

HOPES AND OPPORTUNITIES FOR INNER CITY RESIDENTS:
Temporal and Spatial Assessment of Racial and Socioeconomic Conditions of
Neighborhoods Adjacent to Brownfields in the Detroit Metropolitan Area

BY

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ABSTRACT

Although many environmental justice studies have examined racial and socioeconomic disparities in locations of hazardous waste facilities, no study has examined to date racial and socioeconomic disparities in brownfield locations. In order to fill this gap, this dissertation thus examines the racial and socioeconomic characteristics of neighborhoods adjacent to brownfields in the Detroit region from 1960 to 2000. Based on previous sociological studies, this dissertation argues that deindustrialization in the 1960s and the subsequent concentration of poverty in the 1970s were responsible for socioeconomic disparities in brownfield locations. That is, socioeconomic conditions of neighborhoods adjacent to brownfields (brownfield neighborhoods) are worse than socioeconomic conditions of neighborhoods at a distance from brownfields (non-brownfield neighborhoods). Moreover, it is argued that residential segregation imposed on minorities also was responsible for racial disparities in brownfield locations, meaning that brownfield neighborhoods are minority concentrated compared to non-brownfield neighborhoods.

This dissertation combines the locations of brownfields provided by the Michigan Department of Environmental Quality with 1960, 1970, 1980, 1990, and 2000 US Census data employing distance-based methods. Results reveal that brownfield neighborhoods show a higher concentration of minorities and a lower socioeconomic condition than non-brownfield neighborhoods. In addition, race is the strongest independent predictor of brownfield locations. Longitudinal analyses of brownfield locations from 1960 to 2000

reveal that brownfield neighborhoods experienced greater socioeconomic decline than did non-brownfield neighborhoods. When socioeconomic characteristics in 1970 are controlled, distinctive patterns of subsequent changes in socioeconomic characteristics were found on the basis of initial socioeconomic status. For the wealthiest neighborhoods in 1970, brownfield neighborhoods experienced greater socioeconomic declines than non-brownfield neighborhoods in the 1970s. No significant changes in socioeconomic differences between brownfield and non-brownfield neighborhoods were found in later decades. For second and third wealthiest neighborhoods, brownfield neighborhoods experienced greater socioeconomic declines than non-brownfield neighborhoods in both the 1970s and 1980s. For the most impoverished neighborhoods, no significant changes in socioeconomic differences between brownfield and non-brownfield neighborhoods were found in any decade. Finally, impoverished and minority-concentrated neighborhoods tend to get priority in brownfield cleanup. In summation, findings from this dissertation suggest that deindustrialization led not only to economic and social inequality but also to environmental inequality.

CHAPTER 1: INTRODUCTION

This dissertation assesses racial and socioeconomic conditions of neighborhoods near brownfields in the Detroit metropolitan area. Brownfield development aims at remediation and subsequent redevelopment of such contaminated properties (Fitzgerald and Leigh 2002; Hula 2001; 2002; Simons and Winson 2002). Brownfield development is often expected to improve environmental as well as economic conditions for residents living adjacent to brownfields, but regardless of such optimism, relatively few studies have examined to date the socioeconomic consequences of brownfields, especially those on neighborhoods adjacent to those properties. That is, current brownfield studies have tended to focus on racial and socioeconomic differences between cities and municipalities with and without the presence of brownfields (Greenberg et al. 2000). The above study does not necessarily, however, reveal that brownfields are disproportionately located near impoverished and minority neighborhoods because the unit of analysis of the above study is city. Therefore, this dissertation is to first assess racial and socioeconomic characteristics of neighborhoods adjacent to brownfields. In addition to assessment of the racial and socioeconomic conditions of individuals residing near brownfields for the first time, there are no theoretical explanations of why impoverished and minority populations might be residing near brownfields. Those two are objectives of this dissertation. The study area is a tri-county area (Macomb, Oakland, and Wayne) that was the 1990 definition of the Detroit Primary Statistical Area provided by the US Bureau of Census. The Detroit metropolitan area was selected because this area is the largest urbanized areas in the state of Michigan where the majority of brownfields tend to be concentrated. This chapter will discuss research questions of this study, a brief overview of brownfield development especially in the state of Michigan, and organization of this dissertation.

1-1 Research Questions

In order to fill theoretical and empirical gaps, this dissertation will address three questions. They are: (1) Whether brownfields are located disproportionately in

minority and low-income neighborhoods; and (2) Whether the presence of brownfields is associated with socioeconomic declines in nearby neighborhoods over time; and (3) Whether brownfield cleanup prioritization is associated with racial and socioeconomic conditions of nearby neighborhoods.

This dissertation has two purposes: make academic contributions and explore policy implications. In terms of academic contributions, in order to answer the first two questions, this dissertation will develop a theoretical framework which explains why brownfields are expected to be located near impoverished and minority neighborhoods. Although environmental justice research has already developed theoretical explanations of disparate siting of hazardous waste facilities, such explanations limitedly explain disparate brownfield locations (see chapter 4 for more detailed discussion). For instant, Saha and Mohai (2005) explain that hazardous waste facilities tend to be sited near impoverished and minority neighborhoods due to economic reasons for facility owners; because lands near such neighborhoods are inexpensive in these areas, it is profitable for the owners to site their facilities there. Governments tend to issue a permit for hazardous waste facilities in hope for economic benefits such as employment opportunities from such siting. In terms of brownfields, because the key issue is why properties are abandoned rather than sited, permits from governments are irreverent to explain why brownfields are located in impoverished and minority neighborhoods. This is because no permit from governments is required for facilities to be relocated. In terms of economic rationale of owners, because owners of facilities did not directly introduce environmental burdens on nearby neighborhoods by relocating their facilities, it is difficult to attribute this rationale causes disproportionate environmental burdens on adjacent neighborhoods. Rather, disproportionate environmental burdens from brownfields are appeared to result from the departure of facilities and failure to appropriate subsequent management of these facilities. Because of the above differences between hazardous waste facilities and brownfields, new theoretic explanations of locational disparity of brownfields are needed. Although a few studies (Greenberg et al. 2000; Kuehn 2000; Mank 2000; Solitare and Greenberg 2002) approach brownfields within the environmental justice framework, no study, to my best knowledge, develops theoretical frameworks to explain why disparate brownfield locations are

expected at least in the field of environmental justice.

In order to fill this gap, my dissertation connects an existing theory, or concentration of poverty, to brownfields – concomitant of deindustrialization –, claiming that locations of brownfields are associated with socioeconomic decline of adjacent neighborhoods to brownfields. That is, deindustrialization leads to concentration of poverty in central cities where manufacturing facilities were previously located. Departure of such facilities deprived of employment opportunities for nearby residents who did not possess high skill and education level, resulting in pervasive joblessness in those areas. Subsequently, concentration of poverty resulted in creation of additional brownfields that are service businesses for local residents. Although concentration of poverty exists in urban sociology literature, this dissertation intends to connect that deindustrialization also resulted not only in social and economic inequalities but also in environmental inequality.

In addition to developing theoretical framework, there is no study, to my best knowledge, examining who are living near brownfields. The neighborhood-level of assessment is crucial because many contemporary environmental justice studies (Ash and Fetter 2004; Boer et al. 1997; Boone 2002; Mohai and Bryant 1992; Pastor et al. 2001, 2004, 2005; Pulido et al. 1996; Stretesky and Hogan 1998) tend to focus on disproportional environmental burdens in the neighborhood level (e.g., census tracts or block groups) rather than such burdens in larger geographic levels (e.g., cities or counties). Because the presence of brownfield could be regarded as another type of environmental burdens, the neighborhood level assessment is important to link to previous environmental justice studies to answer whether brownfields add other environmental burdens to those who are already exposed to disproportional environmental burdens. Therefore, empirical assessment proposed in this dissertation will address whether impoverished and minority populations might be exposed to an additional environmental burden, namely the presence of brownfields.

In terms of policy implications, this dissertation can provide a critical first step to help policy makers become aware of efficient and effective brownfield policies given possible shortcomings of brownfield development (see the background section for detailed discussion). The conventional economic development policy proves to be ineffective (Blakely and Bradshaw 2002; Jennings 2004; Spencer and Ong 2004; Stoecker 1997).

That is, the mere hosting of outside businesses in impoverished and minority neighborhoods, as the conventional approach of economic development, may not always work due to the low level of skills that local residents possess in conjunction with racial discrimination in the labor market (Ihlanfeldt 1999; Kasinitz and Rosenberg 1996; Meiklejohn 1999; Neckerman and Kirschenman 1991; Pager 2003; Turner 1997). One alternative could be encouragement of public participation in the brownfield development process to identify local needs (see the background section for detailed discussion). Thus, knowledge of target populations can lead to client-specific economic development policies reflecting needs of local residents. Further, assessments of the socioeconomic changes to neighborhoods on the basis of levels of concentration of brownfields can provide policy makers with information about where economic development is most needed. Finally, if brownfields, as another type of environmental burdens, are located near other hazardous waste facilities, lowering of the cleanup standards which brownfield development often offers to developers perhaps should be reconsidered.

1-2 Overview of Brownfield Development

The United States Environmental Protection Agency (USEPA) Region 5 defines brownfields as “abandoned, idled, or underutilized industrial or commercial sites where expansion or redevelopment is complicated by real or perceived environmental contamination that can add cost, time, or uncertainty to a redevelopment project” (Davis 2002: 5). In addition, the United States Office of Technology Assessment (USOTA) also defined brownfields as sites “whose redevelopment may be hindered not only by potential contamination, but also by poor locations, old, or obsolete infrastructure, or other less tangible factors often linked to neighborhood decline” (Davis 2002: 5). Although definitions of brownfield between USEPA region 5 and USOTA share similarities, the definition from USOTA adopts a more liberal definition of brownfield by including properties that do not suffer from environmental contamination. In terms of the definition that USOTA provides, it is unclear what roles environmental contamination plays in determining brownfields. Under the USOTA definition, a run-down public housing complex with little suspicion of environmental contamination can be a brownfield. Although USEPA region 5 provides a more stringent definition of brownfields by adding environmental contamination factor and commercial and industrial

sites, this definition is also ambiguous. Specifically, because the definition of USEPA region 5 includes perceived environmental contamination, it is subjective to decide which properties are brownfields and which properties are not. Therefore, a more objective definition of brownfields is needed to eliminate confusions in designating brownfields.

In addition to ambiguous nature of brownfield definition, there is considerable confusion between voluntary cleanup programs and brownfield development. Voluntary cleanup programs tend to state-sponsored programs to encourage owners and developers to clean up contaminated properties. However, unlike brownfield development, voluntary cleanup programs do not focus on redevelopment of such properties; rather, their main goal is to eliminate environmental contamination (Reisch and Bearden 2003). Environmental Law Institute states that "... voluntary [cleanup] programs do not focus on redevelopment nor do they target urban site specifically. Voluntary [cleanup] programs are more often aimed at simple, less contaminated sites cleaned up regardless of whether they are reused. Brownfield programs, on the other hand, are more likely to focus on redevelopment and be part of a broader State strategy or set of social policies aimed at improving distressed urban areas" (Reisch and Bearden 2003: 4).

Although there are an estimated 21,000 brownfields in the U.S. (Fitzgerald and Leigh 2002), the exact numbers are extremely difficult if not impossible to ascertain for several reasons. Because of ambiguous brownfield definition discussed above, each state adopts slightly different definitions of what constitutes a brownfield (Mank 2000; Reisch and Bearden 2003). In other words, a brownfield in one state would not necessarily be a brownfield in another. For example, it appears that the state of Michigan adopts USOTA definition of brownfield¹ (Trigger 2002) whereas the state of Illinois tends to designate contamination as the most important component of brownfields (Montgomery 2002). Cleanup standards tend to be different from states. For instance, the state of Mississippi rely on risk assessment rather than the cleanup standard while the state of Florida provides specific cleanup standard for each site on the basis of risk (Reisch and Bearden 2003). Further, because brownfields are associated with stigma, local

¹ There is no formal definition of brownfields in the Michigan's Brownfield Redevelopment Financing Act (Michigan Legislature undated). However, based on the definition of 'Blighted Properties' in this Act, it is assumed that brownfields in the state of Michigan include abandoned, idled, or underutilized industrial or commercial sites without tangible environmental contamination.

governments are often reluctant to declare them as such (Greenberg et al. 2000). Finally and most importantly, mothballed properties in which there is neither physical activities nor delinquent property taxes make it difficult to assess the exact number of brownfields. Although such mothballed properties are clearly underutilized or even abandoned, property owners pay their property taxes; thus, there is no legal basis for governments to investigate whether or not those properties are contaminated. Because it is expensive to clean up environmentally contaminated properties once environmental contamination is known, it is a better deal for property owners to pay property taxes but not place their properties on the real estate market (Greenberg et al. 2000). For these reasons, exact assessment of brownfields is a difficult if not impossible plus costly task.

Brownfield development was the hot issue at the 1993 U.S. Conference of Mayors (Fitzgerald and Leigh 2002; Simons and Winson 2002), and at the 1998 conference, mayors declared that brownfield development should be the highest priority for federal government support (Greenberg 2002, 2003). In 1994, the EPA initiated a grant program (Brownfield Assessment Pilot Grant) to assist municipalities in assessing environmental contamination in potential brownfield sites in their jurisdictions (Solitare and Greenberg 2002). The U.S. Department of Housing and Urban Development (HUD) also published a study exploring the potential federal roles in state-level brownfield development (HUD 1999). In order to remove the barriers to redevelopment of abandoned contaminated properties, the EPA removed more than 30,000 sites from the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) database² as part of its brownfields initiative (Solitare and Greenberg 2002). Although some have argued that brownfields tend to be less severely contaminated than sites listed on the Superfund national priority list (Mank 2000; Reisch and Bearden 2003; Davis 2002), there is no published study that to date compares the severity of contamination between brownfields and the Superfund National Priority List (NPL).

In Response to the growing attention paid to brownfield development, the U.S.

² This database, provided by the EPA, contains information on actual as well as potentially hazardous waste sites (i.e., Superfund national priority list sites) and remedial actions of such sites. Specifically, citizens can report sites suspected to be environmentally contaminated; then, those sites are registered in the CERCLIS database. The EPA presumably evaluates sites listed in this database, and then determines whether such sites are designated as NPL sites.

Senate and House of Representatives passed the Brownfield Revitalization and Environmental Restoration Act (BRERA) in December of 2001. This act modifies the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) “to encourage brownfield development by providing federal liability relief to prospective purchasers of brownfield properties and to persons who undertake cleanups of these properties under state law, and by providing funding both to state brownfield programs and to local government who seeks to return brownfield properties to productive use” (Hird 2002: xxxv). Because rigid liability scheme under the CERCLA often discourage development of brownfields³, the BRERA can encourage redevelopment of those sites by provision of federal liability relief. Further, the BRERA states that the federal government needs to create the funding sources to help state and local governments to develop strategies for brownfield development including voluntary cleanup programs (Hird 2002).

Paralleled with the federal government, the state of Michigan has initiated a series of efforts to encourage brownfield development. First, the Brownfield Redevelopment Financing Act, passed in the late 1990s, authorizes local governments to develop comprehensive methods of financing brownfield development, methods that include: (1) creation of a brownfield development authority, (2) authorization of implement tax increment financing, (3) designation of brownfield redevelopment zones, and (4) authorization of the acquisition and disposal of specific properties (Michigan Legislature undated; Trigger 2002). Furthermore, the Detroit Economic Growth Corporation (DEGC), established in 1978 as a public-private partnership to assist businesses in providing jobs as well as in leveraging private investment in Detroit, has been interested in brownfield development (DEGC undated). DEGC staff members of the Detroit Brownfield Redevelopment Authority actively pursue brownfield development by identifying and consulting with investors interested in investing in cheap Detroit properties.

³ One of the biggest barriers under the Resource Conservation and Recovery Act (RCRA) in 1976 and CERCLA in 1980 lies in ambiguous cleanup standards. Wagner (2002: 17) states that “Prospective Purchasers who desire quantification of cleanup costs before purchasing a contaminated site are dismayed to learn that government entities are often unable to provide assistance in determining what constitutes an acceptable cleanup, even though ultimate redevelopment of a contaminated property may serve the public interest.”

The state of Michigan additionally developed the Clean Michigan Initiative (CMI) of which voters approved in July 1998. The bill, whose purpose is to preserve and protect Michigan's valuable environmental assets, then, proceeded to issue \$675 million in general obligation bonds for environmental cleanup and natural resource protection. The administration of Governor John Engler conceived of this initiative, which for the issuance of general obligation bonds required the approval of two-thirds of the legislature and a majority of the voters. Because this was a well-intentioned proposal, there appeared to be little organized protest. However, the 1998 Democratic gubernatorial candidate Geoffrey Fieger complained that the proposal "would not toughen environmental enforcement" whereas it enjoyed the supports of various public and private groups such as the Michigan Municipal League, Urban Core Mayor, Michigan Township Association, Southeast Michigan Council of Government, and Michigan Chamber of Commerce (Katz 2002: 7). There is little evidence to indicate that Michigan environmental groups got involved in this initiative either for or against.

Although the CMI is not restricted to brownfield development, this section discusses brownfield development under that legislation. Apparently, more than half of the initiative's budget (\$335 million) was allocated to brownfield redevelopment with the bulk of the brownfield fund (\$263 million out of \$335 million) earmarked for the cleanup of contaminated properties (Katz 2002; Hula 2002). Under the CMI, local governments were to nominate contaminated government-owned properties⁴ in their jurisdictions, after which the State selected "winners" on the basis of development potential and contamination level (Hula 2002). Governments often acquire contaminated properties when property owners abandon them and default on their property taxes (Meyer and Lyons 2000).

1-3 Promises of Brownfield Development

Three broad promises are associated with brownfield development: (1) economic development of distressed areas in socioeconomically declining U.S. central cities, (2) prevention of suburban sprawl, and (3) efficient usage of governmental resources. Some scholars (Fitzgerald and Leigh 2002; Hula 2001; 2002; NEJAC 1996; Simons and

⁴ Most brownfield properties under CMI are owned by local governments (county or municipalities). However, some brownfields are owned by private parties as well.

Winson 2002) claim that brownfield development has emerged as an alternative method for addressing the problem posed by hazardous waste sites in the United States. In other words, the Superfund remediation of contaminated properties does not take into account economic redevelopment. Furthermore, developers, financial institutions, and lenders all tend to avoid investing in properties listed in EPA's CERCLIS database (Solitare and Greenberg 2002). Because of the above, contaminated properties often prove difficult to redevelop in distressed U.S. central cities. By removing the stigma (listed in CERCLIS) and providing incentives (e.g., financial subsidies, flexible standards, and/or liability relief), such properties can arguably be redeveloped and thus become of benefit to local residents who suffer from impoverished socioeconomic conditions.

Some scholars (Bealey and Manning 1997, Greenberg et al. 2001; McAvoy 2004; Roseland 1998) also claim that brownfield development can reduce suburban sprawl. Beatley and Manning (1997) find that land consumption has outpaced population growth in U.S. metropolitan areas. When governments encourage infill development, they might cause the amount of suburban development to fall. Some states (e.g., Maryland and New Jersey) identify brownfield development as a smart growth option (Greenberg et al. 2001), and Greenberg et al. (2001) argue that brownfield development is the most viable option in smart growth and growth management policies. Protection of the ecosystem can be realized through reducing suburban development (Zovanyi 1998). That is, by suppressing development in suburban areas, such land can be devoted to various ecological purposes such as habitat conservation (Noss et al. 1997), wetland and coastal preservation (Beatley et al. 1994), and farm land preservation (Stokes et al. 1997).

Finally, brownfield development can lead to efficient use of limited governmental resources, this efficiency being realizable because brownfield properties already contain existing infrastructures (Fitzgerald and Leigh 2002; Simons and Winson 2002) even though they can sometimes serve as obstacles to development when developers prove unable to find parcels large enough for their purposes (Fischer 1997). By the same token, tax revenues experience an increase due to brownfield development, and an increased tax base for impoverished central cities is crucial for provision of better municipal services for clients. According to the 2000 U.S. Mayoral report, for example, there are more than 21,000 brownfield properties encompassing 81,000 acres in 231 cities

which if completely developed would realize an estimated gain in tax revenues of \$878 million (Fitzgerald and Leigh 2002; 74).

In short, brownfield development can be an excellent example of sustainable development. The popular paradigm of sustainable development developed by Campbell (1996) is to balance economic development, environmental protection, and promotion of equity (Beatley 1995; Beatley and Manning 1997; Roseland 1998). As discussed, brownfield development can protect environment by reduction of suburban sprawl. Brownfield development can also secure economic development by investment of abandoned properties. Finally, brownfield development can also promote equitable resource distributions within a metropolitan area by developing properties in neighborhoods in U.S. central cities where socioeconomic declines have been evident after the 1970s (Wilson 1987; 1996). However, in order to realize equitable resource distributions, benefits from brownfield development should be given to local residents who have been suffering from concentration of poverty. Unfortunately, there is scientific evidence benefits from such development tend to be given to local residents, and this is one of the critical environmental justice issues (see chapter 3 for more detailed discussions).

1-4 Study Design and Organization

The study area of this dissertation is the tri-county region in the Detroit metropolitan area⁵. Further, this dissertation will rely on the secondary data, specifically the decennial Census of Housing and Population from 1960 to 2000. This dissertation will employ spatial and temporal analyses. Spatial analysis will be conducted by application of the Geographic Information System (GIS). That is, brownfield locations will be mapped on the digitized map with census units (i.e., census block groups or census tracts), which allows researchers to analyze the racial and socioeconomic conditions of neighborhoods geographically close to brownfields. Temporal analysis will be conducted on the basis of racial and socioeconomic characteristics of neighborhoods over time. In other words, this temporal analysis can address the question of whether neighborhoods adjacent to brownfields experienced the dramatic decline in

⁵ In the 1990 definition, the tri-county area, or Macomb, Oakland, and Wayne counties (includes the city of Detroit) was the Primary Metropolitan Statistical Area (PMSA). However, the Detroit PMSA is expanded in 2000 by adding three additional counties, Lapeer, Monroe, and St. Clair counties (see Figure 5-1).

socioeconomic conditions from 1960 to 2000.

The order of dissertation is as follows. This chapter discussed the research questions and general overview of brownfield development. Chapter 2 will review literature on environmental justice with an emphasis on empirical studies with respect to locational disparity of hazardous waste facilities. Chapter 3 will also review literature on brownfield development. The purpose of reviewing literature on brownfield development is not only to link between environmental justice and brownfield development but also to introduce what types of research have been conducted on brownfield development. Chapter 4 will provide theoretical framework for this dissertation, borrowing from urban sociology literature, and such a framework should differ from the one in environmental justice explaining locational disparity of hazardous waste facilities. Chapter 5 will discuss method of this dissertation. Chapters 6 through 9 will present results of research questions posed on this dissertation. Specifically, Chapter 6 will present results to answer whether brownfields are found near impoverished and minority neighborhoods. Chapter 7 and 8 will present results to answer whether the presence of brownfield is associated with decline in socioeconomic conditions of adjacent neighborhoods from 1960 to 2000. Chapter 9 will present results to answer whether racial and socioeconomic conditions of neighborhoods can predict cleanup prioritization of brownfields. Finally, Chapter 10 will conclude this dissertation by summarizing major findings and providing future research agendas.

