which they are segregated from the African American population. As the map (Figure 106) of white migration in Saint Bernard Parish shows, this includes most of the census tracts in and around Arabi, Chalmette, and Meraux but not those bordering the Ninth Ward of New Orleans or directly on the main transportation route in Meraux, which includes the large oil refinery. The white population has also moved into areas with high absolute segregation levels between the Native American and white populations. This would suggest a bifurcation in migration patterns, with part of the white population seeking out census tracts where the Native American population generally has not settled together, specifically in the more urban tracts in Chalmette and Meraux, and another segment of the white population moving into areas of the parish where the Native American community has tended to be more segregated from other population groups, specifically the rural areas beyond Toca and Kenilworth.
Figure 105 Migration Patterns of the Asian Population, 1995-2000, Saint Bernard Parish, Louisiana
Figure 106 Migration Patterns of the White Population, 1995-2000, Saint Bernard Parish, Louisiana
The African American population in Saint Bernard Parish has likewise migrated into census tracts where they are highly segregated from the white population. The significance of both the general and absolute levels of segregation indicates that the African American population is moving into census tracts with high levels of African American segregation, avoiding even areas where there is some amount of integration between themselves and the white population (Figure 107). Significantly, these census tracts also have older, low-value housing.

The Native American population, as we saw in many of the other case studies, has migrated into census tracts for economic reasons. An examination of the census tracts into which the Native American population has migrated indicates that, with the exception of a single census tract in Chalmette, they have moved into the more rural census tracts, with the most significant numbers moving into the census tract containing Toca and Kenilworth (Figure 108). These census tracts continue to have significant numbers of Native Americans living relatively segregated from the white population, though the migration of white population into these tracts could change this. The Native American population is the only group that has moved into census tracts in proximity to the refinery in Chalmette and the gas processing plants in Toca and Yscloskey, explaining in part the results of the regression model.

Finally, when the analysis examines the spatial pattern of Hispanic population migration, it shows what appears to be a bimodal distribution, with the most significant number of Hispanics moving into the rural census tracts of the parish and less significant clusters upriver of the refineries along the border of Saint Bernard Parish with New Orleans’ Ninth Ward (Figure 109). The only explanatory variable is a strong negative correlation with the tons of air releases. This regression model, along with an examination of the map of Hispanic migration reveals that the Hispanic population has significantly not moved into the census tracts in Chalmette and Meraux, downriver to Violet and Poydras. The most likely explanation for the bimodal
Figure 107 Migration Patterns of the African American Population, 1995-2000, Saint Bernard Parish, Louisiana
Figure 108 Migration Patterns of the Native American Population, 1995-2000, Saint Bernard Parish, Louisiana
Figure 109 Migration Patterns of the Hispanic Population, 1995-2000, Saint Bernard Parish, Louisiana
distribution is that the rural population considered Hispanic by the U.S. Census Bureau are most likely the Isleños population, descendants of Canary Islanders brought to Louisiana during the time of Spanish Rule in the eighteenth century. The more urbanized population is likely a combination of Isleños and other Hispanics moving into Saint Bernard Parish from New Orleans.
CHAPTER 7 – CONCLUSION: THE NEED TO MOVE BEYOND TRADITIONAL NOTIONS OF ENVIRONMENTAL EQUITY

This dissertation aimed to identify and analyze the spatial patterns of risk associated with the oil and gas industry in southeast Louisiana and to determine if these patterns have a racial or class-based component. Based upon past research conducted on environmental equity in Louisiana, which tended to follow the more “traditional” models, I anticipated that the greatest impacts would have been found in urban areas, which is to say in areas with dense populations around a major labor market. I also expected that potential environmental inequity would lessen with distance from the urban core. Finally, I anticipated finding no significant environmental inequities in the communities on the wetland fringe of Louisiana’s coastal zone, where developable land is at a premium. None of these expectations were borne out by the research. Instead, the results seem to suggest a hodge-podge of potential impacts affecting a wide swath of communities. The community facing the greatest immediate risk, for example, is the one with the lowest proportion of minority residents. Conversely, minority communities residing far out on the wetland fringe, away from the large urban core, stand at greater risk from the oil and gas industry, both directly, through potential residential exposure, and indirectly, through natural resource consumption.

These results suggest that we need to move away from the traditional models of environmental equity and towards a finer grained, localized model. As Feng Liu notes,

We live in a heterogeneous world. Case studies are useful, but you can always find cases with opposite results. That is the way the world works. That is why we should treat environmental justice issues locally. (Liu 2001: 320)

While it is vital for researchers to capture this heterogeneity, caution must be exercised to avoid viewing environmental equity communities as though they are castaways on a deserted island. It
is important to recognize that local environmental equity issues have regional effects. For example, pollution created at the local level may have impacts well beyond the boundaries of the community, just as decisions made at the regional level may have a trickle down effect at the local level. Similarly, population flows in and out of potentially impacted communities, constantly creating subtle shifts in the landscape of environmental equity. The methodology developed in this research has allowed me to take a bottom up approach to environmental equity, while at the same time evaluating the regional impacts of the oil and gas industry. This methodology has allowed me to capture the essential heterogeneity present in the cultural geography of southeast Louisiana.

In the remainder of this chapter, I will draw several relevant conclusions which will help to shape a more viable theoretical model of environmental equity. In the following section, I will discuss the interaction of physical and industrial geography, and how this interaction has shaped the distribution of risks and hazards across southeast Louisiana. This will be followed by a discussion of the social and economic factors that create shifts in the racial and ethnic geography of southeast Louisiana, making environmental equity in the region difficult to pin down and define. Finally, I will conclude with a discussion of public policy and its role in shaping the environmental equity dialogue. It is this public dialogue that will ultimately define environmental equity, for better or for worse.

