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There Goes the Neighborhood:
Environmental Equity and the Location of New Hazardous Waste Management Facilities

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Many research studies have examined if hazardous waste treatment, storage, or disposal facilities (TSDFs) tend to be located where people are disproportionately minority, low-income, and politically inactive. This article focuses on whether variables representing potential neighborhood activism were related to where new TSDFs located during the 1990s. My analyses demonstrated that there is no consistent, substantial evidence that the demographic characteristics of neighborhoods around new TSDFs affected their location decisions. The overall composition of these neighborhoods indicates that there are disproportionately high concentrations of minority and low-income people around these TSDFs and disproportionately fewer people who were more likely to be politically active and concerned about new TSDFs. The skew towards more minorities was overwhelmingly due, however, to a relatively small number of TSDFs in heavily populated neighborhoods with high minority proportions.

Over the last decade, concern has grown about the impact of pollution on particular population groups. Some people claim that minority and/or low-income people bear disproportionately adverse health and environmental effects from pollution (Austin & Schill, 1991; Bullard, 1994). This belief produced the "environmental equity" movement for the fair treatment of people of all races, incomes, and cultures in developing, implementing, and enforcing environmental laws and policies.

The environmental equity movement emerged in the early 1980s (Hamilton, 1995; Szasz & Meuser, 1997). Subsequent studies and public attention raised concerns about the fairness and protection of environmental programs, which now receive increased attention by all levels of government and the private sector. The Clinton administration documented its concern through an executive order (42 U.S.C. §4321) requiring that federal agencies make environmental equity part of their missions. Similarly, the U.S. Environmental Protection Agency (EPA) identified environmental equity as a priority, creating an Office of Environmental Equity (now the Office of Environmental Justice) in 1992, starting a task force on environmental equity, and overseeing the National Environmental Justice Advisory Council, a federal advisory committee of citizens that offers guidance to the EPA (U.S. Environmental Protection Agency, 1995).

Environmental equity research exists on various topics—location and pace of cleanup of contaminated sites (Hird, 1993; Zimmerman, 1993), distribution of air pollutants (Brooks & Sethi, 1997; Perlin, Setzer, Creason, & Sexton, 1995), and location of facilities using toxic chemicals (Centner, Kriesel, & Keeler, 1996; Ringquist, 1997). One aspect of environmental equity that has aroused particular

controversy is the alleged tendency to site "hazardous waste" management facilities in disproportionately minority and low-income neighborhoods. Hazardous wastes are industrial process wastes that the EPA has designated, under the federal Resource Conservation and Recovery Act (RCRA), as posing dangers if they are not managed and disposed of with special precautions. These wastes are different from those disposed of in municipal landfills. Facilities managing hazardous wastes through treatment, storage, or disposal (TSDFs) must obtain government permits. Although it is illegal to release hazardous waste into the environment (with the narrow exceptions of the processes of underground injection, in which waste is injected far below the surface, and land treatment, in which certain wastes are spread on land as fertilizer), the mere presence of TSDFs nearby could still arouse public concern. Because extensive public notice, comment, and hearing requirements apply to TSDFs seeking permits (40 C.F.R. Part 124, Subparts A and B), neighborhoods prospectively hosting TSDFs would have the opportunity to voice their opposition. Naturally, this opportunity could be diminished if these legally required notices, as well as any other publicity about these facilities, did not result in actual notice to residents.

Numerous studies have examined the siting of TSDFs, with conflicting results. This article advances and expands that stream of research by using more accurate data, additional explanatory variables on political and environmental activism, and a focus not just on operating TSDFs but on those that are new entrants in the hazardous waste management industry.

Literature Review

Numerous studies have examined the siting of TSDFs managing hazardous waste shipped to them from other facilities. The studies reached conflicting results as to whether these TSDFs are disproportionately located in certain types of areas. A 1983 U.S. General Accounting Office (GAO) report found that three of the four neighborhoods around certain hazardous waste landfills were disproportionately African American, and all were disproportionately poor (U.S. General Accounting Office, 1983).

The first national study of TSDF locations in 1987 by the United Church of Christ (UCC) found that the percentage of minority people in zip codes with a commercial TSDF (i.e., a TSDF managing, for a fee, hazardous waste from other facilities) was twice that of other zip codes (United Church of Christ, 1987). It also found that the minority percentage in zip codes with multiple TSDFs or with any of the nation's largest hazardous waste landfills was three times greater than in other zip codes.