CHAPTER 2: LITERATURE REVIEW ON ENVIRONMENTAL JUSTICE

This chapter reviews existing quantitative studies pertaining to environmental justice, specifically, studies that examine locational environmental disparity¹. The purpose of reviewing such literature is to determine the types of research that have previously been conducted and to identify the major findings of those studies. In addition, the methodological techniques employed, especially as regards spatial analysis, come from previous environmental justice studies because there is no previous study on racial and socioeconomic disparities on brownfield locations at the neighborhood level. It is important to note that all environmental justice studies are not reviewed in this chapter, but studies reviewed in this chapter are a fair representative of studies examining locational environmental disparity.

Many qualitative environmental justice studies employ the case study method to examine the evolution of environmental struggles in a community, the outcomes of such protests, the types of actors involved, and the strategies they implement to achieve the goals of their protests. Such studies help researchers comprehend causal factors and subsequently to formulate hypotheses and theories (Mohai and Saha 2007). In other words, many hypotheses from quantitative studies indeed come from prior qualitative studies. Thus, it is important to appreciate the importance of qualitative studies in the field of environmental justice. For example, Cole and Foster (2001) introduce a case in Chester, Pennsylvania, where governments granted placement of commercial waste facilities in the African American enclave. In order to prevent from siting of such

¹ There are several lines of locational environmental disparity inquiry. Many studies use hazardous waste facilities as proxy for environmental burdens. Such studies map locations of such facilities and then compare the socioeconomic conditions of neighborhoods adjacent to such facilities and neighborhoods at a distance from them. Other studies probe into the relationship between levels of air pollution in census units (e.g., zip codes, census tracts, block groups) as well as racial and socioeconomic characteristics of the units. Although those studies that consider only one source of pollution exclude numerous other sources of pollution (e.g., land and water pollution), the actual level of pollution is a better proxy than are locations of hazardous waste facilities. The final type of locational environmental disparity resides in transportation-related environmental inequalities, with studies of the same examining the relationship between transportation-related environmental disamenity (e.g., road density, volume of vehicle trips, level of vehicle emissions) of census units and socioeconomic characteristics of those units.

facility, coalitions between Chester Residents Concerned about Quality of Life (CRCQL) and external organizations such as Campus Coalition Concerning Chester (C4) was formed. Known as C4, such a coalition delivered the strong message to local governments and corporations, and settlements between companies and residents were finally reached. Indeed, the legal solution which residents pursued previously failed, but building a coalition was proven to be effective (Cole and Foster 2001). Furthermore, Pulido et al. (1996) conduct a historical analysis of environmental inequalities in two Los Angeles neighborhoods and conclude environmental inequalities result from various historical factors such as housing discrimination, development of zoning ordinance, and labor market division by races. From this study, several subsequent studies included industrial land use as an independent variable to explain locational disparity (Lejano and Iseki 2001; Pastor et al. 2004).

On the other hand, some scholars attempt to link the environmental justice movement into broader social movement theories. Taylor (2000), for instance, examines what factors led to the emergence of the environmental justice movement in 1980s and 1990s. The author argues that the environmental justice movement employs an injustice frame as the master frame which identifies not only human harming nature but also race, gender, and class discrimination in various environmental contexts. She further claims that the environmental justice movement tends to take advantage of existing social networks (civil rights activists and social justice activists) to expand their membership. The academic community also contributed to the environmental justice movement by advancing spatial analysis skills. Finally, she states that “[l]ike mainstream environmental activists, environmental justice activists were poised to take advantage of the political opening the pro-environmental Clinton-Gore administration presented” (Taylor 2000: 565). In short, although the importance of qualitative environmental justice studies should not be overlooked, reviewing such studies is beyond the scope of this dissertation.

2-1 Early Studies on Locational Disparity

The general characteristic of early spatial environmental justice studies lies in the use of the unit-hazard coincidence method (to be discussed later in the section). The United Church of Christ (UCC) study (1987) compares racial and socioeconomic characteristics

of zip codes areas hosted at least one hazardous waste treatment, storage, and disposal facilities (TSDF) with the characteristics of zip codes not hosted any TSDF. This study finds that race is an independent predictor of locations of hazardous waste treatment, storage, and disposal facilities (TSDFs). Later, Mohai and Bryant (1992), using the 1990 Detroit Area Study, a probability sample of three Michigan counties (Macomb, Oakland, and Wayne county), subsequently find race to be a stronger predictor (and independent predictor as well) than income in measuring distance between residences of survey participants and distance from 14 commercial hazardous waste and 2 planned facilities. Unlike earlier findings indicating the locational disparity of TSDFs, Anderton et al. (1994) discovered that race is not a statistically significant predictor of such facilities. Referring to the UCC study (1987), Anderton et al. (1994) claim to replicate the UCC study by employing a different unit of analysis (UCC use zip code areas and Anderton et al. use census tracts). They argue that their unit of analysis is superior to the UCC's because census tracts are less likely than zip code areas to lead to ecological fallacy².

Anderton et al. (1994) find that the percent of African Americans and Hispanics are not significant predictors but the percent of persons employed in manufacturing occupations is a significant predictor of whether census tracts host at least one TSDF facility. Based on this finding, the authors claim that census tracts hosting TSDFs are generally white working class neighborhoods. In a later study, Anderton et al. (1997) examine the relationship between sites under Comprehensive Environmental Response Compensation and Liability Act (CERCLIS) and National Priority List (NPL)³ sites and demographic characteristics based on 1990 US Census data using census tract as the unit of analysis. They find that the differences in percent of African Americans and

² The term ecological fallacy refers to the failure to acknowledge errors in aggregate data. That is, interpretation of individual characteristics identified in aggregated data sets often gives rise to inaccurate descriptions of reality. Anderton et al. (1994: 232) claim "Because geographic data can be aggregated to produce information on larger regions, it seems reasonable to begin with an analysis of areas that are as small as is practical and meaningful. Beginning with too large a geographic unit invites the possibility of 'aggregation errors' and 'ecological fallacies'; that is, reaching conclusions from a larger unit of analysis that do not hold true in analyses of smaller, more refined units."

³ Sites are listed in CERCLIS if they are under suspicion of environmental contamination. Because sites in CERCLIS can be listed through simple phone calls from concerned citizens, not all CERCLIS sites are environmentally contaminated. Through site assessments, sites listed in CERCLIS will be listed in the NPL if contamination scores of sites are higher than the predetermined threshold by the US EPA. When sites are listed in the NPL, they are thoroughly cleaned up.

Hispanics between census tracts containing at least one CERCLIS and census tracts not containing CERCLIS are insignificant. Examination of NPL sites yields the same conclusion. However, the authors do in fact find that the likelihood of prioritization of cleanups may be influenced in an ultimately inequitable fashion; that is, communities with a high percent of African American and impoverished population are less likely to be designated NPL sites. The authors claim that such disparity cannot be strong evidence of environmental inequality because severity of contamination is not considered. That is, it is possible that NPL sites near African American neighborhoods are not as seriously contaminated as ones in white neighborhoods. Therefore, it is important to consider “Hazards Ranking System for NPL designation” to reach a more definitive conclusion that racial disparity of NPL designation exists (Anderton et al. 1997: 23). Finally, Davidson and Anderton (2000), relying on 1990 US tract-level Census data, find that census tracts hosting at least one the Resource Conservation and Recovery Act (RCRA) facility⁴ exhibit lower percentage of African Americans and Hispanics and a higher percent of persons employed in manufacturing industries than census tracts not hosting RCRA facility on the national as well as metropolitan levels (employment status being important here). Nonetheless, when they include census tracts adjacent to at least one facility⁵, the percent of African Americans becomes higher than census tracts not hosting them.

The emergence of counterevidence with respect to environmental inequalities requires more conclusive findings supporting disproportionate environmental burdens imposed on impoverished and minority population. Krieg (1995) examines the relationship between waste sites and demographic characteristics by considering the spatial dynamics of industrial activities in Greater Boston, that the differing histories of industrial development within region should be considered as determinant factors in revealing the relationship between waste sites and demographic characteristics of towns⁶. He finds further that race is a strong predictor for location of waste sites in areas with a

⁴ Facilities are listed in the RCRA database if they handle toxic chemicals defined under the Resource Conservation and Recovery Act.

⁵ They use centroid-containment method with 3 mile radius from each RARC facility.

⁶ The author categorizes townships (N=44) into two groups. Townships inside or close to route 128 (N=25) represent a newly developed industrial region while the remaining townships (N=19) represent a historical industrial region.

long history of industrial activity (i.e., Boston) while class is a strong predictor of the sites in areas with a relatively brief history of industrial activity (suburban townships in Greater Boston). Although this study highlights the fact that a history of industrial activity of an area turns out to be a critical factor to explain relationships between racial and socioeconomic characteristics and locations of waste sites, he reaches his conclusion based on bi-variate analysis.

Lejano and Iseki (2001) examine the relationship between a number of TSDFs and racial composition (the 1990 US Census with zip code as unit of analysis) by controlling for socioeconomic characteristics and the total area of the zip code area devoted for industrial land use. In other words, the dependent variable of this study is the number of TSDFs in a zip code area in Los Angeles County regardless of the exact locations of such facilities. By employing parsimonious regression analysis excluding statistically insignificant variables, they find that the proportion of non-Black Latinos, proportion of impoverished (fraction of the population with incomes under 50% of the poverty line), and the total area industrial land use are statistically significant predictors of the number of TSDFs, while income is not a significant predictor of number of TSDFs. Two-stage ordinary least square regression⁷ indicates that the proportion of non-black Latinos remains statistically significant whereas as proportion of impoverished populaces and estimated industrial areas become statistically insignificant. The authors interpret the significance of the proportion of Latino and total industrial area as evidence of zoning and land use policies contributing to unequal distribution of such facilities.

Ringquist (1997) argues that previous environmental justice studies here have overlooked several important points, as follows: (1) Sites in the Toxic Release Inventory (TRI) are more inclusive than are ones in RCRA (most used in studies); (2) no multiple impact is considered; (3) the amount of release is not considered; (4) case studies have weak external validity; and (5) appropriate comparison groups need to be chosen (national average v. state average). Relying on 1990 US Census data with zip code as unit of analysis, the author employs multivariate analysis of four sets of

⁷ The authors use two-stage OLS to avoid the endogenous bias in which two variables cause each other. Because locations of TSDFs influence as well as are influenced by industrial land uses, the total industrial area is estimated by the proportion of Latino residents in 1980 and 1990 and income in 1980 and 1990. The estimated industrial area is replaces the total industrial area in the earlier simple regression model.

dependent variables: (1) the existence of zip code hosting in at least one TRI facility, (2) the number of TRI facilities in zip code areas, (3) the density of TRI facilities, and (4) the amount of toxic release and finds that racial and socioeconomic variables are significant predictors of all four. In terms of significance, the author calculates expected values with increase of one standard deviation in a variable and find that the general background characteristics of residential areas which are (1) the percent residents in urban areas, (2) percent of persons employed in manufacturing occupations, (3) percent of homeowners, and (4) median house age best account for the distribution of environmental risks arising from TRI facilities followed by race and class.

Other studies find the existence of environmental inequality in Superfund sites (Hamilton and Viscusi 1999⁸; Stretesky and Hogan 1998; Zimmerman 1993) in distinction to the findings of Anderton et al. (1997). Stretesky and Hogan (1998), for instance, examine the relationship between Superfund sites⁹ and the racial, ethnic, and economic characteristics of surrounding areas in the state of Florida. Multivariate analysis indicates that race remains a significant predictor of such sites when controlling for economic variables. Longitudinal analyses reveal that the percent of minority populations has increased in census tracts with at least one Superfund site. Based on these findings, the authors conclude that “environmental justice is more than just the direct placement of hazards into minority communities. Even without evidence for direct discrimination, clearly, social processes beyond the sitting decisions themselves are furthering such inequality” (Stretesky and Hogan 1998: 284).

2-2 Application of a New Method and a New Dataset

The above studies employ the unit-hazard coincidence method, the term introduced by Mohai and Saha (2006) referring to simple dichotomization of spatial units in accordance with the hosting or non-hosting of at least one hazardous waste facility. This method does not accurately capture all geographic units such as census tracts or census block groups which might be affected by such facilities. Specifically, a problem of the unit-hazard coincidence method lies in an assumption that effects of hazardous waste facility are solely in host geographical units such as census tracts or zip code areas

⁸ Unlike other studies, Hamilton and Viscusi (1999) employ the distance-based method.

⁹ Superfund sites refer to sites listed in the NPL.

(Downey 2006; Saha and Mohai 2006, 2007). In order to capture areas that might be affected by hazardous waste facilities, a new method, the distance-based method, has been developed. By employing the Geographic Information System (GIS), the distance-based method creates circular buffer around each facility and aggregate or average demographic characteristics of geographical units within the circular buffers. Thus, this method allows researchers to more precisely estimate neighborhoods near polluting facilities (Mohai and Saha 2006). Results differ from the unit-hazard coincidence method when the distance-based method is employed. For example, Boer et al. (1997) compare results employing the unit-hazard coincidence method to ones employing the distance-based method and find that the percent of African Americans in census tracts within one mile radius of TSDFs in Los Angeles County is significantly higher than it is for census tracts beyond a one-mile radius of TSDFs. Relying on the unit-hazard coincidence method, there is no significant difference in percent of African Americans between census tracts hosting or not hosting at least one TSDF.

Although Boer et al. (1997) are the first to show that different results are yielded on the basis of methods (the unit-hazard coincidence method v. the distance-based method), the study area of this study is one California county. Thus, it is difficult to assert that this pattern maintains at the national level. On the other hand, Mohai and Saha (2006, 2007) compare results employing the unit-hazard coincidence method to ones employing the distance-based method at the national level. They find that race is not a significant predictor of locations of TSDFs when the unit-hazard coincidence method is used while it becomes a significant predictor of locations of TSDFs when the distance-based method is employed. Furthermore, race is an independent predictor of locations of TSDFs when employing the distance-based method. When distance from TSDFs lengthens from one mile to three mile, race becomes a stronger predictor yet income loses its explanatory power¹⁰.

As another example of a study employing the distance-based method, Pastor et al. (2004) examine the locations of TRI facilities and demographic characteristics of nearby

¹⁰ Strength of explanatory power refers to values of a coefficient. For example, a coefficient of the percent of African American is 0.698 with one mile radius from TSDFs, the coefficient increases to 1.522 with three mile radius from TSDFs. A coefficient of mean household income is -0.025 with one mile radius from TSDFs, the coefficient decreases to -0.015 with three mile radius from TSDFs (Mohia and Saha 2006: 395 Table 3).

neighborhoods in the state of California by using the 2000 US Census data (census tract as unit of analysis) and the TRI in 2000. Results show that when controlling variables (home ownership, income, population density, and occupation), race is a significant predictor of locations of such facilities, regardless of use of a minority as one unit (i.e., non-white) or use of different racial groups (i.e., African American and Hispanic). That is, higher minority presence in a census tract increases the probability of its hosting facilities. The authors adjust spatial autocorrelation¹¹ by employing two-stage regression analysis, producing results which show that, even after adjusting for spatial autocorrelation, race remains a significant predictor in spite of any decline in coefficient or t-statistic. They state that “The overall pattern suggests that spatial clustering is occurring but this does not affect the basic insights and conclusions of the earlier regression work” (Pastor et al. 2004: 434).

The distance-based method is superior to the unit-hazard coincidence method since it takes into account adjacent geographic units that may be affected by the presence of the hazardous waste sites. That nearby units, not just host units may be affected is verified by a number of studies (Nelson et al. 1992; Ihlanfeldt and Taylor 2004; Simon and Saginor 2006). Nelson et al. (1992), for example, examine effects of a landfill on the price of adjacent housing in Anoka county in Minnesota and find that residential property values decline if properties are located within 2.5 miles from the center of a landfill. Ihlanfeldt and Taylor (2004) also examine the relationship between property values and proximity of hazardous waste facilities in Fulton county, Georgia, where the city of Atlanta is located, using individual property as unit of analysis. They find a negative relationship between proximity to the nearest site and property values after the site is listed in CERCLIS or the Georgia Environmental Protection Division’s Hazardous Waste Inventory (HWI). However, they find no significant association between density of hazardous waste facility (numbers of hazardous waste facilities within 1.5 mile radius) and decline of property values. They further estimate over \$1 billion total property value loss due to hazardous waste facilities in the study area (properties within 1.5 mile

¹¹ Spatial autocorrelation refers to the violation of an assumption of regression; geographic proximity between observations introduces biases (Gujarati 1995). That is, the regression model assumes that residuals (the unexplained portion from the model) are random. Due to geographic proximity, however, residuals that are systematically associated violate one of the assumptions of regression.

radius from the nearest site). Simons and Saginor (2006) conducted a meta-analysis and reach the same conclusion that hazardous waste facilities reduce nearby residential property values. Given adverse economic effect of hazardous waste facilities on adjacent neighborhoods, exclusion of neighborhoods near such facilities leads to a critical measurement error which yields biased estimates.

In the variation of the distance-based method, Downey (2006) discusses the distance-decay method. The distance decay model calculates decline rates of negative effects of hazardous waste facilities on study areas as distance from facility increases by creating 105.6 foot (1/50th of a mile) resolution of grid cells. That is, as the distance from hazardous facilities increases, impacts of such a facility on grid cells decrease. Using the 2000 TRI facilities and the 2000 US Census data (census tract as unit of analysis), Downey (2006) finds that African Americans are disproportionately burdened by TRI facilities in the Detroit Metropolitan area.

Previous review of literature on environmental inequality on locations of hazardous waste facilities, researchers consistently point out that a growing number of studies find such facilities tend to be located near impoverished and minority neighborhoods (Mohai and Bryant 1992; Goldman 1994; Ringquist 2000; Szasz and Meuser 1997). Recently, Ringquist (2005) conducts a meta-analysis of existing studies pertaining to locational disparity. Results suggest that while environmental inequality exists along a racial line, evidence is relatively weak to suggest that economic class is a significant predictor of the locations of such facilities.

Associations between locations of hazardous waste facilities and racial and socioeconomic conditions of adjacent neighborhoods do not establish causality between the two. In other words, conceivably the siting of hazardous waste facilities could attract impoverished and minority populations given the discounted housing value in those locations. By the same token, it is also possible that hazardous waste facilities could be sited disproportionately near impoverished and minority neighborhoods at the time of siting. Using the 1970, 1980, and 1990 US Census data and toxic storage and disposal facilities (TSDF) whose annual release exceeds 50 tons in Los Angeles County and there upon applying the distance-based method (a quarter of one and one mile radii), Pastor et al. (2001) find that TSDFs tend to be sited near impoverished and minority

neighborhoods rather than that the presence of such facilities tends to attract impoverished and minority populations. Saha and Mohai (2005) also test the same question for TSDFs in the state of Michigan from 1950 to 1990, by applying the distance-based method (1.0 mile radius) to identify temporally differing patterns. That is, whereas TSDFs were not sited near impoverished and minority neighborhoods prior to 1970, the disparate sitting pattern did in fact emerge after 1970. This study implies that increased awareness with regard to environmental problems probably results in disparate siting, and once people become aware of the fact that the presence of such facilities might threaten their well-being they refuse to host them. Due to their unwanted nature, such facilities tend to be located in economically-distressed areas whose inhabitants exercise a low level of political power.

The major focus of environmental justice inquiry focuses heavily on the relationships between locations of environmentally-adverse facilities and racial and socioeconomic conditions of adjacent neighborhoods. In this inquiry, the authors often accept the presence of environmentally-adverse facilities in proxy for environmental risk. To more accurately assess actual levels of risk, a number of studies rely on actual air pollution data (Apelberg et al. 2005; Ash and Fetter 2004; Lejano et al. 2002; Morello-Frosch and Jesdale 2006; Morello-Frosch and Lopez 2006; Pator et al. 2005; Sicotte and Swanson 2007). For example, Lejano et al. (2002) construct a model to exhibit the spatial distributions of health risk in Los Angeles County, California. By using Health Risk Assessment data, calculations of chronic risk from air pollution prepared by the Los Angeles Unified School District, Los Angeles County land use data, and the 1990 US Census data (census tract as unit of analysis), the authors employ the Ordinary Least Square (OLS) to examine the relationship between chronic cancer and non-cancer risks and spatial (i.e., industrial land use) as well as demographic variables (i.e., percent of Hispanics, percent of African Americans, per capita income, and educational attainment). The authors find that the percent of Hispanics and poverty levels tend to increase chances of chronic cancer risk. They also identify 11 vulnerable census tracts that show high risk of chronic cancer and low per capita income, concluding that an understanding of the spatial dynamics of estimated risk and identification of highly vulnerable communities in cities or metropolitan areas are essential for planners because these kinds of information

help to pinpoint where governments should pay additional attention. Similarly, Pastor et al. (2005) examine the relationship between potential lifetime cancer risk and the socioeconomic characteristics of census tracts that rely on the EPA's 1996 National Air Toxics Assessment (NATA) along with the 2000 US Census data. The authors control spatial autocorrelation by introducing space as an independent variable and discover that cancer risk in California is not equally distributed. That is, impoverished and minority census tracts tend to pose a higher cancer risk after controlling for income, occupation, land use, and region. The authors conclude that zoning and land use can explain significant portions of such disparity on the basis of racial composition. Finally, Ash and Fetter (2004) examine relationships between the level of air pollution¹² and the racial and socioeconomic conditions of census tracts in 1990 in urbanized areas. They find that African Americans and the impoverished tend to live in cities and neighborhoods with higher air pollution than their counterparts. Hispanics, on the other hand, tend to live in cities with lower air pollution but live in neighborhoods with higher air pollution.

2-3 New Topics on Environmental Justice

Some researchers are interested in exploring new dimensions of environmental justice. Harner et al. (2002), for example, attempt to construct several indices with which to measure the relationship between distribution of environmental hazards and socioeconomic conditions of adjacent neighborhoods. The Comparative Environmental Risk Index, for example, is computed based on the ratio between the percent of whites and non-whites within a 1.5 mile radius of CERCLIS and NPL sites and a 1.5 mile radius of other environmentally adverse facilities in metropolitan areas. This computation is repeated for Hispanics and persons living below the poverty line. These three numbers are then averaged, after which they are multiplied by the total MSA toxicity rate (toxic sites / total population of MSA * thousand) for normalization purposes in comparing between MSAs. Higher numbers indicate severity of environmental risk. Throughout the article, the authors develop different indices to measure the severity of environmental injustice in MSAs. Lopez (2002) also examines the exposure to toxins of racial economic groups in US metropolitan areas with a population of a million or more in 1990 (N=44). Using the 1990 US Census and EPA toxic release data, the author constructed

¹² The level of air pollution is measured by 1998 US EPA data on toxicity-adjusted exposure to air pollution.

a net differential score, or probability of African American exposure to air pollution comparing to white's exposure of the pollution. This score is constructed by combining direct impact (i.e., release from facilities in census tracts) and indirect impact (release of adjacent census tracts) while considering win patterns. The results suggest that African Americans are more likely than whites to live in census tracts with higher air pollution levels. Specifically, 52% of the score variations can be explained by an index of dissimilarity and percent of persons in manufacturing occupations.