7.1 Industrial Geography

Many differing patterns of present-day environmental equity emerge in the case study parishes, from the impact of shipyards and gas plants on Lafourche Parish’s Houma Indian population to the siting of petroleum bulk storage in the heavily urbanized areas of Jefferson Parish’s west bank. In this research, I have created a number of localized hazards models,
geared specifically to each oil industry sector. Of the three sectors explored in this study, I found that OCS-related hazards are the most dispersed, and thus the least overtly hazardous. This is due in large part to the fact that the actual extraction sites are located far offshore, away from the parish itself. As a result, industries have fewer constraints on where to locate their facilities. While Port Fourchon, for example, is clearly the most convenient place for industry to locate, relative to proximity to the offshore wells, it is economically feasible for facilities to use upstream sites. Thus, we see shipyards located all along Bayou Lafourche, from Fourchon to Golden Meadow, up through Larose and Lockport. Petroleum bulk storage facilities occupy locations in many communities across south Lafourche, with a larger facility in north Lafourche. In the case of some industries, such as platform and pipeline fabrication, facilities are even located in adjacent parishes, reducing the overall hazardousness of the region, despite dense population concentrations along the bayou.

The other two sectors are much more constrained in their siting choices, economically, geographically, and politically. In Jefferson Parish, the onshore-related infrastructure occupies places in the immediate vicinity of the oil fields. Thus we see a much greater clustering of facilities and, consequently, hazardousness. Petroleum refining requires large-scale facilities and a large labor force, as well as transportation infrastructure and easy access to large amounts of water for reactive and cooling purposes. In coastal Louisiana, the potential siting locations for large refineries are extremely limited. In addition, there may be any number of political incentives and disincentives involved in siting such a potentially hazardous facility.

As would be expected, the refining district in St. Bernard Parish dominates the overall hazardscape. Nonetheless, when we explore the risk surface statistically, localized high points around Marrero, the Barataria and Avondale fields, and the gas plants in rural Saint Bernard
Parish still stand out, despite much lower relative values. Though the localized high hazard areas in Lafourche are still significant, they are statistically much less so than in the other two regions.

The flexibility in locating new facilities results in OCS-related infrastructure being lower on the potential hazardousness scale than both the onshore extraction and petroleum refining industries. The more dispersed the industries, the less the cumulative potential toxicity of the region. However, it is important to note that the dispersion of the industries also means that more people may be potentially exposed to environmental hazards from these industries, albeit at lower levels. In theory, however, an increased dispersion should allow for a more equitable distribution of environmental hazards. In concentrated industries such as oil refining, we find that the potential impact is limited to a small number of nearby communities, creating an opportunity for extreme cases of environmental inequity.

**7.2 Population Geography**

This research has revealed that social and economic factors often cause the levels of environmental equity to subtly shift. From a racial and ethnic standpoint, the United States has never truly become the grand “melting pot” that Jean de Crevecoeur envisioned when he wrote that individuals of all nations will be “melted into a new race of men, whose labors and posterity will one day cause great changes in the world” (Crevecoeur 1782). More recent observers have chosen to replace this “melting pot” metaphor with that of the “salad bowl” or, as seems appropriate in Louisiana, a “gumbo.” While many theorists might describe this “gumbo” as multiculturalism, in a geographical sense it could just as easily be defined as segregation, at least at the community level.

The historical analysis reveals that there is very little evidence of systematic environmental inequity in the siting procedures of various oil related industries, though certain
individual facilities have been sited in minority communities. In most cases, however, the
demographic makeup of the community changed after the facilities arrived. In the case of Saint
Bernard Parish, a blue-collar suburb of New Orleans, the proportion of African Americans
dropped precipitously following the siting of two oil refineries in Chalmette and Meraux and the
surrounding communities became predominately white and middle class. Today, in addition to a
desire to reside in neighborhoods made up of one’s own race or ethnicity, residents are moving
into these towns in to be closer to their jobs. Similarly, new residents are moving into Lafourche
Parish to live in the town where they work. When examined in more detail, we find that Native
American and Hispanic residents are moving into communities in south Lafourche where the oil
industry is a major employer.

7.3 Public Policy and the Role of Government

A public policy agenda should consist of practical, attainable programs that involve tough
decisions about what will and will not be done by particular groups and agencies (Getches and
Pellow 2002). With regard to environmental equity and public policy, the cornerstones of
environmental justice, we need to be careful to differentiate between issues related to racism and
classism and those related to race and class. It would be impossible for most people and
institutions to eliminate racism and classism, no matter how well intentioned they are. Race and
class, on the other hand, can be precisely and unambiguously identified and thus factored into a
workable, operational public policy agenda. For an environmental justice agenda to succeed in
achieving environmental equity, it should not add another level of ambiguity to the dialog, but
should instead set forth a clear priority within environmental policy (Bryner 2002).

Racism and classism, undeniably important social concerns, cannot be operationalized
into an effective environmental justice agenda. Are environmental inequities the result of
intentional racism? We cannot confirm or deny this with any degree of certainty. Are there racial company owners, business leaders, and politicians? Clearly, this answer would have to be “yes.” This is likely very much true in terms of historical development. But, can we say that these attitudes have resulted in intentional discrimination? This is very likely not the case.

Economics drives industry. Especially today, where individuals do not single-handedly run large corporations, business leaders would not survive if they allowed racist agendas to override economic considerations. Corporations are run in boardrooms.

This brings us to the question of unintentional racism and classism. The problem is that ignoring racial issues in industrial siting is just as much a form of racial discrimination as the direct targeting of minorities. To ignore the problem is to turn a blind eye, which is essentially saying that race does not matter. Now, let’s carry this one step further. If a community considered for development has resources (either in terms of political power or finances) or if its residents are influential in some way, then that neighborhood has the means to stand up and say that industry cannot site there. This is the classic “Not In My Backyard” or NIMBY phenomenon. While not directly racist or classist, the community often perceives the results as such. An environmentally just public policy needs to acknowledge race and class as integral components of the environment, while not allowing the dialog to shift to issues of racism and classism. Such a shift would not only add a level of ambiguity to the dialog, but would focus attention on the question of discriminatory intent, which ultimately works against the environmental justice movement.

While focusing in on issues of race and class, an effective environmental justice policy also needs to acknowledge that people experience the impacts of industry most intensely at the local level. The impacts are thus place-specific. This research, by identifying critical areas
where minority groups may be exposed to multiple risks through consumption of potentially contaminated aquatic and terrestrial wildlife, provides but one example of how environmental equity research is able to move beyond the traditional residential exposure model towards a more place-specific model that includes the social and cultural context. The same level of protection should be assured for residents who choose to hunt or fish in areas proximate to potentially hazardous facilities as for residents living near potentially hazardous facilities. This should be true of all population groups, from Houma Indians trapping in the wetlands of south Lafourche to African Americans fishing in an urban waterway. A more inclusive environmental justice agenda needs to acknowledge and protect the health and safety of the ecosystem upon which a wide variety of people depend for subsistence, traditional, cultural, and religious purposes.