A 1992 study concluded that the likelihood that people in Detroit, Michigan, were minorities or poor increased the closer they were to commercial TSDFs (Mohai & Bryant, 1992). A 1993 study found that the inhabitants' racial characteristics of a county hosting a commercial TSDF were not significant factors in the TSDF's expansion plans, but the higher the minority percentage in a county, the less likely its processing capacity was scheduled to be reduced (Hamilton, 1993). That study also concluded that a county's past voter turnout was inversely related to the likelihood of a planned capacity expansion, perhaps indicating TSDF operators'

concern about opposition from politically active neighbors. A follow-up study examined these data at the zip code level and again found that the minority percentage did not significantly predict which TSDFs intended to expand their capacities (Hamilton, 1995). That study also concluded that home ownership levels, population size, and electoral participation were inversely related to the likelihood of capacity expansion plans. Again, this could indicate concern about opposition from large numbers of politically active neighbors with vested interests in preserving their property values.

A 1994 study challenged the UCC research, comparing the average characteristics of census tracts containing commercial TSDFs against those of other census tracts (Anderton, Anderson, Oakes, & Fraser, 1994). This research found little difference in the minority percentages between these two areas, and the percentages of poor people were inversely related to the presence of TSDFs. Most of these same authors subsequently published another study basically confirming their earlier results (Oakes, Anderton, & Anderson, 1996). Another 1994 study updated the UCC study and basically reaffirmed its conclusion that a neighborhood's minority percentage increases along with the concentration of TSDFs (Goldman & Fitton, 1994). Yet another 1994 study examined the demographic characteristics of areas around the hazardous waste landfills cited in the 1983 GAO study at the time that the facilities began operations (Been, 1994). It determined that those facilities were started in disproportionately minority areas.

A 1996 study of Texas hazardous waste landfills concluded that they were more likely to be in low-income White areas (Yandle & Burton, 1996). A 1996 study of South Carolina TSDFs concluded that they were more likely to be in counties that were relatively high income and White, but there was no significant relationship with race and income variables at the census tract or block group levels (Cutter, Holm, & Clark, 1996). That study also found that the percentage of children in an area was inversely related to the presence of a TSDF, perhaps indicating that TSDF managers were concerned about opposition from neighbors with special fears about health threats. The study also found, however, that population density and the percentage of college-educated people were positively related to the presence of TSDFs, contrary to earlier studies and theories about political pressure.

A 1997 study of TSDFs in Los Angeles County, California, concluded that the percentage of minority, but not low-income, people was likely to be higher around TSDFs (Boer, Pastor, Sadd, & Snyder, 1997). Another 1997 study found no substantial evidence that TSDFs were originally sited in poor or African American areas, though it claimed that TSDFs were sited in areas that were disproportionately Hispanic (Been, 1997). That study also found that population density was inversely related to the presence of a TSDF, perhaps again indicating TSDF operators' concern about opposition from large numbers of neighbors. Finally, a 1998 study of Michigan TSDFs found that they were more likely to be in zip codes with more minority people, but that income levels were irrelevant (Hockman & Morris, 1998).

Outside observers and these studies' authors have compared, reconciled, or criticized some or all of this research on various grounds. Inconsistencies or inadequacies in selecting the "area" in which a TSDF is located (e.g., census units, zip

codes, counties, or geographic concentric rings) have been noted (Goldman & Fitton, 1994; Mohai, 1995). Other inconsistencies were the variables measuring race (e.g., African Americans, Hispanics, or non-Whites) and wealth (e.g., median household income or families on public assistance or in poverty). The control group against which the areas with TSDFs were compared also varied (e.g., all zip codes without TSDFs or census tracts in selected areas). Different studies also examined different TSDFs (e.g., all TSDFs, landfills, or TSDFs with capacity expansion plans). Also, research focused on areas' characteristics at different points in time (e.g., the time of the study or when the TSDF began). Finally, in multivariate analyses, different independent variables aside from race and income were used, and only infrequently did they include explicit measures of political or environmental activism. Thus, research on the location of TSDFs has provided many interesting results and raised at least as many issues about these studies' methodologies and conclusions. Because of their varying methodologies, however, it is difficult to draw any firm or generalizable conclusions from them.