Furthermore, some studies link environmental injustice to urban transportation, arguing that individuals who avail themselves of private transportation should bear more of the bill for vehicle-related air pollution (Grineski et al. 2007; Gordon and Dorling 2003; Houston et al. 2004). Using national data on NO_x concentrations and the 1991 UK Census data for demographic variables¹³, Gordon and Dorling (2003) find that in high-poverty wards residents who are less likely to own vehicles are more likely to suffer from high level of air pollution. That is, the air pollution in the wards with high vehicle-ownership rates is lower than the air pollution in wards with low vehicle-ownership rates, meaning that those who are more likely to be air polluters in fact enjoy cleaner air in their residential areas. Similarly, Houston et al. (2004) examine the historic and structural process of creating and maintaining environmental inequalities related to transportation systems. Using the 2000 US Census data, 2000 traffic data, and zoning land use maps of four counties (Los Angeles, Orange, Riverside, and San Bernadino Counties) in the Los Angeles metropolitan area, the authors find that road density and traffic density of poor and very poor census block groups are twice as high as non-poor census block groups. Because residents of poor and very poor census block groups show lower percent of vehicle ownership and higher percent of reliance on public transportation for work commutes than do non-poor census block groups, these residents experience disproportional shares of vehicle-related air pollution. In considering racial segregation in poor census tracts, the authors conclude that disproportionate burdens of transportation-related pollution are imposed on the disadvantaged of the Los Angeles metropolitan area.

While the majority of researchers are preoccupied with unequal environmental

¹³ The unit of analysis is the ward which is equivalent to US census tract: N=10,444.

burdens imposed on impoverished and minority populations, they often do not adequately address economic factors (i.e., compensation of environmental bads). Jenkins et al. (2004) examine the relationship between the amount of compensation of hosting community and four factors: negative externalities, community participation, employers' financial capability, and socioeconomic composition. Using 1990 US Census data, phone interviews of landfill owners, and Chartwell Information Publishers (directory containing landfills information), the authors find that community participation significantly increases the amount of compensation paid to cities and counties for environmental bads. Especially, participation that entails community knowledge ability about landfills and the presence of a state mandatory host fee are found to be significant predictors of greater amounts of compensation. Socioeconomic variables, on the other hand, are not significant predictors of compensation to cities, though the percent of minority and impoverished inhabitants is found to be significant for compensation to counties. Although this study highlights the importance of community involvement in the decision-making process as to the hosting of landfills, it is unclear whether compensation fees directly benefit adjacent neighborhoods.

In conclusion, reviewing quantitative environmental justice studies yield several conclusions. First, methodological advances, use of the Geographic Information System in particular, improve scientific inquiry, which helps researchers comprehend why inconsistent results were reported in earlier studies on environmental inequality (see Table 2-1). That is, all studies (reviewed in this chapter) employing the distance-based method find that race is not only an independent but also a stronger predictor of locations of hazardous waste facilities from (than) income. Furthermore, environmental justice studies attempt to link various other types of environmental inequality (rather than proximity to hazardous waste facilities) into racial contexts such as residential segregation, cancer risks, and urban transportations. Such a diverse coverage with respect to disproportionate environmental burdens is certain over time to open up the topic to productive interdisciplinary discussions. Such discussions can only enhance conceptual understanding of environmental injustice in the United States as, for instance, of the sociological understanding of residential segregation, the political understanding of power relations and political empowerment, the scientific

understanding of toxic substances and their possible synergetic effects, public health understanding of impacts of toxic substances on public health, and the planning understanding of evolving land uses and zoning and their decision-making mechanisms. In addition to the above, it is critical to determine whether the existence of brownfields constitutes yet another environmental burden on disadvantaged populations. The next chapter will introduce the environmental justice issues relevant to brownfield development, followed by a survey of studies on brownfield development.

Table 2-1 Comparisons of methods in spatial environmental justice studies

Method	Unit-Hazard Coincidence	Distance-Based	Distance-Decay
How to Capture Spatial Units	Host units proper	Specified distance from points of interests (i.e., hazardous waste facilities)	Distances from points of interests to centroid of spatial units
Advantage	Easy to employ	Inclusion of adjacent spatial units that might be affected by points of interests	Differentiation of spatial units by distances
Disadvantage	This method disregards possible impacts of points of interests on adjacent spatial units from host units proper.	Same impact of points of interests on spatial units is assumed if they are captured specified circular buffers from the points.	It is unknown that what degree impacts of points of interest is discounted as spatial units' distances from the points.
Example Study	Anderton et al. (1994)	Mohai and Saha (2006)	Downey (2006)

CHAPTER 3: LITERATURE REVIEW ON BROWNFIELD DEVELOPMENT

As discussed in the previous chapter, environmental justice studies have found that disproportional environmental burdens are imposed on impoverished and minority neighborhoods. In other words, race is not only an independent but also a more significant predictor of locations of hazardous waste facilities than income. In addition to these burdens, the presence of brownfields may well pose an additional environmental burden on these neighborhoods. Environmental justice scholars have been interested in brownfield development and began to identify environmental justice issues on brownfield development (Bullard et al. 2007; Dixon 2003; Greenberg and Lewis 2000; Hula 2002; Kuehn 2000; Mank 2000; McCarthy 2002; National Environmental Justice Advisor Council 1996).

The National Environmental Justice Advisor Council (NEJAC 1996)¹, for example, identified environmental justice issues on brownfield development and provided recommendations. Issues that NEJAC identifies include realization of the confronting the issue of race and class, urban revitalization and community-driven models of redevelopment, and community-based mapping and environmental protection. NEJAC claims that race does matter in many issues such as economic disparity between whites and racial minorities and environmental disparity, or disproportionate environmental burden on minority populations. Thus, policy makers “must find every opportunity to forthrightly confront issues of race and class in American society” (NEJAC 1996: 12). In terms of urban revitalization and community-driven models of redevelopment, NEJAC argues that brownfield development must be a bottom-up process which “proceeds from a community-based vision of its needs and aspirations and seeks to build capacity, build

¹ The National Environmental Justice Advisor Council (NEJAC), established on 1993, is a federal advisory committee to provide independent advice, consultation, and recommendations to the Administrator of the U.S. Environmental Protection Agency on matters related to environmental justice.

partnerships, and mobilize resources to make the vision a reality” (NEJAC 1996: 12). Active participation in the process can reduce gentrification, or displacement of existing residents. Community-based mapping and environmental protection refers to the process that residents shape their own future by actively engaged in decision-making process. Community-based mapping is an idea that residents identify environmental hazards and burdens in their neighborhoods, and such mapping can help them to promote their objections when new environmentally hazardous facilities are sited in their communities in the future. Community-based environmental protection is critical because this concept includes not only ecological but also social/cultural dimensions of local environmental protections. NEJAC (1996) proposes recommendations to deal with issues such as public participation and encouraging community vision in the brownfield development process, preparing environmental standards/liability for public health, and encouraging public and private sector partnerships.

Regardless of descriptive discussions of environmental justice concerns on brownfield development, little effort has been made to date to empirically evaluate such concerns. Furthermore, there is no study to examine racial and socioeconomic disparities of brownfield locations. This chapter, therefore, summarizes environmental justice issues relevant to brownfield development that appear in descriptive brownfield development literature. Empirical studies on brownfield development are then also introduced to examine what types of studies on brownfield development have been conducted.

3-1 Environmental Justice Issues on Brownfield Development

There are several crucial environmental justice issues in brownfield development: (1) the potentially adverse impact of brownfield cleanup, (2) the uncertain economic impacts on local residents, (3) the gentrification displacement of the impoverished, and (4) the uncertain roles of residents adjacent to brownfields in the developmental process. Before discussing those shortcomings, it should be noted that brownfield development is not clearly articulated for environmental improvement purposes. The Clean Michigan Initiative tends, for instance, to consider developmental potential as the main selection criteria for brownfields to be cleaned up for subsequent development (Hula 2002). Lack of articulation of environmental improvement purposes in brownfield development may

prove a reason why environmental justice researchers overlook brownfield development as an environmental justice agenda.

Residents of inner cities have historically suffered not only from the concentration of poverty (Massey and Denton 1993; Wilson 1987; 1996) but also from the location of environmentally hazardous facilities and locally unwanted land uses (Ash and Fetter 2004; Boer et al. 1997; Boone 2002; Lejano et al. 2002; Mohai and Bryant 1992; Pastor et al. 2001, 2004, 2005; Pulido et al. 1996; Ringquist 1997; Stretesky and Hogan 1998; UCC 1987). Considering the existence of environmental disparity along with racial and class lines, the cleanup standards allowed by brownfield development pose a concern. Cleanup standards under brownfield development programs for most U.S. states are generally lower than the Superfund standard for industrial and commercial uses (Fitzgerald and Leigh 2002; Greenberg 2002, 2003; Hula 2002; Mank 2003; NEJAC 1996; Simons and Winson 2002; Solitare and Greenberg 2002). Given the passage of the Brownfield Revitalization and Environmental Restoration Act (BRERA) that provides federal liability exemptions once purchasers meet cleanup standards set up by state and local governments (Hird 2002), they tend to set lax cleanup standards (laxer than ones under the Comprehensive Environmental Response, Compensation, and Liability Act) to provide incentives for brownfield developers. Thus, it is unclear whether lowering the cleanup standards is healthy for adjacent residents. Hula (2002: 18) claims, “There is little question that [an overall lowering of standards] has reduced developer costs. Less clear, however, is the adequacy of the new standards to protect public health.” Therefore, if various types of environmental burdens are spatially concentrated and impoverished and minority populations disproportionately live near the sites of such burdens, lowering of the cleanup standards should be reconsidered. In addition to reconsideration of the lowering of the cleanup standards, further studies should be connected with respect to the cumulative impacts of various pollutants on adjacent neighborhoods.

Brownfield development also raises questions as to its potential economic benefits, the key question being whether economic benefits from development are in fact realized in residents in adjacent neighborhoods. Historically, economists have argued that hosting environmentally hazardous facilities can enhance local economic conditions (e.g.,

create jobs and increase local tax revenues), while environmental justice advocates and residents of affected neighborhoods have suspected the promised economic benefits (Kuehn 2000; Mank 2000). With respect to their suspicions, brownfield development is no exception, for as Kuehn (2000) states, “Plans by developers and government entities for redevelopment of the lower income, people of color communities where brownfields are found often have failed to create tangible benefits for local residents” (10700). The General Accounting Office of the United States (GAO 2002) confirms that it is unclear whether local residents are actually hired by industrial facilities in the area. Moreover, despite the high concentration of chemical factories in Louisiana’s ‘Cancer Valley,’ local residents often suffer additionally from high unemployment rates (Bullard 2000). This finding indirectly suggests that local residents may not be to any appreciable degree be hired by local businesses².

Even when brownfield development can in fact generate tangible economic benefits to local neighborhoods, another unintended negative consequence arises in the form of gentrification, which involves the influx of relatively affluent newcomer populations to inner cities (Bridge 2003; Lees 2000, 2003; Refern 2003; Smith 1982; Zukin 1982). These newcomers often purchase their ubiquitously-located properties on the cheap and then renovate them. The influx of such population segments and the improvement of the properties they acquire tend to increase the overall property values or rents in adjacent areas. But because existing residents are most likely to come from impoverished racial minorities they subsequently cannot afford the increased property taxes or rents and thus often face residential displacement (Chambers 2002; Kuehn 2000). Displacement poses a serious problem because the displaced often end up in neighborhoods of even lower environmental, economic, and social quality than the ones in which they previously resided.

Finally, brownfield development is often implemented via a property-specific

² Local residents are excluded from the local labor market for various reasons. However, some scholars posit that labor market discrimination could be one of the crucial reasons for impoverished and minority inner-city residents often being excluded from labor markets (Ihlanfeldt 1999; Kasinitz and Rosenberg 1996; Meiklejohn 1999; Neckerman and Kirschenman 1991; Pager 2003; Turner 1997). One experimental study (Pager 2003) finds that being an African American in the U.S. is equal to whites with criminal records in the labor market. In other words, African Americans without criminal records show the similar probability of being hired as do whites with criminal records. This study provides strong evidence that racial prejudice exists in the labor market.

development effort in the absence of cooperation in the community planning process (Dixon 2003; Fitzgerald and Leigh 2002; Garson 2002; Hula 2002; National Environmental Justice Advisor Council 1996; Simons and Winson 2002). The challenge thereby involves incorporating brownfield development within the larger framework of community planning and development. The critical aspect of this issue lies in public participation in the development process, as noted by the claim of Cole and Foster (2001) that racial minorities and lower-income residents are often excluded in governmental environmental decision-making processes, a fact which raises concerns for procedural justice. English (1999: 36) also stresses the importance of public participation in the community planning process in holding that, “Open processes inviting participation of members of the community are no magic bullet, but they improve the chances that the resulting plans will be consulted in making future decisions.” The question needful of answering lies in “[to] what extent local neighborhoods should be involved in local redevelopment efforts” and how the desired level of public participation in brownfield development can be achieved in the absence of strict formal requirements (Hula 2002: 18). Some scholars (Dixon 2003; Greenberg 2003; Hula 2002; McCarthy 2002) argue that brownfield development should be incorporated into broader community planning efforts for the purpose of community mobilization. McCarthy (2002) reports that Powers et al. find that public participation in the brownfield development process produces faster and more reliable outcomes.

In conclusion, Hula (2001) anticipates that brownfield development can be an excellent alternative for a new toxic waste policy in the United States, and many others appear to agree with him because brownfield development aims at environmental as well as economic improvements (Fitzgerald and Leigh 2002; Simon and Winson 2002). However, it is too premature to overstate the benefits of brownfield development based on potential rather than actual effects. That is, despite the immense potential of brownfield development, there are many problems associated with it. Environmental justice issues identified in the above include; (1) who lives near brownfield sites; (2) whether jobs created will given to local residents; (3) whether lowering the cleanup standard is safe for human health; and (4) what roles should be played by affected residents from brownfield developments. Those are important questions that need to be

answered in assessing the actual impact of brownfield development on local neighborhoods. The next section reviews studies to date on brownfield development.

3-2 Studies on Brownfield Development

There are three broad themes in previous studies with respect to brownfield development: the developer/governmental perspective, the resident-oriented perspective, and the legal/political aspects of brownfield development³. The developer/government perspective on brownfields includes the process of brownfield development (Fitzgerald and Leigh 2002; Howland 2003; Simon and Wilson 2002), the perception of developers and/or governmental officials regarding development of contaminated properties (Alberini et al.; De Sousa 2005), and the roles of contamination in market transactions (Howland 2004; Pryce 2003; Schoenbaum 2002; Yount 1997). The resident-oriented perspective of brownfield development includes the locations of brownfields (Solitare and Greenberg 2002), the city-wide impacts of brownfield development (Greenberg et al. 2000; De Sousa 2005), and the preferences of residents in terms of brownfield usage (Greenberg et al. 1999; Greenberg and Lewis 2000). The legal/political aspects of brownfield development address questions such as whether state-initiated Voluntary Cleanup programs are violations of the Title VI of the Civil Right Act (Mank 2003) or how brownfield development can be linked to broader community development goals including public participation in the process of brownfield development (Dixon 2003; Hula 2002; McCarthy 2002) and/or growth management-related endeavors (Greenberg et al. 2003).

3-2-1 Developer/Governmental Perspectives

In terms of the process of brownfield development, many studies deal with the process that leads to successful brownfield development (Fitzgerald and Leigh 2002; Howland 2003; Simon and Wilson 2002). Successful brownfield development is frequently defined as completion of site cleanup, after which new businesses move in⁴. With the case study method, typical research questions in these studies involve how development projects have been pursued, whether properties are fully renovated or

³ Taxonomy provided is based on author's understanding and judgment of brownfield literature, and some might not agree with such a taxonomy. Readers should thus bear in mind that categorizations of literature are suggestive rather than conclusive.

⁴ These studies do not include the use of local residents as a component of successful brownfield development. Furthermore, all studies cited the above define success cases as the same manner.

developed such that new businesses can operate, and how many governmental subsidies have been granted the development. Howland (2003), for example, examines three brownfield sites in Baltimore, Maryland, and notes that two of the three sites zoned for industrial uses have in fact been renovated and currently are in use. On the other hand, a brownfield site zoned for residential uses have difficulty in getting the development completed. He observes that a stringent cleanup standard imposed on residential uses up limited feasible options available to a developer when unexpected additional contaminations arise. Subsequently, developer in this study pulled out from the voluntary cleanup program in the absence of room to negotiate with respect to the additional cost of cleanup for contamination. Although Howland (2003) notes that one developer's inexperience in brownfield development contributed to its failure, the stringent cleanup standard was considered as the major reason for project incompleteness. Similarly, Fitzgerald and Leigh (2002) also introduce successful brownfield development cases identified by the EPA as successful cases and describe how they were processed.

In terms of the perception of developers and governmental officials in developing contaminated properties, studies deal with questions such as whether developers hesitate to invest in previously contaminated sites and whether there are perceptual differences between private and public stakeholders in brownfield developments. Alberini et al. (2005), for instance, survey private real estate developers and find that past contamination does not deter redevelopment of previously contaminated properties. The authors additionally find that liability relief is stronger incentive than the simple financial subsidies provided by governments. Although this study sheds light on perceptions of private developers engaging in development activities, the majority of respondents come from European countries where legal structures are different from those of the US. Therefore, caution should be exercised when interpreting the findings of this study. De Sousa (2005), for another example, interviews the stakeholders (private as well as public) and reveal that economic factors (i.e., whether or not profits or revenues can be generated) are the dominant reasons for involvement in brownfield development. The stakeholders report that high costs and limited governmental support is the major obstacle for their investing in brownfield properties. Respondents report

that governments should secure stable funds for brownfield development and should as well simplify developmental procedures (i.e., elimination of procedural sluggishness) in order to increase policy effectiveness. Finally, the author finds that respondents generally agree that brownfield development should be connected to a broader sustainable development framework.

Finally, some researchers are interested in the roles of contamination in market transactions (Howland 2004; Pryce 2003; Schoenbaum 2002; Yount 1997). This is an interesting topic because hazardous waste facilities reduce property values of adjacent area (Nelson et al. 1992; Ihlanfeldt and Taylor 2004; Simon and Saginor 2006). Therefore, some might believe environmental contamination might reduce market transactions; hence, polluted properties tend to be abandoned or underutilized. Studies suggest that environmental contamination played limited role in market transactions of properties. Howland (2004), for example, examines whether contamination influences sales and selling prices of contaminated parcels (N=45) in southwest Baltimore, for one industrial area. He finds that contamination is not the main factor when a parcel remains unsold because the market reflects contamination in reduction of prices of such parcels. Rather, characteristics of unsold parcels tend to be their small and odd shapes, obsolete infrastructure (i.e., served by a narrow road and lacking telecommunications connections), and incompatible surrounding land uses. Similarly, Schoenbaum (2002) finds that contamination alone does not explain unused or underutilized brownfield sites in Fairfield, an industrial area in Baltimore. The author investigates parcel records from 1963 to 1999 and finds no systematic relationships between environmental contamination of a parcel and assessed value, land vacancy, property turnover, and economic development.

3-2-2 Resident-Oriented Perspectives

A numbers of studies focus on resident-oriented brownfield development, and these compare socioeconomic characteristics of cities or municipalities that have brownfield properties (Greenberg et al. 2000; Solitare and Greenberg 2002). The studies fail to examine the impacts of brownfield properties on the neighborhood level. Greenberg and colleagues (2000) examine the impacts of brownfield properties on adjacent properties by surveying local officials in all the municipalities (566) in the state of New

Jersey⁵. Among 454 cities and municipalities responding to this survey, 146 cities and municipalities claim at least one brownfield property. Based on tax assessor knowledge, 15 brownfield properties (major impact brownfields) have experienced adverse impacts (i.e., decline in property values) spreading beyond a quarter mile. Cities and municipalities that have major impact brownfields are considered socioeconomically disadvantaged. Solitare and Greenberg (2002) compare cities that received EPA brownfield assessment pilot grants with ones which did not receive such funding. Because brownfield development aims to improve the socioeconomic conditions of adjacent neighborhoods, the authors reason that grants should be distributed among cities suffering the poorest socioeconomic conditions. It appears that the authors assume brownfield redevelopment leads to improving socioeconomic conditions, which might not be an appropriate assumption. An independent sample T-test reveals that cities receiving such grants tend to be socioeconomically disadvantaged. Based on this finding, the authors conclude that the brownfield assessment pilot grant funds are justly distributed⁶.

With respect to studies examining outcome of brownfield development, De Sousa (2005) uses a brownfield database provided by the state of Wisconsin and finds that the city of Milwaukee created or retained 2,200 full-time and part-time jobs and generated revenues of \$325 million in 64 projects, each project thus generating approximately \$5 million. It is unclear, however, whether local residents in fact became beneficiaries (in terms of employment opportunities) of the development.

Then there are the studies that deal with the preferences of residents in the community development process. Greenberg and Lewis (2000) survey residents living near brownfield properties in Perth, New Jersey, and find that residents are not likely to prefer commercial and industrial development of adjacent brownfield properties. Rather, they prefer recreation facilities such as neighborhood parks and community centers

⁵ The authors rely on knowledge of municipal tax assessors when brownfields are classified. In this study, tax assessors were instructed not to include any abandoned gas stations as brownfields. The major impacted brownfields are termed TOAD (Temporarily Obsolete Abandoned Derelict Site).

⁶ In this study, the unit of analysis is the city or municipality. The authors compare socioeconomic conditions of various groups. Cities or municipalities with EPA grants are compared to ones without EPA grants. Moreover, cities or municipalities with EPA grants are compared to those without EPA grants in the same states. The final comparison groups were chosen based on similar demographic and economic characteristics of cities or municipalities with EPA grants versus ones without EPA grants.

followed by affordable housing. In this survey, the authors find that although about 75% of the respondents are willing to participate in the brownfield development process, only 20% of the respondents have been actively involved in civic activities in the past two years. Greenberg (1999) also summarizes the results of previous surveys, reporting that industrial and commercial development tends to lower residents' perceptions of neighborhood quality unless the development directly benefits their neighborhoods (i.e., provision of employment opportunities). In this study, the authors survey residents in the state of New Jersey with respect to their perception of neighborhood quality and find that crime, blight, and physical decay are negative factors in neighborhood quality. That is, without actually dealing with those problems (crime, blight, and decay), their perceptions of neighborhood quality is unlikely to improve. Interestingly, local residents do not want brownfield properties to be developed for commercial and industrial purposes, possibly because they knew that conventional economic development will not provide employment opportunities for them. Therefore, local residents do not want commercial and industrial development which provides few economic impacts on their neighborhoods at the same time as lowering their perceptions of neighborhood quality⁷.