Finally, an environmentally just public policy should assure that residents living in potentially hazardous communities receive the same level of protection that residents of non-hazardous communities receive. It is important, for example, that agencies with oversight be they local, state, or federal, remain vigilant and assure that no one area comes to dominate the hazardscape of the region, especially if that area is currently home to disproportionately large minority or low-income populations. The presence of existing facilities does not by itself justify the siting of additional facilities.

These protections are not dependant upon whether the community or the facility arrived first. Programs should assure that minority and low-income residents of potentially hazardous neighborhoods have access to accurate and up-to-date data about neighborhood health risks so that individuals who choose to trade risk for affordable housing or nearness to the workplace are not acting on incomplete data. The fact that minority residents may in fact be moving into communities where potential hazards are already present does not lessen the responsibility of
governmental agencies, nor does the fact that minority or low-income residents may have moved into a potentially hazardous neighborhood sometime in the past, with or without knowledge of the degree of hazardousness. That community is still entitled to consideration under the federal environmental justice implementation guidelines.

7.4 Towards a New Theoretical Framework

Environmental equity is one of the most contentious social issues to arise since the massive social upheavals of the 1960s. Even today, when much of the literature “conclusively” finds that environmental inequities are pervasive in society, a large number of researchers doubt or outright reject the very notion of environmental inequity. For every case study that finds evidence of inequity, there are studies that find opposite results. As much as skeptics would like to claim that this represents a repudiation of the very idea of environmental equity, I believe that this is not the case. I believe that these variations represent shortcomings in the in one of two major areas, an inadequate theoretical framework and inadequate methodologies built off of this framework.

First, there is no real theoretical framework that defines environmental equity. Much of this lack of consensus is due to the fact that, as Feng Liu points out, environmental equity analysis as a field of inquiry “is still in it’s infancy and is in the pre-paradigm stage of the normal scientific development process” (Liu 2001). I would argue that, far from moving towards a clear scientific paradigm, environmental equity research has become much more ambiguous in recent years, leading to a set of unclear goals.

In fact, I would claim that most environmental equity studies begin with a faulty premise. Namely that equity exists as an absolute. That is to say that it either does or does not exist, depending on one’s point of view. We have a series of competing definitions with any number
of groups, from politicians to academics to social activists, attempting to lay claim to a particular definition. Barbara Allen once wrote about the vast stretch of petrochemical plants stretching between New Orleans and Baton Rouge that:

The government proudly refers to the region as the Industrial Corridor, a glowing success story of industrial in the state. Company representatives often call it the chemical corridor, laying claim as one of the region’s most powerful political constituents. Many residents, however, call it Cancer Alley, referring to the multitude of health problems its citizens face on a daily basis. People speaking at environmental justice hearings can be readily identified with their political group simply by what they call the landscape. (Allen 2003: 28)

Similarly, we can readily identify a person’s “political group” by how they speak of and define environmental equity. Many environmental justice activists speak, for example, of intentional and unintentional racism in the siting of potentially hazardous facilities in low-income and minority communities. Industry leaders speak of facility siting in terms of economics, saying that to include racist elements in the planning process is counterintuitive and not good business policy. Academics speak of environmental equity, white privilege, and notions of justice in the abstract. An effective environmental equity framework must both acknowledge and move beyond these various parochial definitions and develop a set of precepts that should be a clear priority within environmental policy.

Based upon the results of this dissertation, I have developed a set of six tenets that form the basis of a new theoretical framework for environmental equity research, one that moves research beyond the traditional residential exposure model towards a practical, attainable, place-specific model. First, this new framework must be industry-oriented, not facility-oriented, acknowledging the interconnectedness of the entire industrial landscape. When making siting decisions, industry must acknowledge that that the siting of a single facility has other impacts on the community both upstream and downstream. Just as the producer of hazardous waste is
responsible for that waste from cradle-to-grave, industry should have a responsibility to track the
potential hazards of their operation beyond the facility fenceline.

Second, this framework should require multiple methodologies to reach conclusions on
potential environmental equity impacts. Because specific methodologies will find only what
they are designed to find, a multi-method approach will enable researchers to uncover new
potential concerns and verify existing results. A proximity-based analysis, for example,
acknowledges the total number of facilities impacting a community and thus serves as an
effective measure of quality of life standards in a community. A risk-based analysis, on the other
hand, acknowledges overall toxicity and is a more effective measure of the health risks
associated with a community. Quality of life and quality of health are not mutually exclusive
and an effective environmental equity agenda needs to acknowledge this.

Third, the new theoretical framework should enable a more community-oriented
approach to environmental equity by use of a cumulative hazardscape model. A hazardscape of
the entire geographical region enables local residents to locate specific points on the map, be
they schools, playgrounds, or the “local fishing hole,” and ascertain the potential hazardousness
of this location. In communities where natural resource collection is an important activity, for
example, the hazardscape model allows officials and/or residents to make a quick determination
of potential risk to wildlife and fisheries at any specific location.

Fourth, any environmental equity framework needs to acknowledge the existing toxic
burden in the community. While the focus of this dissertation was on one specific industry, the
analysis can be “stacked” with other industrial hazardscape models to create a model of total
hazardousness. Such a methodology acknowledges the different roles that industry and
government play in creating an environmentally equitable landscape. At the industry level,
specific operators are able to study the potential impacts of a proposed facility within the industry-level hazardscape, allowing them to gauge the impacts that are within their jurisdiction. When we scale up, regulatory agencies can make determinations based upon total toxic burden on the community. Industry operates within its own narrow spectrum, but they must acknowledge the full impact of their industry. Governmental agencies must acknowledge the full impacts of all industry.