Hypothesized Determinants of New TSDF Locations

What largely distinguishes this article from prior research is its focus on TSDFs that recently began operating. As shown later, new TSDFs are a substantial portion of all TSDFs. Although I focus on a unique set of TSDFs, I hypothesize that many of the same factors are relevant in explaining their locations that other researchers have used to explain the locations of all TSDFs. Characteristics of neighborhoods in which TSDFs might be sited could affect which locations are ultimately chosen.

In particular, the intensification of the environmental equity movement after the late 1980s provides a useful backdrop to analyzing new TSDFs. Although the presence of predominantly minority and low-income people may have attracted TSDFs to certain areas in the past, when the issue of environmental equity recently gained more attention, perhaps the resulting public and/or internal corporate pressures led to new TSDFs disproportionately avoiding these same areas. Thus, although studies of all TSDFs may find that they are sited in a particular manner, a different skew may be occurring for new TSDFs.

The neighborhood characteristics that I initially hypothesize are related to the entry of TSDFs are race; income; education; length of residence; population density; property values; home ownership; and the presence of government employees, drinking water wells, and children. I hypothesize that each variable affects the likelihood that a neighborhood around a potential TSDF would organize to oppose the TSDF. This public pressure could actually occur or the prospect of it could simply be enough of a concern to TSDF managers that they decide to avoid possible controversy by not locating there. Although race and income characteristics traditionally have been used in environmental equity studies, the other neighborhood characteristics provide additional measures of political and environmental participation and sophistication, as various studies have indicated that they are relevant to TSDF siting (Been, 1997; Cutter et al., 1996; Hamilton, 1993, 1995; U.S. Environmental Protection Agency, 1979).

Environmental equity studies typically cite the racial composition and income level of an area as influencing TSDF siting, either because of discrimination or because low-income and minority people are assumed to have less political power to resist the siting of undesirable land uses. Aside from these considerations, high-income people may be more likely to consider their property values to be at risk from a nearby undesirable facility and thus be more likely to mobilize against it. Therefore, neighborhoods with disproportionately high minority or low-income populations could be hypothesized to be more likely to have new TSDFs located there. The recent rise of the environmental equity movement, however, may have made these neighborhoods fertile ground for organizing against TSDFs. Therefore, one could just as easily hypothesize that the relationship would be in the opposite direction for new TSDFs—neighborhoods with disproportionate numbers of minority or low-income people would be less likely to have new TSDFs. Consequently, although I hypothesize that race and income characteristics affect locations of new TSDFs, I assume nothing about the direction of their effects.

Researchers have found that educational levels substantially affect political participation, with better-educated people having greater involvement (Brady, Verba, & Schlozman, 1995; Timpone, 1998; Wolfinger & Rosenstone, 1980). Thus, this higher involvement might motivate such people to pressure TSDFs to bypass their neighborhoods. Therefore, I hypothesize that the more highly educated people in a neighborhood, the less likely it is to have a new TSDF.

Studies also have reported that government employees have higher levels of political participation (Leighley & Nagler, 1992; Sigelman, Roeder, Jewell, & Baer, 1985; Wolfinger & Rosenstone, 1980). Because siting TSDFs involves at least some local (e.g., zoning), and always state or federal (e.g., permitting), government action, one would expect that people familiar with government procedures would be better prepared and positioned to resist TSDFs. Furthermore, their higher levels of political involvement might better motivate them to pressure TSDFs to stay away. Thus, I hypothesize that the more government employees in a neighborhood, the less likely it is to have a new TSDF.

Aside from characteristics associated with political activism, there are characteristics that may be especially relevant to siting TSDFs. First, I hypothesize that neighborhoods with more homes using well water would be more likely to oppose TSDFs because of their perceived greater vulnerability to health risks if contaminants escaped (McComas, 2001). Second, I hypothesize that neighborhoods with more children would be more likely to oppose TSDFs because of concern over potential health risks to children (McComas, 2001; Schulze, McClelland, Hurd, & Smith, 1986). Third, I hypothesize that neighborhoods with more long-time residents would be more likely to oppose TSDFs because of concern over possible negative effects on their property values and because of their greater personal attachment to and past political involvement in the area (Jackson, 1996; Sigelman et al., 1985; Timpone, 1998). Furthermore, also due to property value considerations, I hypothesize that neighborhoods with higher levels of home ownership and housing values would be more likely to oppose TSDFs (Hamilton, 1995; U.S. Environmental Protection Agency, 1979). Finally, I hypothesize that neighborhoods with higher

population densities would be better able to oppose TSDFs due to strength in numbers (Been, 1997; Hamilton, 1995).