3-2-3 Legal/Political Perspectives

In terms of the legal/political aspects of brownfield development, Monk (2000) argues that state-initiated Voluntary Cleanup programs are vulnerable to lawsuits on the basis of Title VI of the 1964 Civil Right Act, which prohibits discrimination based on race, color, or national origin in any program or activity of a federal financial assistance recipient (Eady 2003). In other words, brownfield programs in most states allow lower cleanup standards when the use will be commercial or industrial. Coupled with the fact that minority populations tend disproportionately to live near brownfields, those programs produce disproportional impacts on minority populations, which is interpretable

⁷ One study suggests conflicts between local residents and governmental officials in the process of local economic development (Jennings 2004). When the city of Boston proposed a bio-tech company in the impoverished African American neighborhood of Roxbury, coalitions among Roxbury residents, neighborhood organizations, the Roxbury Neighborhood Council, and the Boston Redevelopment Authority successfully prevented approval of the biotech company through the Roxbury Master Plan process in which local residents played the critical role of defining clear community interests for future land uses. Instead of outside companies, community residents could successfully argue for small local businesses, affordable housing, and safe neighborhood parks. What residents wanted in this study is consistent with the study introduced above (Greenberg and Lewis 2000).

as a violation of the Civil Right Act (Monk 2000). Although it is reasonable to claim that brownfields are located near impoverished and minority neighborhoods given the historic economic decline of US central cities, there is no study to date to scientifically evaluate such disparity. Many environmental justice lawsuits have relied on Title VI of the Civil Rights Act in winning their suits (i.e., Chester, Pennsylvania: Cole and Foster 2001; Monk 2000). However, the application of Title VI of the Civil Rights Act has in recent years become attenuated (Stephens 2005). In 2001, the US Supreme Court held that private citizens did not have the legal standing to enforce the Title VI ruling in an unrelated Alabama case (Eady 2003). After this decision, a number of complaints based on Title VI claims were judicially denied⁸.

Greenberg and his colleagues (2001) claim that brownfield development is one of the most viable smart growth options, the central theme of smart growth or growth management endeavors being to reduce suburban sprawl by inducing development in urban areas where development has already occurred. The advantages of brownfield development as a smart growth option are environmental improvement, economic feasibility, and reduction of economic disparities between cities and suburbs. Brownfield development enhances air and water quality by reducing the number of private automobiles due to the compacting of urban forms and the preserving of open spaces in suburban areas, respectively. Furthermore, the cleanup of contaminated properties reduces potential threats to public health. Considering that many smart growth options often impose restrictions on development⁹, brownfield development is more economically feasible given that economic improvement of adjacent areas can be

⁸ Before the Alabama case, the federal district court of New Jersey ruled in 2001 that the New Jersey Department of Environmental Protection failed to perform an adequate Title VI analysis, and the court granted a preliminary injunction against construction of a cement plant to the plaintiff, the South Camden Citizens in Action company (Eady 2003). After the Alabama case, however, the Third Circuit Court of Appeals voided its previous decision and allowed the cement company to begin operation. Because the court interpreted that the right of the South Camden Citizens in Action to sue the government for enforcement came from federal regulations and not from Title VI itself, private citizens were prohibited from suing to enforce the EPA Title VI regulations (Pomar and Godsil 2006).

⁹ Two popular smart growth options are purchasing development rights from property owners whose properties are located in environmentally sensitive areas and imposing impact fees. When developmental rights are purchased, uses of such properties are limited with the exception of agricultural activities (Stokes et al. 1997). Many local governments imposed impact fees for suburban properties to compensate governmental costs of providing infrastructure such as water and sewers (Kelly and Becker 2000; Porter 1997; Zovanyi 1998). The basic idea behind these two approaches lies in the fact that sprawl will be reduced if it proves difficult and costly to develop suburban areas.

expected. It is also anticipated that brownfield development can reduce economic disparities between cities and suburbs. Suburban sprawl is in fact responsible for increasing economic disparities between cities and suburbs given that it attracts the wealthy to suburbs and leaves the impoverished in cities (Orfield 1997; Rusk 1997; 2000). Thus, brownfield development is capable of reducing social and environmental injustice.

Regardless of its advantages, brownfield development poses a considerable dilemma (Greenberg et al. 2001). Too-flexible cleanup standards can harm the comparative advantage of public health given inadequate cleanup while too-inflexible cleanup standard can reduce the comparative advantage of economic feasibility given blocking the economic development of contaminated properties. By the same token, too-stringent cleanup standards could lead to project delays, resulting in brownfield development's losing comparative advantage over greenfields as discussed in Howland's study (2003). Accordingly, policy makers and urban planners should be aware of the tradeoffs of developing and implementing effective and efficient brownfield policies.

Although brownfield development can be a tool to reduce suburban sprawl and social and/or environmental injustice, there are several issues that must be considered. As discussed, brownfield development must provide direct economic benefits to local residents to reduce economic and social disparity between city and suburb. Furthermore, as discussed, gentrification must be controlled. If existing impoverished residents are displaced by relatively wealthy newcomers, it is difficult to claim that brownfield development reduce economic and social disparity between city and suburb. Therefore, when brownfield development is employed as a smart growth tool, policy makers and planners should deal with the two issues.

Finally, McCarthy (2002) claims that brownfield development faces challenges in terms of land use policy. Whereas brownfield development should eliminate or reduce barriers that prevent brownfield properties from being developed, brownfield development should correspond to broader community goals, a daunting challenge given that the preference of local residents differ from those of local politicians and policy makers. While local residents prefer to have community-oriented facilities such as parks or community centers, politicians and policy makers prefer commercial and industrial facilities capable of creating revenues for their jurisdictions (Greenberg and

Lewis 2001). Therefore, public participation is critical in the process of brownfield development, and many scholars agree that public participation in brownfield development is important (Dixon 2003; Greenberg et al. 1999, 2000; Greenberg and Lewis 2001; Hula 2002; McCarthy 2002). However, it is equally important that the public should be involved in the decision-making process. In the planning literature, public participation is often held in the late phase of the decision-making process (Jarobe 1986; Plein et al. 1998; Tauxe 1995), limiting the degree of influence that participants can exercise given that most of the decisions will already have been made. In this respect, public participation in the planning process is often misused to legitimize decisions or avoid responsibility when goals are not achieved. Thus, McCarthy (2002) asserts that early involvement of local residents is crucial for successful brownfield development¹⁰.

Although these are crucial topics in brownfield development, contemporary brownfield research is devoid of small-scale analysis in brownfield development. In other words, it is not scientifically proven that brownfields are located in impoverished and minority neighborhoods within a metropolitan area, a city, or municipality. Furthermore, previous studies suggest that the presence of brownfields influences subjective opinions of neighborhood quality as reported by local residents. However, it is to date unclear whether the presence of brownfields influences the socioeconomic conditions of adjacent neighborhoods. Finally, also unclear is whether positive externalities were generated by governmental economic development policies, that is, whether the socioeconomic conditions of local neighborhoods show improvement after governmental economic development policies have been implemented. The next chapter will introduce theoretical frameworks and hypotheses of this dissertation.

¹⁰ The most compelling reason for public participation in the decision-making process lies in the democratic nature of decision-making. However, one study indicates that public participation can improve the quality of decisions given the contributions of unique knowledge of local residents (Corburn 2003).

CHAPTER 4: THEORETICAL FRAMEWORKS

The theoretical frameworks of this dissertation consist of two bodies: borrowing from environmental justice literature and synthesizing sociological theories. For locations of brownfields and changes in socioeconomic status of adjacent neighborhoods (research question 1 and 2), new theoretical explanations will be developed based on synthesizing sociological theories; they are concentration of poverty, residential segregation, and deindustrialization. In regard to cleanup prioritization (research question 3), theories from environmental justice literature will be used; they are the sociopolitical theory including the resource mobilization theory and indirect institutional discrimination. This chapter discusses a new theoretical framework to explain racial and socioeconomic disparities of brownfield locations followed by reviewing existing theories to explain racial and socioeconomic disparities of brownfield cleanup prioritization.

4-1 Locational Disparity of Brownfields

Environmental justice studies often find that hazardous waste facilities tend to be located near impoverished and minority-concentrated neighborhoods, and three theoretical explanations are offered (Mohai and Saha 2007; Saha and Mohai 2005). First, the rational choice models are one of the reasons why such facilities tend to be disproportionately located near impoverished and minority-neighborhoods. Because cheap land is often available near such neighborhoods, facilities owners tend to site their facilities near these neighborhoods (Mohai and Saha 2007; Saha and Mohai 2005). Second, sociopolitical models offer an explanation why hazardous waste facilities tend to be disproportionately located near impoverished and minority-neighborhoods. Because residents in impoverished neighborhoods need employment opportunities, governments tend to grant siting permits of hazardous waste facilities in hopes for economic benefits from these facilities. In addition, governments often grant siting permits of hazardous waste facilities in impoverished and minority neighborhoods because residents in these neighborhoods possess weak political power (Mohai and Saha 2007; Saha and Mohai

2005). Third and finally, racial discrimination models are also considered as a reason for racial disparities of locations of hazardous waste facilities. Discrimination against minorities in past led socioeconomic disparities between whites and minorities, which in turn led those locational disparities (Mohai and Saha 2007; Saha and Mohai 2005). More detailed discussion with respect to indirect institutionalized discrimination (Feagin and Feagin 1987) will be followed in the next section.

The first two explanations do not provide sufficient explanations of why brownfields are spatially concentrated and why neighborhoods adjacent to high concentrations of brownfields might experience socioeconomic status decline over time. For example, because owners of brownfields abandoned not sited their facilities, rational choice models do not directly introduce environmental burdens into nearby neighborhoods. Moreover, because no governmental permit is required for facilities to leave from one place to others, the claim that sociopolitical models contribute to locational disparities of brownfields make little sense. The key component of brownfield locations lies in why facilities are abandoned rather than sited. As a result, the creation of brownfields should be seen as concomitant of societal change rather than the intentional acts of facility owners or governments. Thus, rather than relying on siting disparity theories, theories must be synthesized to explain brownfield locations. Deindustrialization, spatial concentration of poverty, and residential segregation can provide more direct answers to such questions.

Spatial concentration of poverty along with structural and spatial deindustrialization go a considerable way toward explaining why brownfield properties are disproportionately located in impoverished and minority neighborhoods. Spatial deindustrialization refers to the relocation of industrial facilities to other sites within the U.S. (deindustrialization of central cities: Wilson 1987) and structural deindustrialization refers to the relocation of industrial facilities to foreign countries, and especially Third World countries experiencing the pressures of globalization (deindustrialization of the US society; Davey 1995). That is, spatial deindustrialization represents the spatial rearrangement of manufacturing facilities within the U.S. (from central cities to suburbs or from one state to another) whereas structural deindustrialization represents the transformation of U.S. society from industrial to post-industrial. The availability of

cheap land may be one reason for the occurrence of industrial suburbanization (Fernandez 1994; Sugrue 1996). Further, financial incentives appear to be a reason for interstate relocation of industrial facilities (Ledebur and Woodward [1990] 1999). In terms of international relocation, a cheap labor pool and lax environmental regulation can constitute reasons for U.S. companies to relocate their plants abroad (Kletzer 2000; Simon 2000; Sugrue 1996). Because the U.S. has stringent environmental regulations, full compliance can prove difficult due to the high costs. Further, U.S. labor costs are higher than those of Third World countries. In this light, multinational corporations may have been enticed by cost-saving opportunities to relocate their manufacturing plants to Third World countries in which an abundant supply of cheap labor and lax environmental regulation are available. In short, the relocation of manufacturing facilities from central cities to various new locations has left many potential brownfield properties in central cities though not all such facilities went on to become brownfields.

In particular, deindustrialization in the Detroit region and found that suburbanization of manufacturing plants occurred as early as the 1950s (Boas 1961; Sugrue 1996; Wheeler 1971). Ford and General Motors relocated their assembly plants from the city of Detroit to suburbs in the early 1950s, followed by Chrysler in the late 1950s. It appears that automation has resulted in the suburbanization of such plants. That is, installation of automated assembly lines requires new spatial layouts that are difficult to install in existing Detroit facilities; thus, new assembly plants were built in suburbs that have been specifically designed for automated assembly lines. However, Sugrue (1996) claims that one covert reason for the suburbanization of manufacturing plants is to weaken the power of the unions. Lee (2005) also finds that union power is generally inversely associated with the degree of deindustrialization in nations. Finally, because highways are capable of transporting goods from one place to others with relatively fast and cheap, the construction of highways of the 1950s and 1960s might also have contributed to suburbanization of manufacturing facilities (Farley et al. 2000).

Whatever the actual reasons, suburbanization of plants led to subsequent suburbanization of independent auto-suppliers for the Big Three companies (Ford, GM, and Chrysler). Because of poor provisions of transportation in the mid-20th century, suppliers were often necessarily located near the location of the buyers. Geographic

proximity of industrial facilities sometimes generates mutually beneficial effects (Saxenian 1994). Thus, although the Big Three companies initiated suburbanization of their manufacturing plants in the 1950s, the decline of manufacturing establishments in Detroit became visible in the 1960s when independent auto suppliers for the automobile companies moved to where the Big Three assembly plants moved (Sugrue 1996). The decline in manufacturing establishments in Detroit provides supporting evidence. Manufacturing establishments in Detroit had been relatively stable from 1947 to 1963 (from 3272 in 1947 to 3370 in 1963). However, the number began to noticeably decline, falling from 3370 firms in 1963 to 1954 firms in 1977 (See Table 2-1). Manufacturing employees in Detroit also declined after 1967, from 209 thousand employees in 1967 to 153 thousand employees in 1977.

In terms of manufacturing establishments and their employees in the tri-county area (Macomb, Oakland, and Wayne), it becomes apparent that many manufacturing jobs had been relocated from the city of Detroit to suburbs. In 1947, there were 3272 and 1493 manufacturing establishments in city of Detroit and its suburbs, respectively. However, suburban manufacturing establishments (3653) outnumbered city's ones (3370), and gap between the two became greater in 1992 (see Table 2-2). The total employees in manufacturing show the same pattern, suburban employees in manufacturing began to outnumber city's ones from 1963 until 1992 (see Table 2-2).

A close examination of manufacturing facilities in Detroit reveals an interesting pattern. In 1967, Detroit experienced urban riots that lasted four days. This riot caused 43 dead, 467 injured, over 7200 arrests, and more than 2000 buildings burned down (Farley et al. 2000; Sugrue 1996). When examining declines in manufacturing facilities in Detroit closely, Detroit lost 423 facilities (or 12.3% decline) in the pre-riots period (from 1963 to 1967). In the post-riots period (from 1967 to 1972), however, Detroit lost 549 facilities, or 18.6% decline (see Table 4-1). The city of Detroit continued to lose manufacturing facilities. For example, the city lost 444 manufacturing establishments between 1972 and 1977, approximately a 19% decline (see Table 4-2). Because the inauguration of the first African American mayor, Coleman Young in 1974, might have scared white manufacturing facility owners, this could be a reason for the continual decline in manufacturing establishments in Detroit after 1972. Therefore, it

appears that the Detroit riots in 1967 and the emergence of the Coleman Young administration might have accelerated the process of suburbanization of manufacturing facilities in the 1960s and 1970s. In short, although automation coupled with cheap available land in suburbs contributed to industrial suburbanization in the broader sense, two crucial historic events might provide a reason why industrial suburbanization accelerated in the late 1960s and 1970s.

Then, what socioeconomic impact deindustrialization rendered in inner city neighborhoods? Spatial and structural deindustrialization leads to pervasive joblessness in central city neighborhoods where manufacturing facilities were once located. Pervasive joblessness in inner city neighborhoods also results in the concentration of poverty. There are two perspectives on the links between deindustrialization and the subsequent spatial concentration of poverty: selective out-migration and residential segregation. Wilson (1987) claims that the Civil Rights Movement of the 1960s opened up social opportunities for minorities, especially for African Americans who had historically been singled out for discrimination. To avail themselves of the new opportunities, most working class and middle class African Americans relocated from their inner city neighborhoods to the white suburbs for improved housing and social opportunities. This exodus of the working and middle classes from inner city neighborhoods (selective out-migration) then creates a social vacuum in which residents of disadvantaged neighborhoods suffer from a lack of social institutions and role models. Lack of a social buffer makes juveniles particularly vulnerable when few adults are able to play an appropriate role model for them.

Per Wilson (1987), the exodus of working and middle class African Americans from inner city neighborhoods coupled with deindustrialization generate the so-called 'concentration effect,' or the development of undesirable and/or antisocial behaviors consequent to social isolation from mainstream white culture. Later, Wilson (1996) identifies social network deficiencies as a reason for the high level of joblessness experienced by inner city residents. In other words, residents who are already gainfully employed could provide valuable insights with respect to employment, such as what employers expect from employees, how job prospects should approach the interview, and where jobs are to be found. Because most inner city residents are not gainfully

employed or are employed in low-paying jobs while most working and middle class people who are likely to possess this information have departed for the white suburbs, the jobless residents of inner city neighborhoods have a hard time availing themselves of employment opportunities. It is apparent that persistent inner city joblessness resulting from plant relocations and closures in league with the absence of neighborhood role models then leads to a high rate of poverty.

Massey and Denton (1993) argue that concentrations of poverty do not result from the selective out-migration of working and middle class African Americans from inner city neighborhoods. Rather, residential segregation is responsible for creating concentrations of poverty. If the exodus of the working and middle classes coupled with the departure of manufacturing plants from central cities are together responsible for concentrations of poverty in inner city neighborhoods, why did these disproportionately impact African Americans and not whites? They claim that residential segregation locks impoverished residents into geographically confined areas, the inner cities, and thus they are unable to go where jobs go because of segregation. At this point, residential segregation provides a valuable backdrop for the spatial mismatch hypothesis. It posits that high levels of inner-city joblessness often result from the fact that inner-city residents are unable to move where the new manufacturing jobs moved after the 1960s. This then creates a mismatch between the locations of jobs and the people needing these jobs (Beggs et al. 1997; Blumenberg and Manville 2004; Fernandez and Su 2004; Fong et al. 2005; Gottlieb and Lentnek 2001; Ihlanfeldt and Sjoquist 1998; Kasarda 1989; Mouw 2000; Raphael 1998a; 1998b; Stoll et al. 2000). Due to this mismatch, inner city residents can be seen to suffer from high levels of joblessness leading to high levels of poverty.

In Detroit contexts, the riot of 1967 and inauguration of Coleman Young has played important role in housing segregation against African Americans (Farley et al. 2000; Sugrue 1996). Because whites might perceived that Detroit was not the safe place to live from the riot of 1967, they might subsequently have relocated themselves to suburbs. The former Detroit Mayor, Coleman Young launched on his mayoral campaign on the basis of race, crime, and police and easily defeated his rival white candidate, John Nicholas in the 1973 mayoral election due to the continuing exodus of whites (Farley et

al. 2000). In this vein, the inauguration of Coleman Young might have fortified the beliefs of whites that Detroit was not the safe place to live and led them to leaving the city. Concentration of poverty in Detroit's African American neighborhoods became evident in the 1970s and 1980s (Farley et al. 2000; Sugrue 1996) because of deindustrialization and residential segregation against African Americans.

In terms of empirical evaluation, residential mobility studies find that both selective out-migration and residential segregation are supported (Crowder and South 2005; Morenoff and Sampson 1997; Quillian 1999; South and Crowder 1997). That is, working and middle class African Americans do leave core areas of the inner city (selective out-migration); however, the arrival of working and middle class African Americans at white suburbs impels whites to leave for other suburbs of metropolitan areas, which only serves to maintain residential segregation for the working and middle class African Americans (residential segregation). Inferring from residential mobility studies, the differences between selective out-migration and residential segregation result in failure to understand the spatial dynamics of neighborhood change. Wilson for one fails to understand the process of neighborhood change (i.e., the influx of African Americans does result in the out-migration of whites) while Massey for another fails to consider the prior racial composition of African American working and middle class neighborhoods which he claims to be segregated. With respect to Detroit, Sugrue (1996: 269) stated that whites "reminded reluctant to live in racially mixed neighborhoods, and even when middle-class African Americans moved into prosperous suburbs like Southfield, just north of Detroit, the white population has fled, creating new segregated enclaves."

In order to combine selective out-migration and residential segregation in completing the mechanism that suggests the ways in which poverty is spatially concentrated, the context of time is important. That is, due to historical residential segregation prior to the 1960s, residential areas for minority populations were very limited and found mostly in inner city neighborhoods. However, given the Civil Rights Movement, relatively wealthy minorities could afford to escape from ghetto areas, leaving impoverished residents behind (selective out-migration). Having left them, poor minority residents in inner-city neighborhoods were unable to move due to the

class and racial segregation. Therefore, residential segregation after the 1970s does not appear to provide a cohesive explanation of why poverty is spatially concentrated. Rather, historical residential segregation patterns play a critical role in generating spatial concentration of poverty.

There is a study, however, that suggests why race might be a stronger predictor than income of brownfield locations. Morenoff and Sampson (1997) examine the relationship between population loss and violent crime in Chicago from 1970 to 1990 taking into account of concentration of socioeconomic disadvantage. Using the 1970, 1980, and 1990 census data along with homicide records having geographic identifiers, the authors employed multivariate analysis to find that relatively wealthy African Americans who presumably moved from ghetto areas do not live far from such areas. This finding suggests that relatively wealthy African American populations might live near brownfields compared to white populations of similar socioeconomic status. In other words, while historical residential segregation explains why poverty is spatially concentrated in inner-city neighborhoods, contemporary residential segregation can explain why relatively wealthy African Americans suffer from disproportional environmental burdens including the locational disparity of brownfields.

Spatial and structural deindustrialization and concentration of poverty can also explain why brownfield properties might be spatially concentrated. According to a model of local economy (Blakely and Bradshaw 2002), local economy is built upon basic industries which are the main source of the economic revenue such as taxes for local governments and income for local residents. Furthermore, there are many supplemented industries which rely on basic industries. Finally, local service industries are generated to meet service needs for local residents. Applying this model to the Detroit region, basic industries can be the Big Three companies while supplemented industries can be auto part suppliers for the Big Three. Finally, local service industries are various types such as gas stations, body shops, junk yards, and restaurants. In terms of the present analysis, category 1 brownfield will refer to basic and supplemented industries where as category 2 brownfield will mean local service industries.

Because deindustrialization left category 1 brownfield in inner city areas to become potential brownfields, many more brownfields may have been generated from the spatial

concentration of poverty due to deindustrialization. When poverty is concentrated in inner city neighborhoods, residents thereof lose their purchasing power to sustain local businesses. Loss of purchasing power leads to sluggishness of the local economic base, which in turn results in relocations and/or closures of local businesses. When businesses are relocated and/or closed, some local businesses such as gas stations, body shops, and junk yards have the potential to become category 2 brownfield. In short, spatial and structural deindustrialization suggest that the category 1 brownfields (mostly large manufacturing facilities) were generated by the function of a new social and spatial order (deindustrialization) independent from the racial and socioeconomic conditions of adjacent neighborhoods. When the category 1 brownfields were generated, the category 2 brownfields (mostly small service facilities such as gas stations) were created because of the decline of socioeconomic conditions of the neighborhoods triggered by the category 1 brownfields. Thus, it is reasonable to hypothesize that brownfields may be spatially concentrated (see Figure 4-1 for timeline of deindustrialization and its consequences).