Fifth, any effective environmental equity framework must acknowledge all industry impacts in the study area, not only Toxic Release Inventory sites. The TRI tracks manufacturing facilities that process more than 25,000 pounds or use more than 10,000 pounds of any one of the 650 TRI chemicals and requires them to report their releases to the USEPA, including emissions from routine processing and/or accidental releases (Dolinoy and Miranda 2004). Though the TRI is one of the most robust data sources available to researchers, it presents an incomplete view of the total industrial hazard surface. Specified industries are exempt from reporting their releases to the TRI, potentially creating the false impression that certain neighborhoods have no potential risks. In addition, the TRI is a measure of actual releases whereas environmental equity studies should identify all potential sources of community-level risk. Several smaller facilities operating beneath the TRI reporting thresholds may pose as much risk to a community as a single industry operating beyond these thresholds.

Finally, an effective environmental equity framework must acknowledge and account for the fact that individuals do sometimes move into potentially hazardous communities. The “chicken or egg” question is important in that it sets in motion a different set of public policy responses. If an observed inequity is determined to be the result of disproportionate siting, then policy makers need to examine and possibly revise the existing permitting procedures. If a
potentially hazardous neighborhood has become disproportionately populated by low-income and minority residents through time, then policy makers would need to approach the problem in different ways. In these cases, the role of policy might be confined to ensuring that residents have access to data about neighborhood health risks so that individuals who choose to trade risk for affordable housing are not acting on incomplete data (Pastor et al. 2001).

As an alternative to the existing facility-oriented approach, this new theoretical framework and the methodologies used to develop it are both practical and attainable. The process requires industry to look beyond its fenceline and acknowledge the full impacts of its activities on local communities, while recognizing that these impacts are limited. Regulatory agencies bear greater responsibility in assuring that the risks and hazards of the industrial landscape are justly and equitably distributed. By acknowledging the full environmental impacts of industry across an entire region, the process becomes transparent, fulfilling one of the USEPA’s stated environmental justice goals of providing citizens with more complete information about their communities. By shifting focus from facility-oriented to industry-oriented environmental equity, the process ultimately becomes community-oriented.
On August 29, 2005 at 6:10 a.m. CDT, Hurricane Katrina, a Category 4 storm, struck southeast Louisiana, unleashing untold devastation upon coastal communities in its track. As the storm tracked up the eastern Louisiana coastline, a 26 foot storm surge combined with the strong winds of the hurricane eye wall severely damaged communities in Plaquemines, Saint Bernard, and eastern Saint Tammany Parishes. To compound matters, the high winds, storm surge, and heavy rainfall associated with Hurricane Katrina caused several spectacular levee failures along the Lake Pontchartrain flood protection system, flooding approximately 80 percent of New Orleans and a portion of Jefferson Parish.

Less than one month later, on September 24, Hurricane Rita, became the second major hurricane of the season to make landfall in Louisiana. The strongest storm to ever enter the Gulf of Mexico, Hurricane Rita caused significant damage to the coastal region of Louisiana. Though the storm made landfall at the Louisiana-Texas border, the levee system of New Orleans, which had already sustained heavy damage from Hurricane Katrina, was overwhelmed by the outer bands of rain from Hurricane Rita. As early as September 23, water began to pour through breaches in the patched levees in and around New Orleans.

In the wake of these storms, concerns over widespread chemical contamination in the floodwaters began to surface, with government officials speaking of a potential “toxic gumbo” of biological and chemical hazards. Indeed, the storm surge and high winds of Katrina and Rita not only destroyed homes and businesses, but industrial facilities and pipelines as well. In the days following the passing of the storm, the National Response Center was notified of more than 200 hazardous materials releases and additional hazardous material problems. In addition, the
National Oceanic and Atmospheric Administration (NOAA) had been notified of more than seventy salvage operations that had some type of pollution threat following Hurricane Katrina (Pine 2006).

Initial monitoring efforts by the USEPA revealed dozens of contaminants, including bacteria, lead, arsenic, and chromium in water samples, with eight contaminants exceeding minimum risk levels for drinking water (Wilson 2006). Later sampling efforts have shown that the level of these contaminants in floodwater sediments has generally declined, not surprising given the volatility of soluble petroleum oils and fuel constituents (Reible et al. 2006). In general though, initial concerns about a widespread “toxic gumbo” have not been supported by sampling and analyses conducted by USEPA and LDEQ (Walsh et al. 2006). As one study concludes, however, although acute generalized hazards have not been identified, several hurricane-impacted communities may face localized areas of more serious contamination (Reible et al. 2006). Indeed, even as fears of a “toxic gumbo” of chemical and biological hazards began to dissipate, residents and companies continued to discover and report storm-related hazardous releases to the National Response Center long after the storms had passed.

8.1 Hurricane Katrina and Petroleum-Related Releases

The Gulf of Mexico is the nation’s largest source of oil and gas production and much of the infrastructure supporting this production is located in those coastal communities severely impacted by Hurricanes Katrina and Rita. Both the MMS and the NRC provide data that shows a number of major and minor releases attributable to damaged oil-related infrastructure, including pipelines, storage tanks, and processing facilities. The MMS estimated that 3,050 of the Gulf’s 4,000 offshore oil platforms and 22,000 of 33,000 miles of Gulf pipelines were in the direct path of either Hurricane Katrina or Hurricane Rita. In total, 115 platforms were destroyed and 52
were damaged as the storms moved across the OCS. By January of 2006, 183 damaged pipelines, including 64 large-diameter pipelines, and 418 minor pollution incidents on the OCS had been reported (MMS 2006). Federal agencies define minor pollution incidents as spills of less than 500 barrels of oil that do not reach the coastline.

In addition, NRC received 535 reports of releases categorized as being caused by hurricane, natural phenomenon, or flooding in the between August 28, 2005 and October 31, 2005 (NRC 2005). This time period encompasses Hurricane Katrina and Hurricane Rita, as well as one additional month of recovery efforts. The NRC received notification of nearly fifty large oil spills in the nearshore environment. Spills from stationary facilities affected the immediate area around the sites while breaches in pipelines generally affected the coastal marshes (Pine 2006).