Data

TSDFs

I identified new TSDFs from the EPA's Biennial Reporting System (BRS) database. TSDFs submit certain information about their environmental practices in odd-numbered years (40 C.F.R. §262.41), and this information is aggregated and made publicly available by the EPA in their BRS. BRS data have been collected since 1989, and the most recent year for which they were available for this research was 1997.

TSDFs report if they generated and managed hazardous waste on-site or received it from off-site sources. This information was used in the following manner to identify new TSDFs. TSDFs that only stored hazardous waste on-site that they generated from their own processes were excluded from my analyses. I did so first because I assumed that TSDFs that actively manage their own wastes—through treatment or disposal—or that manage or store any wastes received from off-site sources would be of the greatest concern to the public and thus most sensitive to public pressure. TSDFs that only temporarily store their own wastes should be less likely to create risks and public concern. Second, presumably almost all facilities that generate hazardous waste store some of it at least temporarily. Typically, only facilities that store it longer than 90 days must obtain a permit to do so (40 C.F.R. §262.34). Thus, only the length of time that hazardous waste is stored may distinguish facilities with and without hazardous waste storage permits. In addition, TSDFs that only store their own hazardous waste do not state in their BRS reports if they actually used those storage units during the year in question. Because only TSDFs that actively managed or stored waste were to be included in my analyses,[1] it was impossible to differentiate between active and inactive storage facilities if they did not receive waste from off-site sources.

Thus, I used TSDFs that treated or disposed of hazardous waste, or stored hazardous waste received from off-site sources. Furthermore, I excluded government TSDFs (mostly military facilities), as they likely had different decision-making processes and location constraints than private sector TSDFs. I included not only TSDFs paid to manage wastes from other facilities, but also those that managed their own wastes or wastes from other of their companies' facilities. Other TSDF studies have typically excluded the latter two types of TSDFs. There is, however, no demonstrated reason to believe that the public views TSDFs differently, or that the risks from TSDFs can be distinguished, based upon who ships their wastes there. It is possible that the public distinguishes between TSDFs that only manage their own waste and those that receive off-site waste. In this article, both types of TSDFs are included, but they are distinguished in my analyses.

Because I focus only on new TSDFs, I included only TSDFs that were not managing waste in 1989 but began doing so later. I used 1989 as the best and most recent year before the environmental equity movement became prominent and could have affected TSDF siting decisions. Thus, new TSDFs were composed of five

groups of facilities, those starting in 1991, 1993, 1995, and 1997, respectively, which also were combined into one group in some analyses. Table 1 displays the number of TSDFs initially identified. New on-site TSDFs are those that only managed hazardous waste they generated on-site, whereas new off-site TSDFs are those that managed hazardous waste they received from off-site sources.

Table 1. Numbers of Types of TSDFs by Year, 1991–1997

Type of TSDF	1991–97	1991	1993	1995	1997
Active TSDFs	2,235	1,564	1,302	1,114	832
Government TSDFs	219	191	171	156	95
New private sector TSDFs	1,053	641	185	115	112
New on-site TSDFs	561	279	125	89	68
New off-site TSDFs	492	362	60	26	44

Source: 1991–1997 BRS data

The likely causes of most of the large number of new TSDFs in 1991 were expansions of the legal definition of RCRA hazardous waste in 1990 (U.S. Environmental Protection Agency, 1990a, 1990b) and of hazardous waste management in 1991 (U.S. Environmental Protection Agency, 1991). Thus, it was primarily due not to sitings of new facilities but rather to non-TSDFs becoming newly classified as TSDFs on account of their wastes being newly defined as hazardous or their processes being newly defined as waste management. Just like newly sited TSDFs, however, operators of these facilities had to decide whether to operate as TSDFs or to cease their management of hazardous waste.