According to Wilson (1987, 1996) and Massey and Denton (1993), concentration of poverty in inner-city neighborhoods started in the 1970s with the start of deindustrialization. Morenoff and Tienda (1997) find that relatively few underclass neighborhoods existed in Chicago as of 1970. However, underclass neighborhoods increased remarkably during the 1970s and 1980s. Specifically, there were 22 neighborhoods categorized as underclass in 1970, but that number grew to 187 and 256 in 1980 and 1990, respectively. Once neighborhoods became underclass neighborhoods where poverty and joblessness are concentrated, it is unlikely that they will cease to be underclass neighborhoods in subsequent decades. In the same study, Morenoff and Tienda (1997) find that only two out of 22 underclass neighborhoods in 1970 became non-underclass neighborhoods in 1980. That is, only eleven out of 187 underclass neighborhoods in 1980 managed to upgrade their socioeconomic conditions to become non-underclass neighborhoods by 1990. My own analysis of the Detroit region yields similar results. Considering high concentrations of brownfields in which poverty is concentrated, it is reasonable to hypothesize that the concentration of brownfields can be a predictor of dramatic decline in the socioeconomic conditions of adjacent

neighborhoods between 1970 and 1980. Subsequently, such neighborhoods remained socioeconomically impoverished neighborhoods in the years up to 2000.

4-2 Cleanup Prioritization of Brownfields

Sociopolitical theory, resource mobilization, and indirect institutionalized discrimination are relevant for the third research question; whether brownfield cleanup prioritization is associated with socioeconomic characteristics of nearby neighborhoods. Saha and Mohai (2005) give a sociopolitical explanation for the disparity in siting of hazardous waste facilities. This explanation posits the idea that the political influence of individuals (i.e., power and access to the decision-making process) explains why some receive benefits and some do not (Pastor 2003; Saha and Mohai 2005). In other words, because impoverished and minority populations tend to have limited resources for taking political actions, their voices fail to register. Furthermore, immigrants lacking U.S. citizenship tend to compose a vulnerable population segment excluded from governmental benefits because they do not yet exert any political influences such as found in voting. Bullard (2000) claims, for example, that siting of hazardous waste facilities tends to follow the “path of least political resistance” which holds that siting permits for hazardous waste facilities are often issued in areas populated by less politically powerful groups. Bullard and Wright (1987) claim that a promise of employment opportunities and a broadened tax base in economically distressed area often justifies siting of hazardous waste facilities in impoverished and minority neighborhoods. That is, because residents in economically distressed areas desperately need employment opportunities, environmental risks and potential adverse health effects due to siting of hazardous waste facilities are often seen as acceptable tradeoffs. In other words, residents in economically distressed areas are forced to make personal sacrifices for employment opportunities, or termed as environmental blackmail (Bullard and Wright 1987: 23).

Pastor (2003) reviews the siting disparities of TSDf studies in the Los Angeles area and concludes that they support a political rationale. Cole and Foster (2001) also claim that minority voices are not heeded in siting decisions. More direct evidence with respect to sociopolitical theory can be found in a study examining relationships between capacity expansion of hazardous waste facilities and racial and socioeconomic conditions

of zip codes where the facilities were sited (Hamilton 1995). This study finds that percent of persons voting in the county¹ is the strongest predictor while percent of minority in zip codes is not a statistically significant predictor of whether hazardous waste facilities expand their capacity when voting is controlled. Considering voting as proxy to political power, this study supports the sociopolitical theory. Cole and Foster (2001) observe that building a coalition to form stronger political power is often proven to be effective. In the Chester, Pennsylvania, case where governments granted placement of commercial waste facilities in the African American enclave, residents of this community filed a lawsuit. When they failed to dissuade governments from placing a waste facility, coalitions between Chester Residents Concerned about Quality of Life (CRCQL) and external organizations such as Campus Coalition Concerning Chester was formed. Known as C4, such a coalition delivered a strong message to local governments and corporations, and settlements between companies and residents were reached. These two examples stress the important of political power to obtain governmental concessions. In short, the central thesis of the sociopolitical theory lies in the assertion that politically powerless groups in being excluded from the benefits from governmental decisions often suffer disproportional burdens.

In collective actions or social protests to acquire governmental concessions, resource mobilization theorists claim that resource availability is one of the key factors (McCarthy and Zald 1997; Morris 1981). In other words, political clout is to some extent a function of the availability of resources to individuals and groups for mobilizing a community into action. Resources cannot be narrowly defined in monetary terms but in more inclusive terms such as the presence of pre-existing organizations or pre-established networks (Schwartz and Paul 1992). Schwartz and Paul (1992), for example, argue that the possession of monetary resources alone does not lead to successful social movements. They show that the organization Mother Against Drunk Driving (MADD) received great support among the general public, and large public supports were realized (congressmen, media, and money). However, in terms of membership this movement failed to generate the membership increases comparable to other social movements such as Southern Farmers' Alliance and National Organization for Women. Pre-existing

¹ Although unit of analysis in this study is zip codes, the author estimates the voting by percent of county.

social networks and organizations emerged from the Civil Rights Movement to contribute to the emergence of the environmental justice movement (Taylor 2000).

Although resource mobilization theorists conceive of resources in a broader sense, socioeconomic status is important because those who have financial, informational, and other resources are more likely to mobilize and have influence. That is, higher socioeconomic wealthy individuals tend to create social networks (or social cliques) to help each other. Through established social networks, they mutually support each other (Mill 1994). Thus, socioeconomic status can serve as proxy to current and future resource availability. Given the importance of financial, informational, and other resources, socioeconomic conditions of neighborhood can be predictors of which neighborhoods are prioritized for brownfield cleanup and which ones are not.

Finally, Saha and Mohai (2005) argue that indirect institutionalized discrimination is another possible explanation of why siting disparities of hazardous waste facilities exist. Indirect institutionalized discrimination “refers to practices having a negative and differential impact on minorities and women even though the organizationally prescribed or community-prescribed norms or regulations guiding those actions were established, and are carried out, without prejudice or intent to harm laying immediately behind them” (Feagin and Feagin 1987: 31). That is, the discriminatory intent of certain actions is irrelevant to determining indirect institutional discrimination. Rather, the discriminatory outcomes or consequences are crucial to the concept of indirect institutional discrimination. Feagin and Feagin (1987) explain two forms of indirect institutionalized discrimination: side-effect and past-in-present discrimination. Side-effect discrimination refers to discriminatory consequences in one area resulting from discrimination in other areas; discrimination in education, for example, leads to unequal economic opportunities in employment. Past-in-present discrimination refers to discriminatory consequences in the present resulting from intentional denial from the past; discrimination in hiring practices in the past, for instance, results in unequal job seniority in the present between minorities and whites.

Indirect institutionalized discrimination is applicable to possible discriminatory cleanup prioritization. Due to past constraints (prior to the 1960s) of political activities against minorities such as voting, minorities are underrepresented in the political arena,

which leads to the fact that voices of minorities are not often seriously heard. Although this version of indirect institutionalized discrimination seems to be embedded in the sociopolitical process², many additional racially discriminatory practices (i.e., residential segregation and labor market discrimination) existed in the past, which leads to contemporary racial inequalities.

Although the theoretical dimensions described above (the sociopolitical theory, resource mobilization, and indirect institutionalized discrimination) might seem to be independent of each other, such dimensions are inter-related. Past-discrimination has denied economic and social opportunities of minority populations, leading to resource and network deficiency. Such deficiency leads to lack of political power of minority populations. Resource availability is also a key in establishing strong political power. Thus, such a complicated structural racial inequality makes minority populations be vulnerable to environmental burdens.

4-3 Research Hypotheses

Research question 1 asks whether brownfields are disproportionately located near impoverished and poor neighborhoods. In addition, research question 2 asks whether the presence of brownfields is associated with decline in socioeconomic conditions of adjacent neighborhoods. In order to answer those questions, hypotheses are developed by relying on spatial concentration of poverty (selective out-migration and residential segregation).

Hypothesis 1. Given selective out-migration and historical residential segregation, brownfields are disproportionately located near impoverished and minority neighborhoods. Although brownfield development was initiated in the mid-1990s, its economic effect might be too early to be realized. This hypothesis will be tested by virtue of the associations between the locations of brownfields and the racial socioeconomic conditions of adjacent neighborhoods by using the 2000 US Census.

² Zimmerman (1993) finds that when National Priority List (NPL) sites became controversial near white neighborhoods, residents of such neighborhoods enjoy prompt cleanup of NPL sites. However, controversial NPL sites in African American neighborhoods, such sites will not be cleaned up promptly. Furthermore, the Warren county incident, where the government proposed a toxic incinerator in a poor and African American community, serves as another example. Even though residents of Warren County successfully promoted their cases in the national level and enjoyed supports from the whole nation, residents and their allies failed to accomplish the main goal (dissuading hosting the toxic incinerator: Labalme 1989). These two examples suggest that minority populations might have fundamentally limited political powers compared to whites due to past discrimination.

Thus, if brownfields are more likely to be located near impoverished neighborhoods with high concentrations of minorities, this hypothesis is then supported.

Hypothesis 2. Because deindustrialization resulted in rather than resulted from socioeconomic decline of inner city neighborhoods, the presence of category 1 brownfields is associated with socioeconomic decline of neighborhoods adjacent to category 1 brownfields after, not before, 1970. Furthermore, given concentration of poverty, neighborhoods adjacent to category 2 brownfields experience a decline in their socioeconomic conditions after 1970. It would be a good idea if the brownfield sample in this study could be categorized into the two groups to probe the causal relationships between locations of brownfields and socioeconomic decline in adjacent neighborhoods. However, there is insufficient information to categorize brownfields into the two groups. Due to such limitation³, this hypothesis tests whether there are associations, rather than causal relationships, between locations of brownfields and socioeconomic decline in adjacent neighborhoods.

This hypothesis will be tested based on longitudinal assessment of socioeconomic changes between neighborhoods adjacent and far from brownfields from 1960 to 2000. Thus, if neighborhoods with the presence of brownfields within certain radii (0.5 mile radius or 1.0 mile radius) experience a more dramatic decline in socioeconomic conditions after 1970 than the decline before 1970, this hypothesis is then supported. Furthermore, if neighborhoods with the presence of brownfields within certain radii experience a more dramatic decline in socioeconomic conditions than do neighborhoods with no brownfields within certain radii, this hypothesis is also supported.

Hypothesis 3. Given selective out-migration and contemporary residential segregation, middle class African Americans relocated from neighborhoods adjacent to brownfields; however, they did not move any appreciable distance from neighborhoods adjacent to brownfields. This hypothesis will be tested based on changes in coefficient values of racial and economic variables between 0.5, 1.0, and 1.5 mile radii from brownfields with employment of multivariate regression. If coefficients of racial

³ Regardless of data limitation, brownfields tend to be spatially concentrated. Because the creation of category 1 brownfields affected socioeconomic conditions of adjacent neighborhoods where category 2 brownfields tended to be subsequently located, it can be assumed a close proximity between category 1 and 2 brownfields.

variables increase yet ones of economic variables (i.e., income) decrease their explanatory powers as radius from brownfield expanded (from 0.5 mile to 1.5 mile), this hypothesis is then supported.

Research question 3 asks which neighborhoods enjoy brownfield cleanup prioritization. In order to answer this question, hypotheses are developed by relying on resource mobilization theory, sociopolitical theory, and indirect institutionalized discrimination.

Hypothesis 4. Because sociopolitical theory stresses the importance of political power to receive benefits from governmental policies, cleanup prioritization of brownfields is given to neighborhoods having stronger political power. It appears that resource is a key to establish strong political power, which suggests that individuals with higher socioeconomic conditions have a greater political power than do ones with lower socioeconomic conditions. This hypothesis thus will be tested based on associations between socioeconomic characteristics of neighborhoods and cleanup prioritization of nearby brownfields. That is, if neighborhoods that have higher socioeconomic characteristics are more likely to get prompt cleanup of nearby brownfields than are neighborhoods that have lower socioeconomic characteristics, this hypothesis is then supported.

Hypothesis 5. Because indirect institutionalized discrimination explanations focus on disproportional consequences based on race regardless of intent, cleanup prioritization is predicted to be given to neighborhoods having lower concentrations of minorities. This hypothesis will be tested based on associations between cleanup prioritization and racial composition of adjacent neighborhoods. Thus, if brownfields near neighborhoods with high concentrations of minorities are not likely to get cleanup prioritization, this hypothesis is then supported. Moreover, if race remains a significant predictor of cleanup prioritization even after socioeconomic and sociopolitical characteristics are controlled, such a finding suggests that direct institutionalized discrimination might exist in brownfield cleanup prioritization. Direct institutionalized discrimination⁴ refers to

⁴ Feagin and Feagin (1986: 30) discuss direct institutionalized discrimination as “organizationally-prescribed or community-prescribed actions which have an intentionally differential and negative impact on members of subordinate groups. Typically these actions are not carried out on an episodic or sporadic basis, but continually or routinely by a large number of individuals guided by the rules of a large-scale

the fact that statistically racial variables maintain explanatory power that socioeconomic and sociopolitical variables cannot explain. However, this does not provide evidence of the existence of intentional racial bias because it can be possible that variables that are not introduced in the regression model can explain cleanup prioritization mediating through racial variables. However, before finding those variables, direct institutionalized discrimination is partially responsible for disparate cleanup prioritization. The next chapter will discuss methods of this dissertation including data, variables, and spatial as well as analytic methods.

organization.”

Table 4-1 Manufacturing employment in Detroit from 1947 to 1977

	1947	1954	1958	1963	1967	1972	1977
Manufacturing Firms	3372	3453	3363	3370	2947	2398	1954
Total Manufacturing Employment (1000)	338.4	296.5	204.4	200.6	209.7	180.4	153.3
Total Production Employment (1000)	281.5	232.3	145.1	141.4	149.6	125.8	107.5

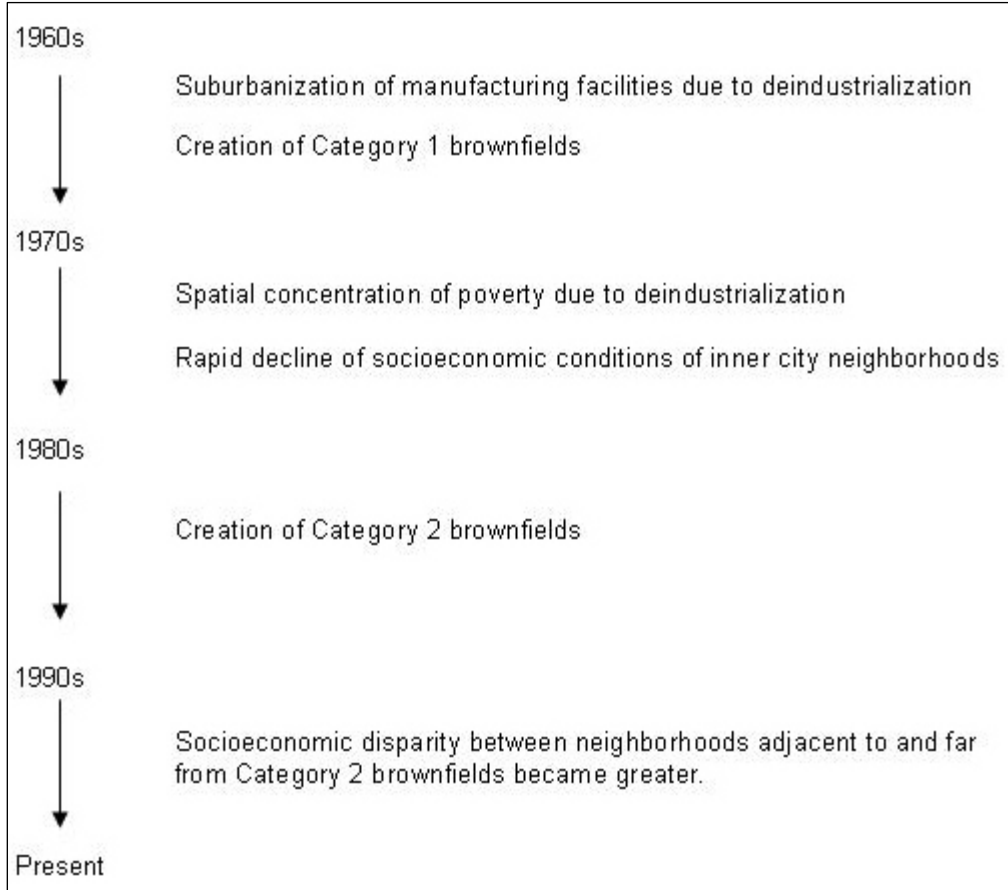
(Sugrue 1996: 144)

Table 4-2 Numbers of manufacturing establishments and their employees in the tri-county area from 1947 to 1992

	1947	1963	1972	1982	1992
Numbers of Manufacturing Establishments					
City of Detroit	3272	3370	2398	1518	1061
Suburbs (Macomb, Oakland, and Wayne)	1493	3653	4726	5763	6195
Total	4765	7023	7124	7281	7256
Total Employees in Manufacturing (in 1000)					
City of Detroit	338	201	180	106	62
Suburbs (Macomb, Oakland, and Wayne)	219	294	356	302	339
Total	557	495	536	408	401

(Farley et al. 2000: 66)

Figure 4-1 Chronology of orders of events and their consequences



CHAPTER 5: RESEARCH METHOD

As previously discussed, three research questions and five hypotheses constitute this dissertation. The first research question asks whether brownfields are disproportionately located near impoverished and minority neighborhoods, the second whether the presence of brownfields is associated with the socioeconomic decline of adjacent neighborhoods, and the third whether brownfield cleanup prioritization is associated with the racial and socioeconomic conditions of nearby neighborhoods. To address those three questions, this chapter discusses the data and spatial/analytic methods of the dissertation.

The study area of the dissertation is the tri-county area including Macomb, Oakland, and Wayne counties within the Detroit Primary Metropolitan Statistical Area (PMSA) comprised of the six counties of Lapeer, Macomb, Monroe, Oakland, St. Clair, and Wayne per definition by the 2000 Census of Housing and Population (see Figure 5-1). This study proposes to conduct a secondary data analysis use of demographic and spatial data referring to locations of brownfields provided by the Michigan Department of Environmental Quality (MDEQ) and demographic data referring to racial and socioeconomic characteristics from the 1960, 1970, 1980, 1990, and 2000 US Census of Housing and Population. While cross-sectional analyses are used to answer the first and third research questions¹, longitudinal analyses of data from 1960-2000 US Census of Housing and Population are used to answer the second research question. The unit of analysis for research questions 1 and 3 is the census block group, while the census tract is the unit of analysis for research question 2. Because census block groups are the smallest available census units containing racial and socioeconomic characteristics, they are selected as the unit of analysis when applicable. In conducting longitudinal analyses, however, employment of census block groups is not feasible because census block groups

¹ The racial and socioeconomic characteristics of census block groups were extracted from the 2000 US Census of Housing and Population in answer to the first research question, whereas the above characteristics were extracted from the 1990 US Census of Housing and Population in answer to the third research question.

did not exist in 1960 and 1970. As an alternative, census tracts are used in conducting longitudinal analyses.

5-1 Data

5-1-1 Spatial Data

With reference to chapter 1 in which two formal definitions of brownfields are provided, the United States Environmental Protection Agency (USEPA) Region 5 defines brownfields as “abandoned, idled, or underutilized industrial or commercial sites where expansion or redevelopment is complicated by real or perceived environmental contamination that can add cost, time, or uncertainty to a redevelopment project” (Davis 2002: 5). On the other hand, the United States Office of Technology Assessment (USOTA) defines brownfields as sites “whose redevelopment may be hindered not only by potential contamination, but also by poor locations, old, or obsolete infrastructure, or other less tangible factors often linked to neighborhood decline” (Davis 2002: 5). No formal definition of brownfields is found in the Brownfield Redevelopment Financing Act; however, in the definition section of this Act, a definition of ‘blighted properties’ is provided, suggesting that the state of Michigan accepts the brownfield definition provided by the United States Office of Technology Assessment which includes physically deteriorated structures not suspected of having environmental contamination in the form of brownfields.

The state of Michigan provides no complete lists of brownfields. When the website of the Michigan Department of Environmental Quality is searched using ‘brownfield’ as the key word, only Underground Storage Tank (USTfield) and Leaking Underground Storage Tank (LUST) lists are found. Properties are listed in the LUST database if environmental contamination (from underground storage tanks) has occurred and the property is still in use. The USTfield database, on the other hand, includes only abandoned properties with past releases from underground storage tanks (e.g., gas stations, dry cleaners, body shops). The USTfield database is a conglomeration of several databases created from lists of state-funded cleanup sites. Furthermore, the Baseline Environmental Assessment (BEA) indicates that additional sites not on the LUST list (i.e., abandoned gas stations whose underground tanks has been removed) are included in the USTfield database (Smedley 2006a). These assessments of the extent of

contamination of properties can be performed if a local government identifies properties suspected to be environmentally contaminated. Prospective owners can also request local governments to perform BEAs to avoid future environmental liabilities from properties they are about to purchase (MDEQ undated). It can thus be assumed that all brownfields listed in the USTfield databases are in fact brownfields, though those databases do not cover all brownfields in the study area. Unfortunately, large-scale abandoned industrial sites, or category 1 brownfields, are not included in this database. No database for such sites, to the best of author's knowledge, exists.

The theoretical framework in this dissertation is built around explaining the socioeconomic impacts of abandoned or underutilized properties in adjacent neighborhoods. In other words, a key hypothesis will be that properties are abandoned or underutilized because employment opportunities have disappeared. As explained previously, LUST sites include currently active properties that contain leaking underground tanks, while the USTfield database consists of abandoned properties with old releases that have not been cleaned up. Because LUST sites include many environmentally contaminated properties when they are still in active use, it is difficult to attribute socioeconomic decline to the presence of such sites (such as the linkage between disappearance of jobs and concentration of poverty) (see chapter 4 for detailed discussion). In addition, LUST database does not contain the cleanup status information that is essential for addressing the third research question of which neighborhoods enjoy prompt cleanup. For those reasons, LUST sites are not appropriate candidates for brownfields and thus are excluded from this study. Because there is no other brownfield databases except for LUST and USTfield, identification of brownfields in this dissertation is thus based on the USTfield database provided by the Michigan Department of Environmental Quality (MDEQ)².

Admittedly, the USTfield database is an incomplete list of brownfields (Smedley 2006a), and the MDEQ is currently working on developing a more complete list of

² This information is available through the web-page (<http://www.deq.state.mi.us/ustfields>). The list of brownfield properties in this web-page were completed in May 2004. The MDEQ assesses whether those sites are environmentally contaminated. If contaminated, they are cleaned up and redeveloped; otherwise, they are redeveloped.

brownfields³. This is an ambitious project, however, and an updated list is not available nor has a release date been announced. As previously discussed, there are three reasons that make it difficult to assess the exact number of brownfields applicable to this study: (1) local governments are reluctant to admit that they have many brownfields given brownfield association with stigma (Greenberg et al. 2000), (2) property owners do not report their abandoned properties for fear of incurring expensive cleanup costs (mothballed properties; Greenberg et al. 2000), and (3) the MDEQ has failed to track blighted or functionally obsolete properties for environmental contamination resulting from other than underground tanks (Smedley 2006a). Considering the difficulty of assessing the exact number of brownfields in Michigan, the MDEQ's USTfield database stands as the most complete list of brownfields available in the study area. To this author's best knowledge, no prior study has taken advantage of this database as a proxy to brownfields.