Despite the numbers of releases reported to both the MMS and NRC, environmental sampling efforts reveal that few locations had individual petroleum-related constituent concentrations exceeding either USEPA or LDEQ soil screening levels. Furthermore, LDEQ determined that the polycyclic aromatic hydrocarbons found in the floodwater sediments were of the type commonly found in petroleum products, exhaust from automobiles and asphalt. They concluded that the elevated levels of petroleum-related chemicals likely were attributable to surface runoff from streets and parking lots as well as releases of from vehicles submerged under floodwaters (Walsh et al. 2006). This is clearly a generalization and one that would likely not hold true across the entire hurricane impact zone.

An initial analysis of the impact of Hurricanes Katrina and Rita on Lafourche, Jefferson, and Saint Bernard Parishes will reveal that each parish was uniquely impacted by the storms and that several localized areas of potential contamination can be located. All three parishes were
declared federal disaster areas, though in fact the issuance of a federal disaster declaration does not require that the parish suffer a large amount of damage. The parish is eligible for federal disaster assistance if the countywide damages are at least $2.77 per capita (Jarmin and Miranda 2006).

The Federal Emergency Management Agency (FEMA) established localized damage estimates for each impacted parish based on remote sensing data. I obtained observation data over the period from August 30 to September 10, 2005 and coded using the following damage categories (FEMA 2005):

- **Limited Damage** – Generally superficial damage to solid structures (e.g., the loss of tiles or roof shingles), some mobile homes and light structures are damaged or displaced.
- **Moderate Damage** – Solid structures sustain exterior damage (e.g., missing roofs or roof segments, some mobile homes and light structures are destroyed, and many are damaged or displaced.
- **Extensive Damage** – Some solid structures are destroyed, but most sustain exterior damage (e.g., roofs are missing interior walls exposed), most mobile homes and light structures are destroyed.
- **Catastrophic Damage** – Most solid and all light or mobile structures are destroyed.
- **Flooded area** – Area under water.

FEMA assumes unclassified areas are either undeveloped or undamaged. Note that in the following preliminary damage analyses, I take the FEMA estimates as given. Future research will likely reveal that FEMA overestimated the level of damage in some cases while underestimating it in others.

**8.1.1 Lafourche Parish**

The one-two punch of Hurricanes Katrina and Rita devastated the communities of southeast and southwest Louisiana respectively. Fortunately for the residents of Lafourche Parish, the storms spared their communities from the worst of the damage as the right front
quadrant of Katrina passed to the east of Lafourche and the right front quadrant of Rita passed to the west. Even as several spectacular levee failures occurred in Jefferson, Orleans, Plaquemines, and Saint Bernard Parishes, to the east of Lafourche, during Hurricane Katrina, the south Lafourche levee system held. In Terrebonne Parish, to the immediate west of Lafourche, Hurricane Rita’s storm surge breached virtually every levee (URS Group 2006). Even as the Rita-related storm surges pushed water levels outside the south Lafourche levees to the very top of the system, the south Lafourche levees again held (LTCR 2006). As a result, coastal flooding had minimal impacts on the communities inside the South Lafourche levee system (Larose, Cutoff, Galliano, and Golden Meadow).

Areas outside of the protection levees, however, did experience surge-related flooding during both storms. In particular, some infrastructure damage and flooding occurred at Port Fourchon (Figure 110) and along the southern portion of Louisiana Highway 1 in south Lafourche during both storms. In addition, according to FEMA, Katrina-related flooding occurred along the largely undeveloped central eastern border of the parish at Lake Salvador At Lake Salvador, the high water line extended anywhere from 150 to 3,000 feet landward of the lake (URS Group 2006). In addition, several low-lying structures in Larose outside the levee system reportedly experienced a storm surge during Hurricane Rita (URS Group 2006 rita). Similarly, on the western border of the parish, significant flooding occurred outside the levees in Pointe-Aux Chenes. Finally, communities adjacent to the Intracoastal Waterway, including Leeville, saw localized flooding as Hurricane Katrina’s storm surge raised water levels in the canal (LTCR 2006).

While the south Lafourche levee system protected the interior communities from the storm surges and flooding that came to define Hurricanes Katrina and Rita, storm-related winds
Figure 110 Hurricane Katrina Damage Estimates, Port Fourchon, Lafourche Parish, Louisiana
still caused significant damage (Figure 111). According to the Louisiana Long-Term
Community Recovery planning team, the storms damaged more than 5,000 homes as high winds
damaged and tore roofs off buildings throughout the parish. In addition, localized flooding
occurred within the levees due to damaged storm drainage systems, particularly around Larose
(LTCR 2006).

The direct physical damage caused by Hurricanes Katrina and Rita represent only one
aspect of the storm-related impacts. As noted above, chemical releases resulting from damaged
infrastructure could potentially result in large-scale environmental contamination. While several
oil spills occurred from storage tanks located in the southern third of the parish, very little data
exists to quantify the total amount released. The largest hurricane-related spill in Lafourche
Parish occurred at Port Fourchon, where Chevron reported a release of approximately 53,000
gallons of product (Pine 2006).

Initial analysis reveals that the National Response Center was notified of approximately
seventy petroleum-related spills in Lafourche Parish from August 28 through October 31 of
2005. Most of the incidents reported involved sheens of unknown origin on the local waterways,
followed by releases from damaged waterborne vessels and pipelines. Storage tank and fixed
facility releases round out the five most common release types reported in Lafourche Parish. The
causes of these incidents varied as well. Reflecting the fact that a large percentage of the
reported spills were of unknown origin, most of the causes were also unknown. Most of the
incidents with known and reported causes resulted from direct hurricane damage (listed as either
“hurricane” or “natural phenomena” by the NRC), followed by operator error or equipment
failure.

Geographically, the onshore incidents reported in Lafourche Parish centered on the
southern half of the parish, particularly Port Fourchon and Golden Meadow. This is not
Figure 111 Hurricane Katrina Damage Estimates, Golden Meadow, Lafourche Parish, Louisiana
surprising given that the majority of facilities are located in south Lafourche. In addition, the storm surge and wind levels were coincident with the density of oil-related infrastructure, being greatest at the coast and decreasing further inland. It is important to note that NRC reporting often only includes information on the city nearest to the location of the spill, which is not always the actual site of the spill. For this reason, a more fine-grained geographical analysis of the NRC data is not possible at this time. Given time, as more of the locations and causes of the various spills become apparent, it may become possible to analyze effectively the social and economic makeup of the impact zones.