Census Data

The demographic data used in my analyses were from the 1990 U.S. Census.[2] The relevant area around an environmentally regulated facility for which such data should be obtained has been defined in various ways in environmental equity studies. Counties, zip codes, census units, judgmentally defined neighborhoods, and geographic concentric rings have been used as units of analysis. Different units of analysis may be more appropriate for different types of studies (Mohai, 1995; Zimmerman, 1994).

Many environmental equity studies focus on whether facilities are discriminatorily located in certain neighborhoods. In those situations, the relevant "neighborhood" is an uncertain historical, sociological, and psychological question that depends largely on what the nearby population and hypothetical discriminators thought of as the neighborhood (Mohai, 1995). Similarly, for my analyses, the area of interest is that which could be the breeding ground for neighborhood activism against a TSDF, either in reality or in the minds of TSDF developers concerned about neighborhood opposition. Realistically, this area is unknown and undoubtedly varies

among TSDFs, depending on existing neighborhood organizations, topography, environmental attitudes, and past neighborhood activism.

Thus, absent any certain definition, I used a geographic concentric ring around a TSDF as the unit of analysis. It seems likely that TSDF developers would physically reconnoiter a prospective site, in which case a moderately sized concentric ring would be a sensible representation of the neighborhood. The width of the ring around a TSDF should again reflect the area potentially hospitable to neighborhood activism against it. Past environmental equity studies used distances from ½ mile to a few miles. Some using the latter cited studies finding significant diminution in property values at such distances from environmentally regulated facilities (Farber, 1998), which should be relevant to neighborhood opposition to a TSDF. Those studies, however, largely were on abandoned contaminated sites—not authorized TSDFs—or on landfills or incinerators. According to BRS data, however, only a small percentage of all TSDFs are landfills or incinerators, thus making studies of them unlike the TSDF population. In a 1995 EPA Environmental Appeals Board ruling, the EPA's use of a 1-mile ring around a TSDF for environmental equity analyses was upheld (*In re: Chemical Waste Management of Indiana, Inc.*, 6 E.A.D. 66, [1995]). Consequently, absent any certain definition of the appropriate distance, my analyses focus on a ring with a 1-mile radius, although I also used a ½-mile radius for sensitivity analyses.

Each TSDF's location was defined by its latitude and longitude, which were obtained from the EPA's Envirofacts database for 1,047 of the 1,053 new TSDFs. Geographic information system software then extracted the census characteristics of people in the rings around those TSDFs.[3] The census data used to test my hypotheses were the following: population density (people per square mile); proportion of housing units using drinking water wells; median value of owner-occupied housing units; and the proportions of people who were Hispanics (i.e., of Hispanic origin), African Americans (i.e., non-Hispanic Black), minorities (i.e., not non-Hispanic White), poor people (i.e., people with household incomes below poverty level), low-income people (i.e., people with household incomes below 150% of poverty level), children (i.e., people under 18 years old), government employees (i.e., employed in local, state, or federal government), college graduates (i.e., people older than 24 years who were college graduates), in owner-occupied housing, and long-time residents (i.e., lived in present housing before 1980), respectively.

Demographic Composition of Neighborhoods Around New TSDFs

My first analyses compared the demographic composition of neighborhoods around new TSDFs with U.S. averages. U.S. averages, not those from smaller areas—such as the state or county of a new TSDF—best reflect where TSDFs could have been sited because no evidence exists that TSDF siting decisions are substantially driven by local geography, as claimed by some (Anderton et al., 1994; Oakes et al., 1996). According to off-site TSDF BRS data, about 60% of hazardous waste received is from another state, and over 80% is from another county. Thus, the market area for off-site TSDFs is at least regional. As a result, there is no basis for automatically assuming that TSDF operators only considered a particular state or coun-

ty in their siting decisions. Consequently, there is no reason to believe that the only other possible locations for a TSDF were in the same state or county.