There are 389 brownfields listed in the USTfield database in the study area. The UTSfield database does not provide zip codes for properties, which are necessary for geo-coding. Zip codes for the brownfields were thus obtained from Mapquest, a firm that provides maps that include zip codes when street addresses, cities, and states are given. The address of each brownfield in this database was thus manually entered and the appropriate zip codes extracted. In extracting the zip codes of the properties, those of 34 properties (8.7%) were not to be found, either because of incorrect street names or incorrect city or municipality names. By excluding those zip codeless properties, the number of brownfields included in this study was thus reduced to 355. Figure 5-2 shows the general pattern of brownfield locations, which tends to be concentrated in the city of Detroit and adjacent cities and townships.

Finally, the USTfield database provides the cleanup statuses of listed brownfields, which are (1) 'not cleaned up,' (2) 'completed,' (3) 'in progress,' (4) 'pending,' (5) 'cancelled,' (6) 'closed,' and (7) 'time to be assigned' (see Table 4-1 for detailed information on these statuses). The three statuses of 'not cleaned up,' 'completed,' and 'in progress,' are straightforward while others need further explanations. 'Pending'

³ This list includes sites in USTfield data as well as properties submitted for approval under the Brownfield Redevelopment Financing Act (Act 381 of 1996) for school tax capture to reimburse eligible environmental costs.

means that environmental assessments or cleanups are temporarily ceased due to insufficient funds. ‘Closed’ refers to the completion of environmental assessments with the determination of no serious environmental contamination requiring cleanup actions, while ‘cancelled’ refers to the completion of an environmental assessment with no environmental contamination. Although both the ‘closed’ and ‘cancelled’ statuses do not require cleanup actions, environmental contamination short of being serious enough to warrant action is found in the ‘closed’ status, while no environmental contamination was found in the ‘cancelled’ status. ‘Time to be assigned’ status means that cleanup actions will be made later and have equivalence to ‘not cleaned up’ (Smedley 2005).

5-1-2 Census Data

The 1970-2000 census data comes from Geolytic, Inc., and provides not only the racial and socioeconomic characteristics of census units (i.e., census tracts and census block groups) but also digitized maps of census units. There are three sources of data for racial and socioeconomic characteristics. To address the first research question of whether brownfields are disproportionately located in impoverished and minority neighborhoods, the racial and socioeconomic characteristics of census block groups in 2000 were obtained from the 2000 Geolytic Census of Housing and Population. Furthermore, in addressing the third research question of whether brownfield cleanup prioritization is associated with socioeconomic conditions of nearby neighborhoods, racial and socioeconomic characteristics of census block groups in 1990 were also taken from the 1990 Geolytic Census of Housing and Population. Because the second research question of whether the presence of brownfields is associated with decline of socioeconomic conditions of adjacent neighborhoods involves longitudinal data analysis, racial and socioeconomic characteristics are extracted from Geolytic’s Neighborhood Change Database (NCDB) that normalized census tract boundaries in 1970, 1980, and 1990 to the boundaries in 2000⁴. Use of NCDB reveals that normalized census tract boundaries from 1970 to 2000 are consistent, a fact that enables researchers to conduct

⁴ Geolytics Inc., teamed up with the Urban Institute to create proprietary weighting tables for 1970, 1980, and 1990 for use in converting census tracts from previous years into census tracts of 2000 (Tatian, 2003). The proprietary weighting tables were created on the basis of the populations of the blocks of preceding years. By summing up and weighting the population of census blocks in preceding years (i.e., 1970, 1980, and 1990) which geographically correspond to the tract boundaries of 2000, both Geolytics Inc. and the Urban Institute claim that this method ensures more accurate data estimation than reliance on the simple areal apportionment method (Geolytics Inc. undated; Tatian, 2003).

longitudinal analyses. Because Geolytic, Inc., does not provide 1960 census data on the tract level, the racial and socioeconomic characteristics for all census tracts in the tri-county area had to be manually extracted from the 1960 US Census of Housing and Population. These data were thus obtained from the University of Michigan Map Library which has the 1960 digitized census tract boundaries for the tri-county area. Inconsistent census tract boundaries from 1960 onward were addressed with by employing distance-based methods to be discussed later in this chapter.

5-1-3 Variables

There are four groups of independent variables in this dissertation: racial, socioeconomic, sociopolitical, and housing, and these variables are frequently used in environmental justice and urban sociology studies. Although two different units of analysis (census block groups for the first and third research questions and census tracts for the second research question) are used, the same variables are applied. Racial variables include percents of non-Hispanic white persons⁵, African Americans, and Hispanics. Socioeconomic variables include percents of female-headed families with dependent children, persons below the poverty line, households receiving public assistance, unemployed persons, average household income⁶, and average housing values for owner-occupied housing units. Sociopolitical variables include percents of persons over 25 who do not have a high school diploma, persons over 25 who have a bachelor's degree or higher, employed persons occupied in white collar occupations⁷, and employed persons occupied in blue collar occupations⁸. Housing variables include percents of vacant housing units and owner-occupied housing units.

Because various racial and socioeconomic variables are not available in 1960, racial and socioeconomic variables for the first part of the second research question are based on what variables are available in the 1960 Census. Racial and socioeconomic variables not available in 1960 but became available in the later decades are (1) the percent of non-

⁵ For the longitudinal analyses, the percent of whites is used because the number of non-Hispanic whites did not exist in 1960 and 1970 US Census data.

⁶ For the longitudinal analyses, average family income is used because it did not exist in the 1960, 1970, and 1980 US Census data.

⁷ White collar occupations include the professional and managerial.

⁸ Blue collar occupations include the construction, production, transportation, and material-moving.

Hispanic whites⁹ (2) the percent of Hispanics, (3) the percent of female-headed family with dependent children, (4) the percent of persons under the poverty line, (5) the percent of household receiving public assistance income, and (6) average household income¹⁰. Occupational variables such as percent of blue and white collar occupations are not included. Because major categories of occupational variable in the 1960 census report were not comparable to later decades, all sub-categories of such a variable need to make comparable white and blue collar occupations. Manually extracting all sub-categories of such a variable for the census tract level turns out to be labor and time intense. Due to limited personal and financial resources, occupational variables are excluded. For more detailed information with respect to the construction of these variables, see Appendices A, B, C, and D.

Each research question employs slightly different sets of dependent variables. For example, dependent variables for the first research question are the presence of brownfields within certain radii (0.5, 1.0, and 1.5 miles) from brownfields and numbers of brownfields within 0.5, 1.0, or 1.5 mile radius from block group centroids. However, the dependent variable for the third research question is the percent of cleaned-up brownfields within certain radii (0.5 and 1.0 mile) from block group centroids. For the second research question, the dependent variable is whether the majority of the areas in census tracts are captured by 0.5 or 1.0 mile circular buffers from brownfields. Each dependent variable will be discussed in greater detail in the corresponding results chapters.

5-2 Method

5-2-1 Spatial Method

Brownfields were geo-coded by employing the address-matching function in ArcView 3.3. In using address-matching to place a point on a digitized map, street maps with street addresses, cities, and zip codes are required. The Topologically Integrated Geographic Encoding and Referencing file (TIGER: available at Census Bureau web site: <http://www.census.gov/geo/www/tiger>) contains not only an all-streets network but also census units such as census tracts, census block groups, and census blocks for every

⁹ This variable is replaced by the percent of whites.

¹⁰ This variable is replaced by the average family income.

county in the United States. Thus, the 2000 TIGER file was employed for address-matching in placing brownfields on digitized maps containing the census units in the tri-county area.

This dissertation employs distance-based methods (or the aggregating or averaging of spatial units in accordance with distance from points of interest) to define the neighborhoods nearest brownfields. Three methods (the centroid-containment, the 50% areal containment, and the areal apportionment) were employed given inconsistent census boundaries between decades and the author's convenience, which is to be discussed below. The centroid containment method aggregates or averages the socioeconomic characteristics of census units whose centroids are captured within circles of a specified distance from brownfields. The 50% areal containment method aggregates or averages the socioeconomic characteristics of census units in which more than 50% of their areas are captured within circles of a specified distance from brownfields. The areal apportionment method aggregates the weighted population characteristics of the census units intersected by the circles of a given radius, with weights equaling the proportion of areas of the census units falling within the radius of a facility (Mohai and Saha 2006). For example, if a census tract has a population of 1000 and 30% of its area falls within the radius of a facility, the number of individuals potentially under the influence of that facility can be estimated to be 300 ($1,000 \times 0.3$). If 50% of the area of another tract falls within the same radius, then 50% of its population is taken and combined with that of the first, and so on. The areal apportionment method assumes that populations are uniformly distributed in spatial units, though this is not always true; nonetheless, this method is capable of more precisely capturing population near sites than the conventional unit-hazard coincidence method (see Mohai and Saha 2006, 2007). Because there is to date no scientific evaluation to measure the precise socioeconomic impacts of brownfields to adjacent neighborhoods, several distances (0.5, 1.0, 1.5, and 2.0 mile) were employed to compare results from among them. This comparison can then determine whether the use of different distances from brownfields seriously alters the results.

This study employs all the distance-based methods for various reasons. First, the areal apportionment method is used for descriptive statistics. This method tends to yield

more consistent results than the other two methods regardless of which spatial units (zip codes, census tracts, census block groups) are used (Mohai and Saha 2007). However, statistical tests under the areal apportionment method are difficult to conduct. Thus, the centroid containment and 50% containment methods were used when conducting statistical tests. In addition, the areal apportionment method was used in conducting longitudinal analysis employing 1960-2000 US Census data, because the 1960 census tract boundaries are inconsistent with the boundaries from subsequent decades and areal apportionment defines circular buffers around brownfields that prove most consistent and stable from decade to decade.

In the statistical analyses, the centroid containment method is used when the unit of analysis was census block groups. If the unit of analysis is census tracts, the 50% areal containment method is used. Ideally, a consistent approach would be used in applying the distance-based method. However, when computing the number of brownfields captured within 0.5, 1.0, or 1.5 mile radii from block group centroids, the process that uses the 50% areal containment method turns out to be labor and time intensive¹¹. Furthermore, when the unit of analysis is the block group, both the 50% areal containment and centroid containment methods capture the identical census block groups within 0.5 and 1.0 mile radii from brownfields. For this reason, the centroid containment method is used when block groups are used in the analyses.

When the unit of analysis is the census tracts, however, the two distance-based methods capture different sets of tracts. For example, centroids of thirteen census tracts in the 1960 US Census are captured within a 1.0 mile radius from brownfields, yet less than 50% of the areas for these census tracts are captured within a 1.0 mile radius from brownfields (see Figure 5-3 (a)). Conversely, eight census tracts are captured by 1.0 mile circular buffers from brownfields at least 50% of the areas, but the centroids of these census tracts are not captured within a 1.0 mile circular buffers from brownfields (see Figure 5-3 (b)). When the socioeconomic impacts of brownfields are estimated, it

¹¹ Arcview software provides the direct function of selecting spatial units (i.e., census block groups) if their centroids fall into the other geographical feature (i.e., into the circular buffer from brownfields). When the 50% areal containment method is used, several steps must be manually taken to compute the proportion of census units captured by circular buffers from block group centroids. Because the number of brownfields must be computed by one brownfield at a time (N=355), use of the 50% areal containment method adds thousands of additional steps in comparison to the centroid containment method.

makes more sense to attribute the presence of brownfields to socioeconomic conditions of census tracts in which the majority of census tracts have fallen into circular buffers from brownfields rather than in which centroids have simply fallen into the buffers. For this reason, the 50% areal containment method is used when the unit of analysis is census tracts.

Conventionally, the unit-hazard coincidence method, or simple dichotomization of spatial units in accordance with the hosting or non-hosting of at least one hazard of interest, has been widely employed in environmental justice research (Mohai and Saha 2006). The problem with this method lies in its inability to capture nearby spatial units that might be affected by the hazard of interest (i.e., hazardous waste facilities or brownfields). This method is particularly problematic for proposed of this study because it uses census units in urbanized areas where such units tend to be small (Mohai and Saha 2006). Thus, nearby units may also be located quite close to brownfields. For instance in Figure 5-4 (a), only one census block group is captured by the unit-hazard coincidence method (see the darkly shaded block group containing the site). However, four additional census block groups relatively close to the brownfield site are captured by the centroid containment method using a 0.5 mile radius from the brownfield site. If the radius is expanded from 0.5 mile to 1.0 mile, several additional census blocks are captured (see Figure 5-4 (b)). If the unit-hazard coincidence method is used, many census block groups that could be influenced by a site are excluded, which could lead to critical measurement errors. For this reason distance-based methods are used in this dissertation.

Ideally, brownfields should be categorized into two groups: category 1 brownfields, or large manufacturing facilities and category 2 brownfields, or small-scale neighborhood service facilities (see chapter 4 for detailed discussion). Based on names of brownfields in the USTfield database, 251 brownfields appear to be category 2¹². The remaining 104 brownfields, it is difficult to determine which category (category 1 or category 2) they fall. Although given that the brownfields in USTfield database contain underground storage tanks which are frequently found in service-oriented facilities such

¹² If the name of brownfield is 'shell gas station,' then this brownfield is category 2. Other typical names that help categorize brownfields are 'body shop' or 'dry cleaner.'

as gas stations, it appears that brownfields in this database might be category 2, insufficient information is provided in the USTfield database to make a definitive categorization of brownfields. In addition, it is essential to know the dates when properties were abandoned and these data are unavailable. Such information can potentially be obtained via an examination of parcel records for each property. However, many property owners continue to pay property taxes even after they decide to stop using their properties out of fear of possible expensive cleanup costs. Thus, the dates of discontinued payments of property taxes from parcel records are not an accurate determiner of property abandonment. Because of these limitations, longitudinal analyses in this dissertation attempts to establish associations at best between the presence of brownfields and the socioeconomic conditions of adjacent neighborhoods rather than establish causal relationships between the two.

Finally, brownfields are spatially concentrated such that it is difficult to classify block groups by brownfield cleanup prioritizations through use of the seven statuses provided by the USTfield database. That is, one 1990 census block could be located within several brownfields whose cleanup statuses differ. This is problematic given that observations must be independent of each other in the conducting of statistical analyses. To ensure that observations are independent of each other, cleanup statuses are dichotomized into two categories, after which the percentages in each category over the total number of brownfields were computed. The first category signifies that cleanup actions have not been initiated. Thus the two statuses 'not cleaned up' and 'time to be assigned' were combined. The second category signifies that cleanup actions have been initiated or completed. At this point the remaining five statuses were combined. For example, suppose that there are five brownfields within a 1.0 radius from a centroid of a census block group and cleanup status for two of the five brownfields is 'completed,' the cleanup status for the third is 'cancelled,' and the cleanup status for the remaining two is 'time to be assigned.' The value assigned to this census block group is therefore 0.6 (three out of five), meaning that cleanup actions has been initiated for 60% of brownfields within a 1.0 mile radius from a centroid of this census block.

5-2-2 Analytic Method

Several analytic methods are employed in this dissertation. For the first and third

research questions, cross-sectional analyses are performed. Both descriptive statistics involving bi-variate correlations and multi-variate analyses involving logistic and linear regressions are applied. For the first research question of whether brownfields are disproportionately located near impoverished and minority census block groups, the dependent variable for the logistic regression is whether the centroids of census block groups are located within a 0.5 or 1.0 mile radius from brownfields. On the other hand, the dependent variable for the linear regression is the number of brownfields located within a 0.5 or 1.0 mile radius from block group centroids. For the third research question of whether or not the cleanup prioritization of brownfields is associated with racial and socioeconomic conditions of nearby census block groups, the dependent variable for the linear regression is the percent of brownfields within a 0.5 or 1.0 mile radius from block group centroids in which cleanup actions have been initiated. Racial, socioeconomic, sociopolitical, and housing variables are used in terms of independent variables (see section 5-1-3 for the list of variables in the four categories).

For the second research question, longitudinal analysis is performed. The analytic method of this research question consists of two parts, the first part comparing the racial and socioeconomic conditions of census tracts or areas within and beyond a 1.0 mile radius from brownfields between 1960 and 2000 and the second part comparing the racial and socioeconomic conditions of census tracts within and beyond 0.5 and 1.0 mile radii from brownfields between 1970 and 2000 as controlled for 1970 socioeconomic conditions. The first comparison examines socioeconomic changes in census tracts or areas within a 1.0 mile radius from brownfields between 1960 and 2000 and then compares them to socioeconomic changes in census tracts or areas beyond a 1.0 mile radius from brownfields in subsequent decades. Specifically, the first comparison determines whether the degree of decline in the socioeconomic conditions of census tracts or areas within a 1.0 mile radius from brownfields by decade is greater than the degree of decline in the socioeconomic conditions of census tracts or areas beyond a 1.0 mile radius from brownfields.

When statistical tests are employed, it is essential to have consistent spatial boundaries over time. In order to construct consistent spatial boundaries from 1960 to 2000, 1.0 mile circular buffers from each brownfield are created, and racial and

socioeconomic characteristics of each area are estimated by employing the areal apportionment method. To create a comparison group of non-host neighborhoods for the statistical analyses, the same numbers of random points are generated inside the study area and 1.0 mile circular buffers are drawn around them. Since there are 355 brownfields in this study, 355 random points are generated¹³ (see Mohai and Saha 2007 for an earlier example of this approach). Then, racial and socioeconomic characteristics of areas within 1.0 mile radius from each random point (non-brownfield areas) are estimated by employing the areal apportionment method. The rationale in this approach is that if there is no relationship between the presence of brownfields and the decline in socioeconomic conditions near brownfields, difference in the socioeconomic characteristics of areas near brownfields will be similar to the difference in areas near random points between two time periods.

The second part of research question 2 addresses whether neighborhoods within a 0.5 or 1.0 mile radius from brownfields experienced greater socioeconomic decline between 1970 and 2000 than did neighborhoods beyond a 0.5 and 1.0 mile radius from brownfields when controlling for socioeconomic conditions of neighborhoods in 1970. Controlling for 1970 socioeconomic conditions means that neighborhoods sharing similar socioeconomic conditions in 1970 are categorized and changes in their socioeconomic conditions tracked separately. Therefore, the main research design for this analysis is the quasi-experimental research design that compares the racial and socioeconomic conditions between treatment and control groups in terms of treatment without random assignment (Robson 2002). The treatment group in this analysis refers to census tracts within a 0.5 or 1.0 mile radius from brownfields. The control group in this analysis refers to census tracts beyond a 0.5 or 1.0 mile radius from brownfields. In a true experimental design, random assignment of study subjects into the two groups (experimental and control) allows researchers to ensure that there are no pre-experimental differences between the two groups. That is, because subjects are randomly assigned into the two groups, it is assumed that such differences tend to be cancelled out between the two groups. Because of the random assignment, researchers are able to claim that observable post-experimental differences between the two groups can be attributed to the

¹³ Random points were generated using ArcView 3.3.

treatment.

Unfortunately, it is impossible to randomly assign neighborhoods into brownfield and non-brownfield neighborhoods. Rather than relying on random assignment, the categorization of neighborhoods on the basis of socioeconomic characteristics in 1970 functions as a random assignment. In other words, controlling for the socioeconomic characteristics in 1970 minimizes the pre-existing socioeconomic differences between neighborhoods within and beyond a 0.5 or 1.0 mile radius from brownfields so as to establish more conclusive associations between the presence of brownfields and the decline in the socioeconomic conditions of nearby census tracts. Cluster analysis, the exploratory data analysis tool that sorts different objects into groups, is used to control for the socioeconomic conditions in 1970 (Aldenderfer and Blashfield 1984; Everitt et al. 2001; Kachigan 1991; Schneider and Roberts 2004; Sireci and Geisinger 1992). The main goal of cluster analysis lies in the development of clusters that “display small within-cluster variation, but large between-cluster variation” (Kachigan 1991: 262). Thus, if census tracts belong to the same cluster, they will share similar socioeconomic characteristics. Otherwise, the degree of associations is minimal among census tracts belonging to different clusters. Initially, each observation (in this study the census tract) stands as its own cluster, at which the two observations with the lowest distance or the highest association based on similar socioeconomic, sociopolitical, and housing characteristics are clustered together. This process then repeats until every observation is clustered and optimal clusters¹⁴ have emerged (Aldenderfer and Blashfield 1984). The next chapter will present the results for the cross-sectional analysis of racial and socioeconomic conditions of neighborhoods adjacent to brownfields in 2000. This analysis aims at answering the first research question of whether brownfields are disproportionately located in impoverished and minority neighborhoods.

¹⁴ Optimal clusters are achieved when the degree of associations becomes the least among census tracts belonging to same clusters.