8.1.2 Jefferson Parish

Jefferson Parish, located to the east of Lafourche Parish and thus closer to the center of the hurricane, suffered significantly more surge-related flooding than Lafourche Parish during Hurricane Katrina, though it fared much better than Orleans, Plaquemines, and Saint Bernard Parishes, its neighbors to the east. As Katrina made landfall approximately 20 miles east of Jefferson Parish, the area was buffeted with wind gusts of 100 to 125 miles per hour. In addition, storm surges of up to 15 feet severely flooded areas in the southern part of the parish.

Katrina-related flooding was concentrated in two areas. First, along Lake Pontchartrain on the east bank of the Mississippi River, heavy rains and overtopping of the Lake Pontchartrain levees resulted in flooding in the northernmost sections of the parish. In addition, sections of Old Jefferson and Old Metairie flooded after water from Lake Pontchartrain flowed westward from Orleans Parish along Jefferson and Airline highways through a gate in the Hoey Canal. Much of the flooding in Jefferson Parish can be attributed to the canal and pumping systems being overwhelmed and the failure of parish officials to safely provide for operations personnel at the pumping stations. Despite significant hurricane-related damage to the entire drainage
system, from outfall canal erosion, levee erosion, to pumping station operation failures, the storm protection system in Jefferson Parish did not fail. Nevertheless, portions of the parish’s east bank did suffer surge-related flooding due to failures of Orleans Parish’s levee system.

Damage from Hurricane Katrina was fairly limited on the west bank of Jefferson Parish because, as with Lafourche Parish, it was located in the southwest quadrant of the wind field created by the storm (Figure 112). The southern portion of the parish is also covered by marshland and swamp, which has a dampening effect on coastal surges as they move inland. Despite this, the central wetlands of the parish’s west bank did experience surge-related flooding along three major water bodies, the Intercoastal Waterway, Lake Cataouatche, and Lake Salvador (Figure 113).

Special notice should be made of Grand Isle, a populated Jefferson Parish barrier island located on the Gulf of Mexico. As Hurricane Katrina tracked farther inland on its northeastern path, the water in Barataria Bay was pushed southward over Grand Isle. Water elevations were the highest in this portion of the coastal area, measuring between 5.8 and 8.9 feet (URS Group 2006). This surge combined with high winds caused significant damage to all structures and facilities on the island (Figure 114).

On September 27, Hurricane Rita struck the western part of Louisiana, bringing sustained winds of 45 miles per hour to Jefferson Parish. Storm surges again flooded areas of southern Jefferson Parish, particularly around Jean Lafitte and Barataria, where FEMA has reported high water marks approaching six feet. Again, Grand Isle saw significant storm surges, this time in the four to five foot range (URS Group 2006).

When all was said and done, approximately 77,989 Jefferson Parish homes incurred significant storm-related damage from both flooding and high winds. Estimates range from 7,000
Figure 112 Hurricane Katrina Damage Estimates, Avondale, Jefferson Parish, Louisiana
Figure 113 Hurricane Katrina Damage Estimates, Barataria, Jefferson Parish, Louisiana
Figure 114 Hurricane Katrina Damage Estimates, Grand Isle, Jefferson Parish, Louisiana
to 19,000 flooded homes, concentrated on the East Bank in North Kenner and Old Metairie, and on the West Bank in the outlying areas of Jean Lafitte and Grand Isle. Wind damage occurred throughout the parish, resulting in approximately 27,000 FEMA blue roof installations (LTCR 2006).

Initial analysis reveals that the National Response Center received notification of approximately fifty-seven incidents occurring in Jefferson Parish from August 28 through October 31 of 2005, most of which again involved sheens of unknown origin on the local waterways. Most known releases occurred at offshore oil platforms off the coast of Grand Isle. Onshore, damaged waterborne vessels presented the greatest volume of reports, followed by fixed facility, pipeline, and storage tank releases, in that order. Again, reflecting the fact that a large percentage of the reported spills were of unknown origin, most of the causes were also unknown. Direct hurricane damage (listed as either “hurricane” or “natural phenomena” by the NRC) and equipment failure resulted in most of the incidents with known and reported causes. It is important to note that the hurricane may have resulted in other secondary releases. For example, NRC has reports on two partially submerged vessels found in Jefferson Parish waterways by USCG pilots. The report indicates that “natural causes” may have caused one of the vessels to submerge. It is also interesting to note that the NRC received a complaint that two businesses were dumping waste oil into the Harvey canal. While it can not be proven, this would suggest that some business owners were taking advantage of the hurricanes to dispose of their own waste products.

Geographically, the onshore incidents reported in Jefferson Parish were centered on the Mississippi River, with releases reported on both banks. However, offshore oil platform releases in the Gulf of Mexico impacted Grand Isle. The NRC received the vast majority of hurricane-
related release reports in the months that followed Hurricane Katrina, although they continued to receive reports through the end of 2005 and into 2006. The lack of reports from the central wetlands of Jefferson Parish suggests that the region suffered far fewer storm-related petroleum releases than other areas impacted by the hurricanes. It could also be a function of the lack of development across much of the area. As noted above, a fine-grained geographical analysis of the NRC data is not possible at this time given the number of unknown releases as well as the uncertainty in the location of the release sites.