Table 5-1 Cleanup Statuses in the USTfield Database

Category	Number	Percent	Explanation
'not cleaned up'	148	41.7%	Cleanup actions have not been initiated.
'time to be assigned'	20	5.6%	Time of cleanup actions will be assigned later.
'completed'	117	33.0%	Cleanup actions have been completed.
'in progress'	36	10.1%	Cleanup actions have been in progress.
'pending'	9	2.5%	Cleanup actions have been temporarily ceased due to insufficient funds
'closed'	14	3.9%	Cleanup actions do not require because no contamination is found.
'cancelled'	11	3.1%	Cleanup actions do not require because contamination is not serious enough.
Total	355	100.0%	

Figure 5-1 Tri-county area in the Detroit Primary Metropolitan Statistical Area



Figure 5-2 Locations of brownfields in the tri-county area

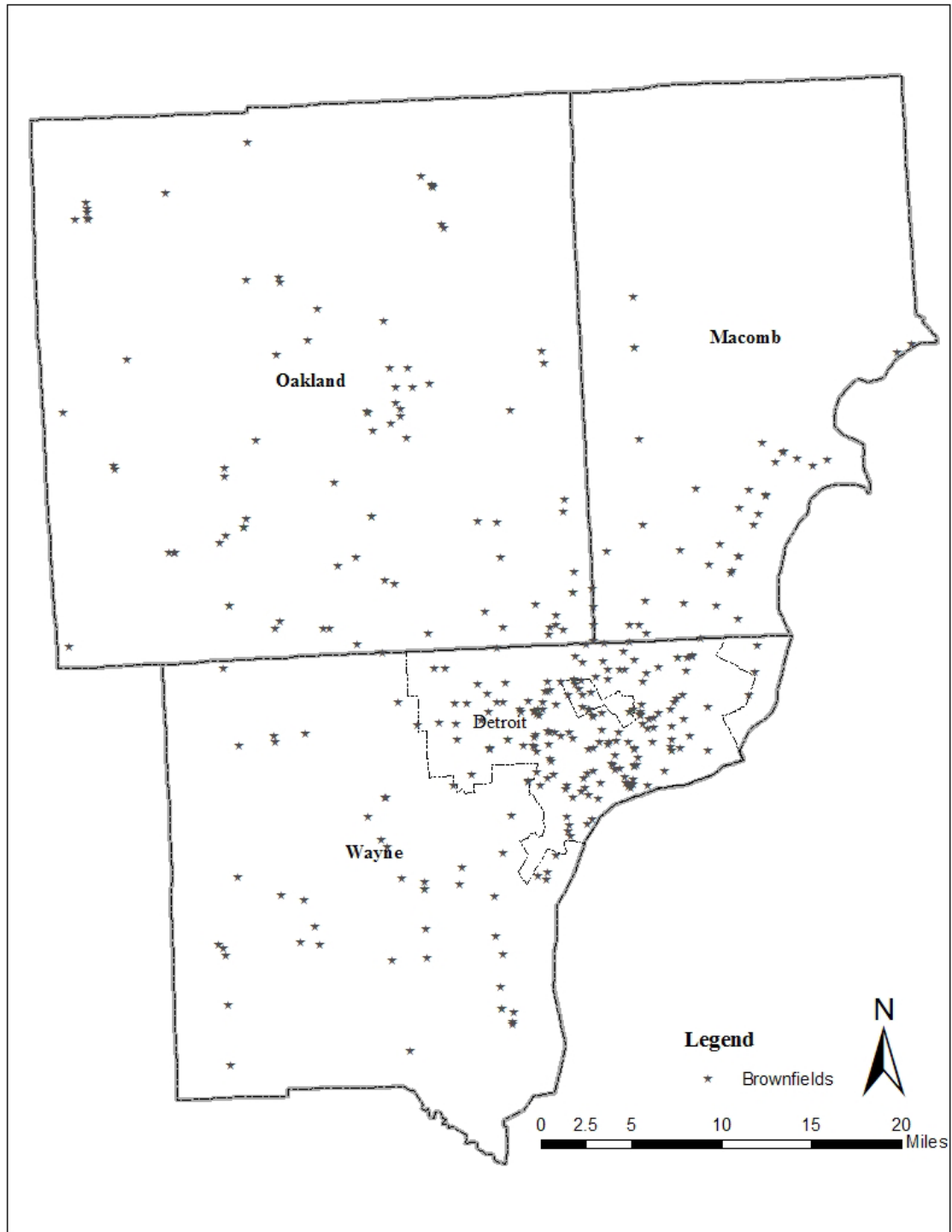


Figure 5-3 1960 Census tracts and 1.0 mile circular buffers from brownfields

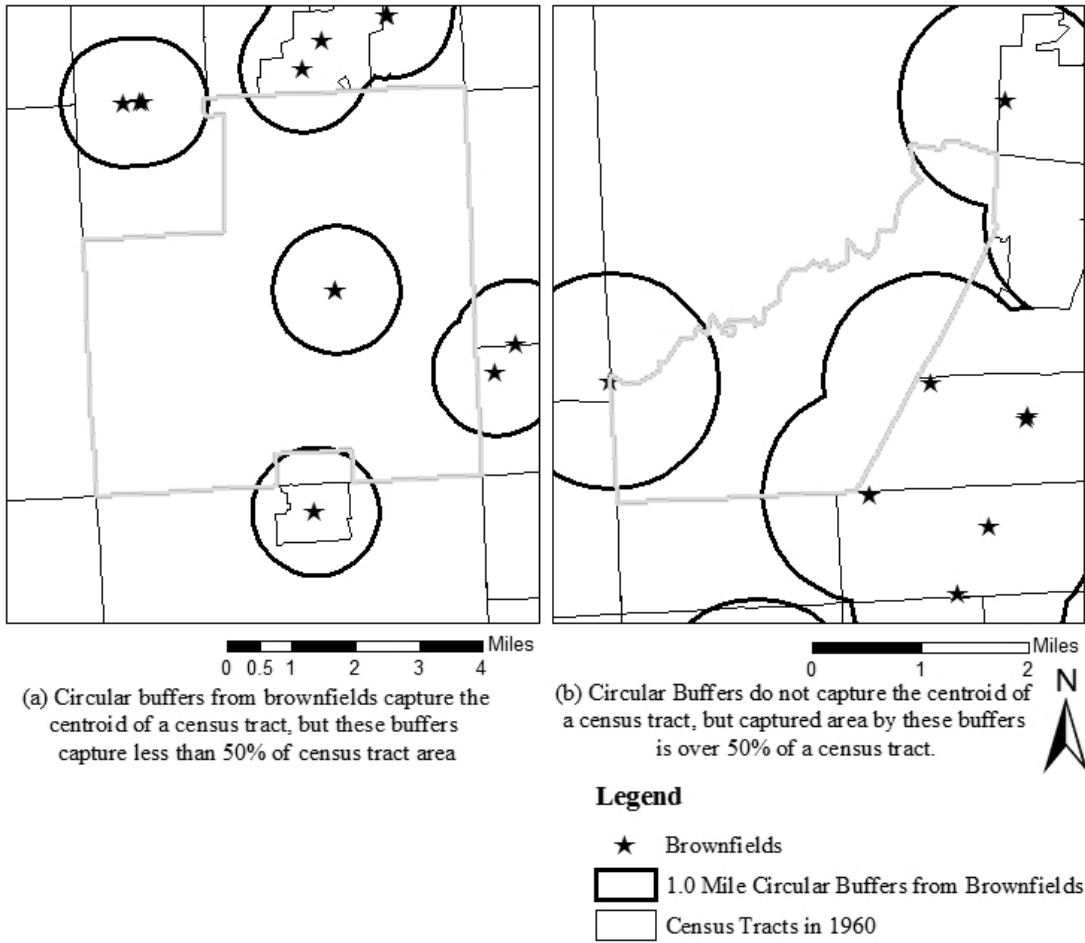
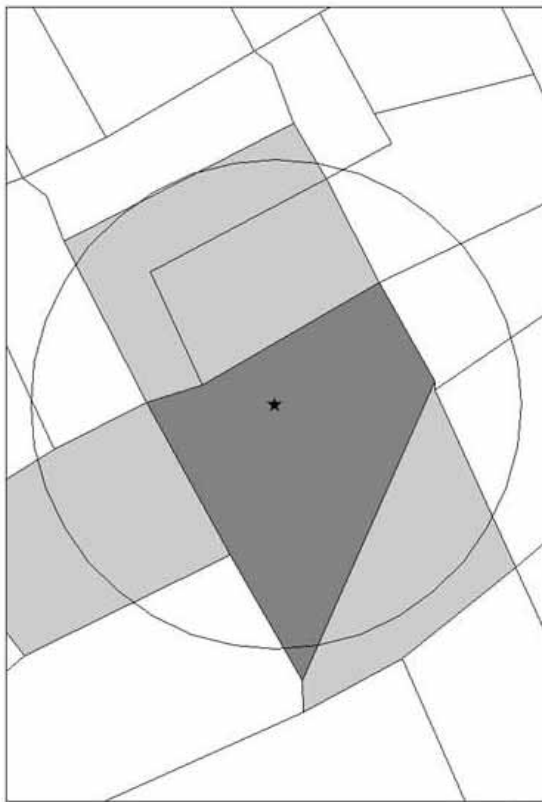
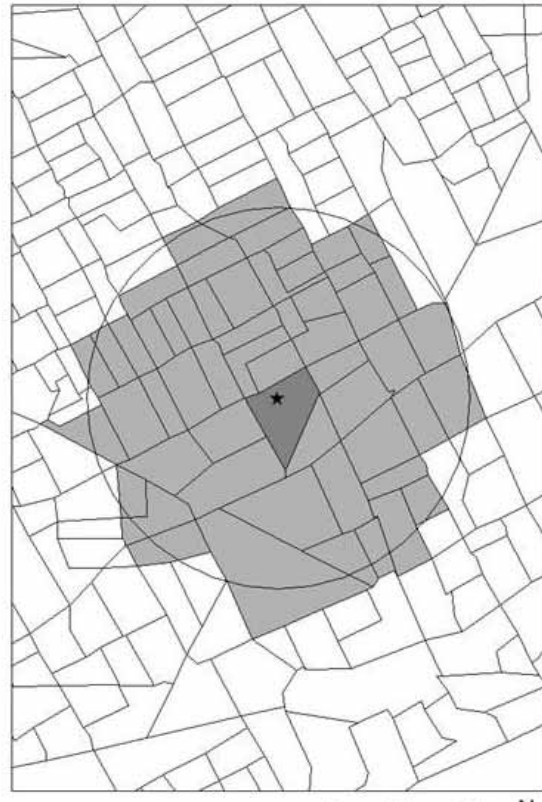


Figure 5-4 Census block groups captured by the unit-hazard coincidence method and the distance-based method



(a) Centroid Containment method with a 0.5 mile radius from a brownfield



(b) Centroid Containment method with a 1.0 mile radius from a brownfield

CHAPTER 6: CROSS-SECTIONAL ASSESSMENT OF RACIAL AND SOCIOECONOMIC CONDITIONS OF NEIGHBORHOODS ADJACENT TO BROWNFIELDS IN 2000

As discussed in the previous chapter, few studies either examine the racial and socioeconomic characteristics of neighborhoods adjacent to brownfields or develop the theoretical framework explaining why neighborhoods near brownfields are prone to socioeconomic disadvantage. An understanding of demographic characteristics is a prerequisite for local economic development plans because it can improve the effectiveness and efficiency of plans given that different population segments call for different policy remedies (Blakely and Bradshaw 2002). For the beginning step in brownfield research, this chapter examines the current locational disparity of brownfields. Specifically, this dissertation examines the socioeconomic conditions of neighborhoods near brownfields in the tri-county area in the Detroit region in 2000.

Environmental justice scholars have developed theoretical explanations as to why hazardous waste facilities are so often found in impoverished and minority neighborhoods (Mohai and Saha 2007; Saha and Mohai 2005). Although results might be similar – i.e., brownfields are disproportionately located in impoverished and minority neighborhoods – there are different theoretical explanations as to why brownfields are found in impoverished and minority neighborhoods. The important distinction between hazardous waste facilities and brownfields lies in whether the facilities are active or inactive. Because brownfields are often referred to as abandoned or underutilized properties, it is more critical to comprehend why properties are either abandoned or underutilized rather than why they are sited in those neighborhoods. Thus, as discussed previously (Chapter 4), the factors of deindustrialization, concentration of poverty, and residential segregation are key in explaining why brownfields often occur in impoverished and minority neighborhoods.

The present chapter answers the research question of whether brownfields are in fact disproportionately located in impoverished and minority neighborhoods. Based on the

theoretical framework developed in Chapter 4, this chapter tests three hypotheses from the above research question. First, it hypothesizes that neighborhoods adjacent to brownfields are socioeconomically more disadvantaged than are neighborhoods farther from brownfields. Second, it also hypothesizes that a higher percent of minority populations resides in neighborhoods near brownfields than in neighborhoods farther from brownfields. In addition, race is seen to remain a significant predictor of brownfield locations even when controlling for other variables. Finally, since Morenoff and Sampson (1997) find that relatively affluent minority populations tend to live near ghetto neighborhoods, it is hypothesized that race becomes stronger while socioeconomic characteristics become weaker predictors of brownfield locations as the radii from brownfields increase from 0.5, 1.0, and 1.5 mile.

The order of this chapter is as follows. The next section discusses data and method for this chapter. Because data and method were discussed in the previous chapter, the purpose of the data and method section in this chapter is to briefly remind readers of critical information. The results section presents findings from bi-variate and multivariate analyses of brownfield locations.

6-1 Data and Method

As discussed in the previous chapter, the units of analysis of this chapter are census block groups in a tri-county area in the Detroit region (see Figure 6-1 and 6-2). In terms of variables, two dependent variables exist. One dependent variable is dichotomous, indicating whether or not there is at least one brownfield located within a 0.5, 1.0, 1.5, or 2.0 mile radius from block group centroids. The other dependent variable indicates the number of brownfields located within 0.5, 1.0, or 1.5 mile circular buffers from a block group centroid. Independent variables include four categories: racial, socioeconomic, and housing (see Appendix A for detailed information on the construction of these variables). Finally, this chapter will employ the areal apportionment method for descriptive statistics, while the centroid containment method is employed for statistical tests (see Chapter 5 for detailed discussion of these methods).

6-2 Results

For bi-variate analysis, the areal apportionment method is employed to examine the racial and socioeconomic differences of areas within and beyond a 0.5, 1.0, 1.5, and 2.0

mile radii from brownfields in the tri-county area. The centroid containment method is used to determine whether the racial and socioeconomic characteristics of census block groups are statistically significantly correlated with distance to brownfields. Also with regard to applying the centroid containment method, logistic and ordinary least square regressions are performed to examine whether race is an independent predictor of the location of a census block group to a brownfield when controlling for socioeconomic characteristics.

6-2-1 Bi-variate Analysis

Table 6-1 gives descriptive statistics for the tri-county area in the Detroit Primary Metropolitan Statistical Area. Of the 3605 census block groups in this area, 37 census block groups contain no person. Among 3568 census block groups that contain at least one person, the mean percent of non-Hispanic whites is 62.8% with a 39.1% standard deviation. The mean percent of African Americans is 30.1% with a 40.2% standard deviation. The maximum percent of whites and African Americans are both 100% while the maximum percent of Hispanics is 83.8% (see Table 6-1). In terms of socioeconomic variables, the mean percent of female-headed families with dependent children is approximately 10% with a 10% standard deviation. The maximum percent of female-headed families with dependent children and persons below the poverty line are both 100% while the percent of unemployed persons and households receiving public assistance is 66.1% and 53.5%, respectively. The mean percent of persons over 25 with no high school diploma and with a bachelor's degree or higher is both about 21% with 13.7% and 17.8% standard deviations, respectively. In the tri-county area, 5.6% of housing units are vacant with a 7.1% standard deviation. The minimum and maximum percent of all housing variables is 0% and 100%, respectively (see Table 6-1).

Table 6-2 employs the areal apportionment method to provide descriptive statistics for the racial and socioeconomic characteristics of areas located within and beyond 0.5, 1.0, 1.5, and 2.0 miles from brownfields. Approximately 800,000 persons, or 20%, were in 2000 living in areas within a 0.5 mile radius from brownfields. As the radius from brownfields lengthens, 46.3%, 63.8%, and 76.2% of people in the tri-county area lived within 1.0, 1.5, and 2.0 mile radii from brownfields, respectively (see Table 6-2). In terms of the number of census block groups (number of observations) captured by a

0.5, 1.0, 1.5, and 2.0 mile radii from brownfields, centroids of 892 (25.0%), 1955 (54.8%), 2652 (72.5%), and 3065 (83.8%) census block groups are captured, respectively. As noted earlier, scientific evaluation is lacking with respect to the racial and socioeconomic impacts of brownfields on adjacent neighborhoods. This study thus proposes to employ multiple radii from brownfields in examining whether the adverse socioeconomic impacts of brownfields are maintained as the radius from brownfields lengthens.

Differences are apparent in the racial and socioeconomic characteristics between areas within and beyond 0.5, 1.0, 1.5, and 2.0 mile radii from brownfields. In terms of racial characteristics within and beyond a 0.5 mile radius from brownfields, a higher percent of minorities lived in areas within a 0.5 mile radius from brownfields (brownfield area) than in areas beyond a 0.5 mile radius from brownfields (non-brownfield areas). For instance, 53.1% and 10.8% of residents in brownfields areas are African Americans and Hispanics, respectively, whereas 17.9% and 3.6% of residents in non-brownfield areas are African Americans and Hispanics, respectively (see Table 6-2). Socioeconomically, brownfield areas are at greater disadvantage than non-brownfield areas. For example, 8.5% of households in brownfield areas (0.5 mile radius) receive public assistance, and 19.6% of persons are below the poverty line. However, 3.1% of households receive public assistance, and 8.0% of persons are below the poverty line in non-brownfield areas (see Table 6-2). Brownfield areas (0.5 mile radius) show a higher percent of female-headed families with dependent children and unemployed persons than do non-brownfield areas. At the same time, brownfield areas also exhibit lower average household income and housing values than do non-brownfield areas (see Table 6-2).

Residents in brownfield neighborhoods have less educational attainment. For instance, the percent of persons over 25 holding a bachelor's degree or higher and persons over 16 employed in white-collar occupations in brownfield areas (0.5 mile radius) are 14.3% and 25.3%, respectively, while the percents for non-brownfield areas are 25.9% and 36.0%, respectively (see Table 6-2). Notably, a lower percent (3.6%) of residents in brownfield areas are not US citizens than in non-brownfield areas (4.3%: see Table 6-2).

Housing characteristics show that brownfield areas are more unstable than non-

brownfield areas. For instance, a higher percent of housing units in brownfield areas are vacant, and a lower percent of housing units are owner-occupied than in non-brownfield areas. In particular, about 8.8% of housing units in brownfield areas (0.5 mile radius) are vacant while only about 4.8% of housing units in non-brownfield areas are vacant (see Table 6-2). Finally, residents in brownfield areas tend to rely more on local jobs than do residents in non-brownfield areas. That is, 33.4% of residents in brownfield areas (0.5 mile radius) were working and residing at the same place¹ while about 22.5% of residents in non-brownfield areas were working and residing in the same place (see Table 6-2).

Even when the radius from brownfields lengthens from 0.5 to 1.0, 1.5, or 2.0 mile, the pattern observed above is maintained. That is, brownfield areas tend to be socioeconomically disadvantaged and unstable minority neighborhoods (see Table 6-2). However, when the radius lengthens, the magnitude of racial and socioeconomic disparity between brownfield and non-brownfield areas tends to decline. For example, the difference in percent of African Americans between brownfield and non-brownfield areas with a 0.5 mile radius is 35.3% (53.1% versus 17.9%). When the radius is expanded to 1.0, 1.5, and 2.0 mile, the differences in the percent decrease to 33.2%, 30.6%, and 27.6%, respectively. On the other hand, the percent of persons who are not U.S. citizens proves an exception. While brownfield areas with a 0.5 mile radius show lower percent of persons who are not U.S. citizens than do non-brownfield areas (3.6% vs 4.3%: see Table 6-2), brownfield areas with a 2.0 mile radius show a higher percent of persons who are not U.S. citizens than do non-brownfield areas (4.2% vs 3.9%: see Table 6-2).

Table 6-3 presents a correlation matrix that shows statistical significance and reveals significant associations between locations of brownfields and neighborhood racial and socioeconomic conditions. In other words, census block groups within 0.5 and 1.0 mile radii from at least one brownfield are more racially and socioeconomically disadvantaged than are ones beyond 0.5 and 1.0 mile radii from at least one brownfield. In addition, census block groups with a greater number of brownfields within 0.5 and 1.0 mile radii from block group centroids are more racially and socioeconomically disadvantaged than are ones with a lesser number of brownfields within 0.5 and 1.0 mile radii from the

¹ The census bureau defines 'at the same place' as the same zip code area.

centroid.

Directions of statistical associations behave in expected ways. For example, as the percent of African Americans in a census block group increases it becomes more likely that this census block group is located within a 0.5 or 1.0 mile radius from at least one brownfield. On the other hand, as the median household income of a census block group increases it is unlikely that this census block group will be located within a 0.5 or 1.0 mile radius from at least one brownfield. For other instance, as the percent of African Americans in a census block group increases, a greater number of brownfields are likely to located within a 0.5 or 1.0 mile radius from the centroid of the census block group. On the other hand, as the median household income of a census block group decreases a greater number of brownfields is likely to be located within a 0.5 or 1.0 mile radius from the centroid of the census block group (see Table 6-3).

When strength of associations is examined, the percents of non-Hispanic whites, African Americans, and persons below the poverty line show stronger associations with the presence of at least one brownfield within a 0.5 mile radius (Pearson's correlation over 0.4: see Table 6-4). When the number of brownfields is examined, the same pattern is observed. That is, impoverished and minority census block groups tend to be located near a greater number of brownfields. When strength of association is probed, Pearson's correlation is highest for the percent of persons below the poverty line (0.419) followed by the percent of non-Hispanic whites (-0.394) and African Americans (0.382: see Table 6-4). In conclusion, bi-variate analyses confirm that brownfield census block groups are more socioeconomically disadvantaged than are non-brownfield census block groups. This analysis also reveals that brownfield census block groups show a higher percent of minority populations than non-brownfield census block groups.

6-2-2 Multivariate Analysis

As discussed in the previous section, impoverished and minority populations tend to live near brownfields. However, simple bi-variate analysis shows associations between the locations or numbers of brownfields and racial and socioeconomic variables. That is, racial variables are possibly associated with the locations and numbers of brownfields mediated through socioeconomic, sociopolitical, and/or housing variables. If this is the case, racial variables are not independent variables in predicting the locations and

numbers of brownfields. Therefore, logistic regression is performed for locations of brownfields, while ordinary linear regression is performed for a number of brownfields. Due to multicollinearity with reference to significant associations among independent variables that often involve directional changes (Gujarati 1995), limited numbers of variables are introduced in multivariate models. Noticeably, it appears that occupation variables are highly associated with other socioeconomic variables. That is, when occupational variables are introduced in multivariate models with other socioeconomic variables, the directions of occupational variables change. Therefore, occupational variables are excluded from the multivariate analyses. Variance influence factors for variables included in multivariate models are less than 10, which indicates that no multicollinearity exists (Gujarati 1995). In addition to multicollinearity, the normality assumption is checked for linear regression by examining standardized normal plots (displaying standardized predicted values and standardized residuals), and no violation of normality is found.

Racial variables are significant predictors of brownfield locations (Model 1 in Table 6-4). As the percent of African Americans and Hispanics increases, the probability that census block groups will be located near at least one brownfield also increases. Socioeconomic variables are significant predictors, and as the percent of persons below the poverty line and the percent of unemployed persons increase and median household income decreases, the probability that census block groups will be located near at least one brownfield increases (Model 2 in Table 6-4). Finally, housing variables appear to be significant; as the percent of vacant housing units increases and the percent of owner-occupied housing units decreases the probability of census block groups located near at least one brownfield increases (Model 3 in Table 6-4). Although each category of variables is a statistically significant predictor of brownfield locations, three variables maintain their explanation power to predict brownfield locations in the full model (Model 4 in Table 6-4). They are the percent of African Americans, median household income (\$1000), and percent of vacant housing units maintain their explanatory powers at the minimal 0.05 significance level. Therefore as expected, the percent of African Americans and percent of vacant housing units are positive predictors, while the median household income is a negative predictor of brownfield locations.

When the radius from brownfields lengths from 0.5 to 1.0 mile, the same pattern is observed (Model 1-3 in Table 6-5). That is, all three groups of variables are separately significant predictors of brownfield locations while the coefficient values for all variables increase. In the full model (Model 4 in Table 6-5), five variables maintain their explanation power to predict brownfield locations. They are the (1) percent of African Americans, (2) percent of Hispanics, (3) median household income (\$1000), (4) percent of persons below the poverty line, and (5) percent of persons over 25 who do not have high school diplomas. It is notable that the percent of Hispanics gains in explanatory power when the radius from brownfields increases from 0.5 to 1.0 mile, this being so because there are few Hispanics in the study area (less than 4.5% in the tri-county area: see Table 6-2). Given that similar ethnic minorities tend to live close to each other, many Hispanic census block groups are located beyond a 0.5 mile radius yet within a 1.0 mile radius from brownfields.