8.1.3 Saint Bernard Parish

Although officially determined to be a Category 3 hurricane at landfall on August 29, 2005 at 6:10 a.m. CDT, Hurricane Katrina still produced a Category 5 surge and winds in excess of 125 miles per hour in Saint Bernard Parish. Hours before landfall, Hurricane Katrina’s storm surge pushed into Lake Borgne and began to pound the levees along the eastern edge of the parish, in the process destroying all of the fishing villages located outside of the levee system, including the Isleño community of Yscloskey (Figure 115). According to FEMA, locating high water marks outside of Saint Bernard’s levee system was difficult due to the level of devastation and the lack of structures with which to measure water levels. Two high water marks were located with surveyed elevations of 17.1 feet in Reggio and 17.7 feet in Yscloskey (URS Group 2006). This would be the first of several devastating impacts of Hurricane Katrina in Saint Bernard Parish. By 5:00 a.m. CDT, the outer set of levees in the parish began to fail, causing extensive flooding of the wetland areas on the eastern half of the parish (Figure 116). The storm surge continued to move westward through the wetlands toward the western set of levees, those protecting the heavily developed areas of the parish. By 8:30 a.m. CDT these levees failed as well and floodwaters poured into the neighborhoods and communities of Saint Bernard Parish.
Figure 115 Hurricane Katrina Damage Estimates, Ysckoskey, Saint Bernard Parish, Louisiana
Figure 116 Hurricane Katrina Damage Estimates, Toca, Saint Bernard Parish, Louisiana
Figure 117 Hurricane Katrina Damage Estimates, Chalmette, Saint Bernard Parish, Louisiana
(Figure 117). The storm surge continued to move across Lake Borgne and up the Mississippi River Gulf Outlet (MRGO) as well, where it overtopped the levee along the northern edge of the urbanized area of Saint Bernard Parish. FEMA estimates that levees in the Saint Bernard Basin, which includes the Lower Ninth Ward in Orleans Parish, were overtopped by 5 to 10 feet of water (URS Group 2006). Sometime between 7:30 and 8:00 a.m. CDT, the surge reached and broke through the levees on the Industrial Canal in New Orleans’ Lower Ninth Ward. The storm surge breached the levee in one location on the Orleans Parish side and two locations on the Saint Bernard Parish side.

By the time Hurricane Katrina had passed, the entire populated area of Saint Bernard Parish was inundated with 14 foot floodwaters spilling over and through the levees to the east, west, and north. These floodwaters would remain for approximately three weeks following landfall (LTCR 2006). To further compound the problem, on September 24, an 8 foot storm surge from Hurricane Rita breached the recently-repaired levees, and combined with 6 to 12 inches of rainfall to again cause widespread flooding in the Saint Bernard Parish, despite the fact that landfall for this storm was far to the west on the border of Louisiana and Texas (LTCR 2006).

With the exception of Orleans Parish, no other area of Louisiana suffered more Katrina-related loss than Saint Bernard Parish. In all, the storm killed 127 Saint Bernard citizens, displaced about 68,000 people, and destroyed or rendered uninhabitable 100 percent of the parish’s housing stock. As with several neighborhoods in New Orleans, Saint Bernard Parish has yet to rebuild following the storms. According to the Louisiana Long-Term Community Recovery planning team, nearly every citizen in the parish evacuated and less than 8 percent had returned as of March 2006, and most of these continue to live in trailers (LTCR 2006).
The physical damage and loss of property in Saint Bernard Parish represents but one impact of Hurricane Katrina. On September 3, during the flooding after Katrina, representatives from the Murphy Oil USA Meraux Refinery notified the federal government that over one million gallons of crude oil escaped from a 250,000-barrel above-ground storage tank. Floodwaters dislodged Tank 250-2, holding only 85,000 barrels of oil when Hurricane Katrina made landfall, and it floated 33 feet to the east and 4 feet to the north, then settled and ruptured, releasing crude oil through the failed berms surrounding the tank (USEPA 2006). The result was the largest oil spill associated with Hurricane Katrina. While USEPA and USCG officials have determined that they recovered a significant amount of product, they also acknowledge that residues remain on properties and in homes (ATSDR 2005). According to recent estimates, clean-up crews recovered approximately 305,000 gallons and contained another 196,000 gallons. Officials estimate that 312,000 gallons evaporated leaving 6,000 gallons unaccounted for (Pine 2006).

Initial estimates from the U.S. Department of Health and Human Services Agency for Toxic Substances and Disease Registry (ATSDR) show that the released oil had impacted approximately 1,800 homes and an undetermined number of other structures in an area of approximately one square mile of Chalmette (ATSDR 2005). The areal extent of the spill, however, has been the subject of both public and legal debate. Murphy Oil’s first map of the impact area was extremely crude, showing the released oil following a straight path down one street, then making a 45 degree turn and heading down another thoroughfare. Significantly, this map shows that the oil spill avoided much of the surrounding residential neighborhoods.

This release zone was eventually expanded to show the spill spreading in a more flow-like pattern, and impact zones were divided into a number of concentric zones flowing outward
from the damaged storage tank via roadways and canals into the surrounding neighborhoods in Chalmette. The extent of contamination in these zones have continued to be the subject of much debate, with a court judgment eventually expanding the potential impact area beyond those established by the results of sediment sampling by the USEPA.

Though the Murphy Oil spill was clearly the most devastating hazardous incident in Saint Bernard Parish, it was not the only one. National Response Center records indicate that thirty-five accidental incidents were reported in Saint Bernard Parish from August 28 through October 31 of 2005, with nine of these occurring in the Gulf of Mexico. Over two-thirds of the reported onshore releases occurred in either Chalmette or Meraux, clearly a function of the presence of the two large refineries in these communities. The remaining one-third of the reported releases was equally spread between Delacroix, Shell Beach, Saint Bernard, as well as Toca and Yscloskey, the rural communities that were home to the two large gas processing plants in the parish.

Unlike the other two parishes examined here, we know the dominant release types and causes in Saint Bernard Parish. Clearly a function of the presence of the two large refineries, the NRC reports that fixed facilities were responsible for most of the releases in Saint Bernard Parish, followed by storage tank and pipeline releases. In total these three sources account for twenty-five of the thirty-five NRC reported incidents. Of the incidents with known and reported causes, the NRC listed only direct hurricane damage (categorized as either “hurricane” or “natural phenomena”) and equipment failure, with the vast majority being hurricane-related. It is important to note that the hurricanes may have resulted in releases listed as “unknown” on the NRC reports. For example, NRC has reports that the Chalmette refinery released oil when operators were forced to shutdown for prior to the arrival of Hurricane Katrina. While the
hurricane did not cause the spill directly, the spill would not have occurred had Katrina not passed through the area.