Although logistic regression demonstrates that the percent of African Americans is a significant predictor of brownfield locations when controlling other variables, this regression does not address the question of whether racial variables are independent predictors of the number of brownfields. To answer this question, ordinary least square regression was performed using a number of brownfields within a 0.5 or 1.0 mile radius from the centroid of census block groups as the dependent variable. All three groups of variables prove to be separate statistically significant predictors of the number of brownfields with a 0.5 mile radius from neighborhood centroids, the same pattern observed in logistic regression (Model 1-3 in Table 6-6). The directions of all variables are the same as observed in logistic regression. The full model is capable of explaining approximately 22% of the variance in the number of brownfields within a 0.5 mile radius from neighborhood centroids (see R^2 Model 4 in Table 6-6). In the full model, four variables maintain their explanation power to predict the number of brownfields. They are the (1) percent of African Americans, (2) percent of persons blow the poverty line, (3) percent of persons over 25 who do not have high school diplomas, and (4) percent of vacant housing units. The directions of variables behave as expected except for the percent of persons employed in blue collar occupations. Given that linear regression presents standardized coefficients, those can be compared to determine which variable is

the strongest predictor. When compared, the percent of African Americans (0.178) is the strongest variable followed by the percent of persons below the poverty line (0.122) and the percent of vacant housing units (0.117: see Beta in Table 6-6).

When the radius expands from 0.5 to 1.0 mile, the explanatory power of the full model (R^2 Model 6 in Table 6-7) increases to 43.3% (21.5% in a 0.5 mile radius). This number signifies that about 45% of the variance in the number of brownfields within a 1.0 mile radius from the neighborhood centroids is explained by variables in this model. Furthermore, all variables except median household income and the percent of owner-occupied housing units are statistically significant predictors of the number of brownfields. Directions of variables behave as expected except for the percent of persons employed in blue collar occupations. Considering standardized coefficients, the strongest predictors are the percent of African Americans (0.305) followed by the percent of persons below the poverty line (0.160) and the percent of vacant housing units (0.129).

Finally, results show that the explanatory power of the percent of African Americans becomes stronger while median household income becomes weaker as the radius from brownfields lengthens from a 0.5 to 1.0 and from a 1.0 to a 1.5 mile. For example, the coefficient of the percent of African Americans in the logistic regression of census block groups within and beyond a 0.5 mile radius from at least one brownfield is 1.159 (see Model 4 in Table 6-4). However, the coefficients in the regression of census block groups within and beyond 1.0 and 1.5 mile radii from at least one brownfield increases to 1.654 (see Model 4 in Table 6-5) and to 2.582 (see Appendix E), respectively. On the other hand, the coefficient of median household income in the logistic regression of census block groups within and beyond a 0.5 mile radius from at least one brownfield is -0.031 (see Model 4 in Table 6-4). The coefficient in the regression of census block groups within and beyond a 1.0 radius from at least one brownfield decreases (-0.022: see Model 4 in Table 6-5) although the coefficient in the regression of census block groups within and beyond a 1.5 radius from at least one brownfield remain the same (-0.022: see Appendix E).

When the number of brownfields is examined, both the percent of African Americans and median household income become stronger predictors as the radius from brownfields lengthens from 0.5 mile to 1.5 mile. For example, the standardized coefficients of the

percent of African Americans increase from 0.178 (see Model 5 in Table 6-6), 0.305 (Model 5 in Table 6-7), and 0.355 (Appendix E) as the radius from brownfields lengths from 0.5, 1.0, and 1.5 mile, respectively. Similarly, standardized coefficients of median household income increase from -0.023 (see Model 5 in Table 6-6), -0.036 (Model 5 in Table 6-7), and -0.048 (Appendix E) as the radius from brownfields lengthens from 0.5, 1.0, and 1.5 mile, respectively. In brief, race becomes stronger predictor of locations of brownfields while income loses its explanatory power as the radius from brownfields lengthens from 0.5 to 1.0 mile. However, both race and income become stronger predictors of the number of brownfields as the radius from brownfields is lengthened. In particular, median household income becomes statistically significant predictor of the number of brownfields within 1.0 and 1.5 mile radii.

That the percent of African Americans becomes a stronger predictor but median household income becomes a weaker predictor when the radius from brownfield expands from a 0.5 to 1.0 mile suggests that relatively wealthy African Americans might live in close proximity to brownfields. In other words, because relatively wealthy African Americans tend to live close to ghetto areas (Morenoff and Sampson 1997), census block groups of residences of relatively wealthy African Americans might also be captured when the radius expands from 0.5 to 1.0 mile. However, when the radius expands from 1.0 to 1.5 mile, median household income does not lose its explanatory power, possibly because many white suburban census block groups are likely to be captured by 1.5 mile circular buffers from brownfields. Because 72.5% of block group centroids (comprised of 63.8% of persons) in the tri-county area are captured by 1.5 mile circular buffers from brownfields, census block groups not captured by circular buffers tend to become highly homogenous (wealthy white suburbs).

In terms of the number of brownfields, both the percent of African Americans and median household income gain in explanatory power as the radius from brownfields expands from a 0.5 to a 1.0 and from a 1.0 to 1.5 mile. In order to offer a clear explanation, it is necessary to differentiate the former dependent variable (the presence of at least one brownfield) from the later dependent variable (the number of brownfields). When the presence or absence of brownfields within these radii from block group centroids is the dependent variable, each census block groups within a 0.5, 1.0, or 1.5

mile radius from brownfields (regardless of their number) carries equal weight. For example, there is no distinction between census block group A in which one brownfield is located within a 1.0 mile radius from its centroid and census block group B in which ten brownfields are located within a 1.0 mile radius from brownfields. Those census block groups are treated as one category (brownfield census block group) as opposed to the other category (non-brownfield census block group located beyond a 1.0 mile radius from brownfield). When the number of brownfields is considered, by contrast, census block groups within a 0.5, 1.0, or 1.5 mile radius from block group centroids make distinct impacts on the model specification, and the impacts are determined on the basis of how many brownfields are located within a 0.5, 1.0, or 1.5 mile radius from block group centroids. Thus, census block group A and B, for instance, carry different weights in the statistical model.

How, then, can the above explain why both the percent of African Americans and median household income gain in explanatory power as radius from brownfields expands from a 0.5 to a 1.0 and from a 1.0 to 1.5 mile? Census block groups with a greater number of brownfields are extremely impoverished with respect to high concentration of African Americans. Also, these census block groups tend to be located at a greater distance from areas where relatively wealthy African Americans reside. Even though the expansion of the radius from a 0.5 to a 1.0 mile or from a 1.0 to a 1.5 mile captures census block groups in which wealthy African Americans reside, the numbers of brownfields near these block groups are not great (chiefly one and two brownfields within a 1.0 or 1.5 mile radius from block group centroids). Possibly, this is why both the percent of African Americans and median household income gain in explanatory powers when the radius is expanded.

In conclusion, statistical analyses in this chapter reveal that brownfields tend to be located near impoverished and minority populations. As well, the racial variable is an independent and stronger predictor than income of the presence of brownfields as well as the number of brownfields. Finally, as radius expands from 0.5 to 1.0 mile, the percent of African Americans gains in explanatory power while median household income loses in explanatory power. The next chapter will present the results of longitudinal analyses of racial and socioeconomic conditions of census block groups within and beyond a 1.0

mile radius from brownfields for the period 1960 to 2000.

Table 6-1 Descriptive statistics of census block groups in the tri-county area in 2000

	N	Mean	Standard Deviation	MIN	MAX
Racial Variables^a					
% Non-Hispanic Whites	3568	62.8%	39.1%	0.0%	100.0%
% African Americans	3568	30.1%	40.2%	0.0%	100.0%
% Hispanics	3568	2.9%	7.6%	0.0%	83.8%
Socioeconomic Variables					
% Female-head Household with Dependent Children	3560	9.6%	9.8%	0.0%	100.0%
% Unemployed Persons	3561	7.6%	7.6%	0.0%	66.1%
% Households with Public Assistance	3560	5.3%	7.0%	0.0%	53.5%
% Persons below Poverty	3560	12.1%	13.0%	0.0%	100.0%
Average Household Income	3560	\$50,315	\$25,300	\$2,499	\$200,001
Average Owner-Occupied Housing Value	3536	\$126,283	\$90,701	\$9,999	\$1,000,001
% Not a Citizen	3568	3.5%	5.7%	0.0%	45.8%
% Less than High School Diploma	3567	20.6%	13.7%	0.0%	100.0%
% Bachelor's Degree or Higher	3567	20.5%	17.8%	0.0%	89.7%
% White Collar Occupations	3561	30.20%	16.5%	0.0%	100.0%
% Blue Collar Occupations	3561	26.80%	12.3%	0.0%	100.0%
Housing Variables					
% Occupied Housing Units	3563	5.6%	7.1%	0.0%	100.0%
% Owner-Occupied Housing Units	3560	72.8%	24.8%	0.0%	100.0%

^a Some racial groups such as Asian and Pacific Islanders, Native Americans, and 2 or more races are excluded in this table.

Table 6-2 Descriptive statistics for the socioeconomic conditions of circular areas within the 0.5, 1.0, 1.5, and 2.0 mile radius from brownfields using the areal apportionment method^a

	Tri-county area		0.5 mile radius from brownfields		1.0 mile radius from brownfields		1.5 mile radius from brownfields		2.0 mile radius from brownfields	
			Beyond	Within	Beyond	Within	Beyond	Within	Beyond	Within
Numbers of Persons	4,043,467	3,236,388	807,079	2,168,513	1,874,954	1,464,469	2,578,998	963,652	3,079,815	
% Persons 16+ who live and work at the same zip code areas	24.6%	22.5%	33.5%	20.2%	29.6%	18.9%	27.5%	18.5%	26.2%	
Racial Variables										
% Non-Hispanic Whites	67.3%	74.4%	38.7%	83.0%	49.1%	87.3%	55.9%	88.8%	60.6%	
% African Americans	24.9%	17.9%	53.1%	9.5%	42.7%	5.4%	36.0%	3.9%	31.5%	
% Hispanics	4.4%	3.6%	10.8%	2.6%	7.8%	2.4%	6.2%	2.3%	5.3%	
Socioeconomic Variables										
% Female-head Households	8.2%	6.9%	13.6%	5.3%	11.6%	4.6%	10.2%	4.4%	9.3%	
% Unemployed Persons	6.0%	5.1%	10.6%	4.1%	8.6%	3.6%	7.6%	3.5%	6.9%	
% Households with Public Assistance	4.2%	3.1%	8.5%	2.0%	6.7%	1.6%	5.7%	1.4%	5.0%	
% Persons below Poverty	10.2%	8.0%	19.6%	5.6%	15.6%	4.7%	13.4%	4.4%	12.0%	
Average Household Income	\$63,647	\$68,002	\$45,702	\$74,593	\$50,908	\$78,792	\$55,140	\$81,707	\$58,215	
Average Housing Value	\$157,820	\$168,930	\$99,380	\$188,111	\$114,456	\$200,928	\$129,011	\$209,387	\$139,364	
% Not a Citizen	4.1%	4.3%	3.6%	4.3%	4.0%	4.1%	4.2%	3.9%	4.2%	
% Less than High School Diploma	18.1%	15.9%	27.2%	13.3%	23.9%	12.0%	21.7%	11.7%	20.1%	
% Bachelor's Degree or Higher	23.7%	25.9%	14.3%	29.1%	17.1%	30.8%	19.5%	30.9%	21.4%	
% White Collar Occupations	34.2%	36.0%	25.3%	38.6%	28.0%	40.0%	30.3%	40.0%	32.1%	
% Blue Collar Occupations	24.7%	23.8%	29.1%	22.4%	27.9%	21.9%	26.6%	22.3%	25.5%	
Housing Variables										
% Vacant Housing Units	5.5%	4.6%	8.8%	4.0%	7.1%	4.0%	6.3%	4.0%	5.9%	
% Owner-Occupied Housing Units	71.5%	74.7%	58.5%	78.3%	63.7%	79.7%	67.0%	81.4%	68.6%	

^a Census Block groups were used as building blocks of areas in this table

^b Some racial groups such as Asian and Pacific Islanders, Native Americans, and 2 or more races are excluded in this table.

Table 6-3 Correlation matrix between locations of brownfields and socioeconomic conditions of census block groups by employing the centroid containment method

	Number of Census block groups	Whether census blocks are located within a 0.5 radius from at least one brownfield ^a		Whether census blocks are located within a 1.0 radius from at least one brownfield ^b		Numbers of Brownfield within a 0.5 mile radius from block group centroids		Numbers of Brownfield within a 1.0 mile radius from block group centroids	
		(a)		(b)		(c)		(d)	
Racial Variables									
% Non-Hispanic Whites	3568	-0.419	***	-0.452	***	-0.394	***	-0.587	***
% African Americans	3568	0.404	***	0.429	***	0.382	***	0.569	***
% Hispanics	3568	0.064	***	0.087	***	0.060	***	0.078	***
Socioeconomic Variables									
% Female-head Household with Dependent Children	3560	0.330	***	0.359	***	0.296	***	0.438	***
% Unemployed Persons	3561	0.370	***	0.361	***	0.352	***	0.518	***
% Households with Public Assistance	3560	0.374	***	0.381	***	0.367	***	0.511	***
% Household below Poverty	3560	0.431	***	0.422	***	0.419	***	0.586	***
Median Household Income	3560	-0.368	***	-0.433	***	-0.333	***	-0.464	***
Median Owner-Occupied Housing Value	3536	-0.306	***	-0.386	***	-0.270	***	-0.393	***
% Not a Citizen	3568	-0.048	**	-0.023		-0.041	*	-0.056	**
% Less than High School Diploma	3567	0.370	***	0.400	***	0.354	***	0.489	***
% Bachelor's Degree or Higher	3567	-0.270	***	-0.327	***	-0.236	***	-0.338	***
% White Collar Occupations	3561	-0.284	***	-0.346	***	-0.247	***	-0.353	***
% Blue Collar Occupations	3561	0.165	***	0.222	***	0.145	***	0.186	***
Housing Variables									
% Occupied Housing Units	3563	0.281	***	0.245	***	0.327	***	0.425	***
% Owner-Occupied Housing Units	3560	-0.320	***	-0.313	***	-0.328	***	-0.443	***

^a zero means that census block groups are located beyond while one means that census block groups are located within a 0.5 mile radius from brownfields.

^b zero means that census block groups are located beyond while one means that census block groups are located within a 1.0 mile radius from brownfields.

* p > 0.05 ** p > 0.01 *** p > 0.001

Table 6-4 Logistic regression^a based on the centroid containment method (0.5 mile radius from brownfields and census block groups as units of analysis)

	Model 1 (N=3567)		Model 2 (N=3558)		Model 3 (N=3559)		Model 4 (N=3558)	
	B		B		B		B	
Constant	-2.122	***	-0.228		-0.074		-0.780	**
Racial Variables								
% African Americans	2.354	***					1.159	***
% Hispanics	3.619	***					0.988	
Socioeconomic Variables								
Median Household Income (\$1000)			-0.035	***			-0.031	***
% Persons Unemployed			2.778	***			0.535	
% Persons below the Poverty Line			2.330	***			0.736	
% Less than High School Diploma			0.287				0.727	
Housing Variables								
% Vacant Housing Units					6.485	***	1.597	*
% Owner-Occupied Housing Units					-2.077	***	0.193	
Model								
Chi ²	607.1	***	741.1	***	434.2	***	816.1	***
-2 Log likelihood	3405.8		3257.7		3567.4		3182.7	

^a zero means that census block groups are located beyond while one means that census block groups are located within a 0.5 mile radius from brownfields.

* p > 0.05 ** p > 0.01 *** p > 0.001

Table 6-5 Logistic regression^a based on the centroid containment method (1.0 mile radius from brownfields and census block groups as units of analysis)

	Model 1 (N=3567)		Model 2 (N=3558)		Model 3 (N=3559)		Model 4 (N=3558)	
	B		B		B		B	
Constant	-0.660	***	0.372		1.472	***	0.032	
Racial Variables								
% African Americans	2.725	***					1.654	***
% Hispanics	5.277	***					1.780	*
Socioeconomic Variables								
Median Household Income (\$1000)			-0.021	***			-0.022	***
% Persons Unemployed			3.829	***			0.027	
% Persons below the Poverty Line			4.374	***			1.911	*
% Less than High School Diploma			1.001				1.541	**
Housing Variables								
% Vacant Housing Units					6.264	***	-0.022	
% Owner-Occupied Housing Units					-2.157	***	0.455	
Model								
Chi ²	809.0	***	939.3	***	436.6	***		
-2 Log likelihood	4106.4		3963.7		4467.6			

^a zero means that census block groups are located beyond while one means that census block groups are located within a 1.0 mile radius from brownfields.

* p > 0.05 ** p > 0.01 *** p > 0.001

Table 6-6 Linear regression for the number of brownfields within the 0.5 mile radius from centroids of census block groups

	Model 1 (N=3567)		Model 2 (N=3558)		Model 3 (N=3559)		Model 4 (N=3558)	
	B	Beta	B	Beta	B	Beta	B	Beta
Constant	0.103	***	0.138	*	0.768	***	0.117	
Racial Variables								
% African Americans	0.872	0.397	***				0.388	0.178
% Hispanics	1.289	0.111	***				0.162	0.014
Socioeconomic Variables								
Median Household Income (\$1000)			-0.002	-0.062	**		-0.001	-0.023
% Persons Unemployed			1.033	0.090	***		0.183	0.016
% Persons below the Poverty Line			1.883	0.277	***		0.830	0.122
% Less than High School Diploma			0.326	0.051	**		0.514	0.080
Housing Variables								
% Vacant Housing Units						3.082	0.230	***
% Owner-Occupied Housing Units						-0.740	-0.209	***
Model								
R ²			0.158	***	0.187	***	0.146	***
								0.215

* p > 0.05 ** p > 0.01 *** p > 0.001

Table 6-7 Linear regression for the number of brownfields within the 1.0 mile radius from centroids of census block groups

	Model 1 (N=3567)		Model 2 (N=3558)		Model 3 (N=3559)		Model 4 (N=3558)			
	B	Beta	B	Beta	B	Beta	B	Beta		
Constant	0.428	***	0.612	***	2.901	***	0.366	*		
Racial Variables										
% African Americans	3.363	0.589	***		1.733	0.305	***	***		
% Hispanics	4.643	0.155	***		1.150	0.038	**	**		
Socioeconomic Variables										
Median Household Income (\$1000)		-0.008	0.086	***	-0.003	-0.036				
% Persons Unemployed		5.401	0.180	***	1.910	0.064	**	**		
% Persons below the Poverty Line		6.603	0.372	***	2.832	0.160	***	***		
% Less than High School Diploma		0.730	0.044	*	1.392	0.083	***	***		
Housing Variables										
% Vacant Housing Units					10.634	0.305	***	4.499	0.129	***
% Owner-Occupied Housing Units					-2.637	-0.285	***	-0.280	-0.030	
Model										
R ²		0.348	***	0.374	***	0.264	***	0.433	***	

* p > 0.05 ** p > 0.01 *** p > 0.001

Figure 6-1 Census Block Group Map of Brownfield Locations in the Tri-county Area

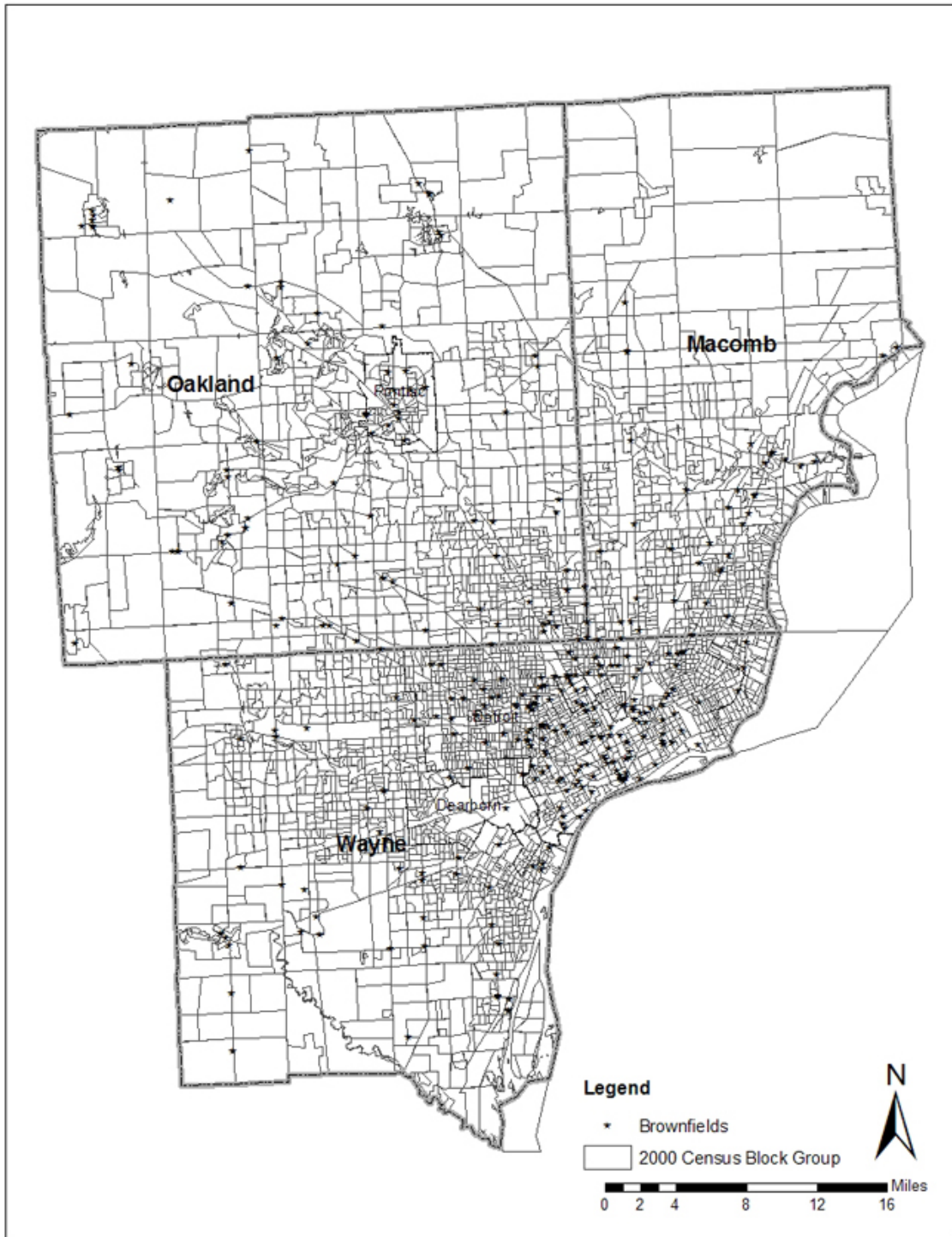


Figure 6-2 Census Block Group Map of Brownfield Locations in the Detroit Area