8.2 Environmental Equity and Floodwater Sampling Techniques

In the days and weeks following Hurricane Katrina, USEPA and LDEQ initiated an unprecedented investigation into the floodwater sediment contamination in residential neighborhoods impacted by the storm. Ultimately, the agencies sampled and tested over 1,800 residential locations for the presence of some 200 individual chemicals (Walsh et al. 2006). The sampling process proceeded in four distinct phases, each one more geographically concentrated. The first phase involved taking 450 samples from areas where analysts determined the soils to be “most likely” contaminated. This included areas with noticeable soil discoloration or odors, as well as drainage paths such as curbs or storm drains. The second phase focused on the Lower Ninth Ward of New Orleans as well as Saint Bernard Parish, the areas that suffered the most serious flooding, taking an additional 280 samples from these areas. The third phase involved taking an additional 147 composite samples from forty-three specific flood-impacted residential areas where previous sampling found concentrations of arsenic, lead, or petroleum indicators in excess of risk management screening levels (Walsh et al.2006). Finally, USEPA gathered samples from 586 locations in Orleans and Saint Bernard parishes based on a 200 foot grid. In this final stage, USEPA was unable to collect samples from an additional 1,090 locations that had either insufficient sediment levels or were not residential.

From an equity perspective, it is difficult to argue with the methods utilized in this endeavor. As one report noted, USEPA and LDEQ have managed to design, implement, and interpret the results of one of the largest urban sampling studies ever conducted and have made both their methods and results transparent and available to the public on their websites (Walsh et
The sampling surface as designed cast a wide net then focused in on areas with the greatest risk of contamination. Under federal environmental justice guidelines, the agencies should utilize the same sampling methodology in all communities, regardless of race or income, which they do. From a social standpoint, there is no bias inherent in the design of the study.

However, there is another side to this story. With any sampling method, no matter how well designed, there is a degree of uncertainty. Some contaminated areas, for instance, may not have been sampled. In other words, random sampling would possibly find uncontaminated areas in even the most heavily contaminated homes (Kaltofen 2007). It is important to stress that, given the study design, any contaminated sites not captured by the sampling surface does not represent an inherent environmental injustice. It is a risk equally shared by all. So, what options are left to property owners who feel that their property may have been contaminated? Clearly, governmental agencies should not be expected to conduct a site-by-site analysis of the entire risk surface. Such a methodology would be far too costly, and perhaps more importantly, far too time consuming. Homeowners are left then with the option to pay for their own individual site assessments. This is where the responsibility and cost would in fact fall disproportionately on the poor (Walsh et al. 2006). Due to a lack of resources, we would expect to see little or no additional testing conducted in economically depressed areas.

Thus we have two sampling surfaces operating concurrently. The first is a governmentally-sanctioned environmentally just surface, one that is constrained however, by both time and money. This surface is generally devoid of social context. The second sampling surface can be considered a function of social privilege. Ultimately, this second surface gains legal legitimacy as it is entered into the public record, and then has the potential to reshape the official map of the disaster. As we saw in the case of the Murphy Oil spill, the oil company
initially released a map showing a rather limited impact of the spill. The scientific sampling study extended this risk surface based upon a sampled sediment analysis. Finally, the courts extended the impact zone even further as a result of public input and individual property sampling.

8.3 The Need for Further Analysis

Only the future will allow us to truly grasp the impacts of Hurricanes Katrina and Rita on the landscape and communities of southeast Louisiana. As the hurricane recovery process moves into the rebuilding phase, two important questions arise. Which residents will return to their hurricane-damaged communities and what are the risks they face in doing so? The answers to both of these questions may be closely tied to the socio-economic status of the neighborhoods and the resources available to residents.

Clearly Hurricanes Katrina and Rita have exposed deep racial and economic divisions in New Orleans. Less clear is the cultural impact of these storms on the smaller ethnic communities of southeast Louisiana. The Houma Indians and Isleños represent but a sampling of the cultural gumbo that made up southeast Louisiana before the storms arrived and forever altered the human landscape of the region. They also represent a portion of the culture of southeast Louisiana at risk of being forever lost as they come to grips with the devastation of their communities. In Saint Bernard Parish alone, the storm surge destroyed the homes of 650 Houma tribal members, and like much of south Louisiana’s lower income residents, many of these residents had little or no insurance (Norrell 2005). In addition, most of Saint Bernard Parish’s Isleño community resided outside of the protection levees in small towns and fishing villages that were either destroyed or damaged sufficiently enough to make them uninhabitable. Like other residents of Saint Bernard Parish, many Isleños say that they will return and rebuild
their communities (Burnett 2007). As of March 2006, however, only 8 percent of the parish’s pre-Katrina population had returned (LTCR 2006).

Those residents who do return or rebuild in hurricane-impacted areas must contend with the potential contamination of their homes and communities. In some areas, the potential hazards are well documented. In Chalmette and Meraux, for example, industry representatives, federal and state environmental agencies, and outside contractors hired by lawyers in a class action lawsuit against Murphy Oil USA undertook several sediment sampling analyses. Had the original Murphy Oil USA spill map been accepted as the official impact zone, thousands of residents may have moved back into potentially hazardous neighborhoods, unaware that the crude oil released from the Meraux refinery had saturated their homes. While the exact delineation of the impact zone is subject to debate, most residents were aware of the potential risks to their communities.

Other communities may not fare as well. Without additional sediment sampling, smaller localized petroleum and chemical spills that may have slipped through the USEPA sampling surface could go unreported. Without adequate resources, low-income individuals who suspect sediment contamination would be unable to receive additional sampling of their properties. Finally, these smaller spills may not draw the attention of the legal community, especially if there is not the potential for a large class action payoff. Let us remember that the majority of hazardous releases reported to the National Response Center in the days and weeks following Hurricanes Katrina and Rita were of unknown type and cause. As residents begin to return and rebuild in hurricane-damaged neighborhoods, relying on existing sediment sampling results, one important question remains. How many of these unknown spills have been identified and analyzed?
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410


VITA

Scott Allan Hemmerling was born December 18, 1969, in Buffalo, New York. He completed his undergraduate studies in 1992 at the State University of New York at Buffalo with a Bachelor of Science degree in environmental studies with a minor in geography. In 1999, he completed his Master of Science degree in the College of Urban and Public Affairs at the University of New Orleans. In August 1999 he began his doctoral studies in the Department of Geography and Anthropology at Louisiana State University where he will complete the Doctor of Philosophy degree in May of 2007. Mr. Hemmerling is currently employed as a geographer with the U.S. Geological Survey’s National Wetlands Research Center.