Table 2 displays the demographic characteristics of the combined populations (or housing units) around categories of new TSDFs, as well as the U.S. averages. The new TSDFs are separated by the year they began and whether they were on- or off-site TSDFs. For example, of the combined population around the 520 new TSDFs in populated areas in 1991, 18.5% were Hispanics. Compared with the entire United States, people around new TSDFs were more likely to be minority, lower income, and densely populated and less likely to be government employees, college graduates, well users, and homeowners. There was little difference between the U.S. averages and the neighborhoods around TSDFs with respect to children, long-time residents, and median housing values.[4]

Table 2 also reveals patterns by type of new TSDF and over time. If environmental equity concerns affected the siting of new TSDFs, the demographic characteristics of the neighborhoods around them would be expected to become closer over time to U.S. averages—that is, a more equitable distribution. Almost every demographic characteristic around new on-site TSDFs was closer to the U.S. average in 1997 than in 1991, except for the percentage of Hispanics, which increased over time. Thus, although the minority percentage declined slightly over time, its composition became more Hispanic. What is especially striking about the Table 2 data is that, despite recent attention on equity in TSDF siting, the percentages of minority people around new TSDFs still are substantially higher than U.S. averages, especially for Hispanics. In particular, it is the prevalence of Hispanics around what might be the most objectionable new TSDFs—those accepting waste from off-site sources—that offset consistent progress in the location of on-site TSDFs. In contrast, the presence of lower-income people around new TSDFs has consistently decreased over time, such that they are just slightly overrepresented around these TSDFs.

Thus, these results could reflect a continuing, though lessening, inequity for some groups. A closer examination of the data, however, indicates that it is not so much that new TSDFs have consistently clustered in heavily minority neighborhoods, but rather that a relatively small number of new TSDFs are in neighborhoods with a large number of minority people. Most new TSDFs actually were in neighborhoods with lower minority percentages than the U.S. average. Of all minority people living around the 829 new TSDFs in populated areas, half live around 6% of the new TSDFs, and three-quarters live around 16% of them. Of all the Hispanics, half live around 3% of the new TSDFs, and three-quarters live around 8% of them. Of all the African Americans, half live around 5% of the new TSDFs, and three-quarters live around 13% of them. Thus, the seemingly high representation of minority people around all new TSDFs is largely due to a relatively small number of heavily populated, heavily minority neighborhoods. This phenomenon also has been found in environmental equity studies of other facilities (Hamilton & Viscusi, 1999; Zimmerman, 1993). Consequently, there is no widespread siting of new TSDFs in disproportionately minority neighborhoods, but there is a noticeable skew in that direction.

Table 2. Demographic Characteristics of People or Housing Units

Demographic Characteristic	All New TSDFs					
	U.S. Total	1991–97	1991	1993	1995	1997
Median housing value	$99,226	$93,500	$91,989	$94,433	$95,036	$101,176
Population density	1,855	2,419	2,516	2,181	1,800	2,494
% with Characteristic						
Hispanics	8.8	19.2	18.5	22.4	17.2	20.4
African Americans	11.8	16.4	18.2	11.1	14.2	14.3
Minority people	24.2	40.5	41.4	40.1	34.8	39.3
Poor people	12.7	17.6	18.4	16.8	15.4	15.3
Low-income people	21.0	27.6	28.6	27.1	24.9	24.5
Children	25.6	26.2	26.1	27.1	25.2	25.7
Government employees	7.1	5.8	5.8	5.7	5.7	6.1
College graduates	13.0	9.8	9.2	9.4	12.9	11.6
In owner-occupied housing	66.2	51.1	49.8	53.1	52.4	55.9
Long-time residents	43.3	46.9	48.9	44.9	45.2	37.6
Housing units using wells	14.8	1.7	1.5	2.3	1.6	2.0
Number of new TSDFs in populated areas		829	520	139	89	81

Regression Analyses

Regression Models

I also developed three sets of five regression models each to assess the relationship between neighborhoods' demographic characteristics and locations of new TSDFs. The models in each set consisted of one model for each of the four BRS years (i.e., 1991, 1993, 1995, and 1997) and one model for the entire 1991 to 1997 period. This was done to determine whether the relationships among variables differed over time. The three sets of models were three different forms of regression corresponding to different ways that a neighborhood might view a new TSDF. Under one theory, people might regard all new TSDFs as similarly undesirable, and thus their prospective opposition to a new TSDF would not vary depending on its type. This theory was operationalized through logistic regression, which uses a binary dependent variable. In this situation, the dependent variable was a 1 if the neighborhood contained a new TSDF and a 0 otherwise.

Under another theory, people might regard new on-site TSDFs as different from new off-site TSDFs, because the former manage waste only as a by-product of their manufacturing and receive no off-site waste. Thus, their need for a TSD unit may be seen as a minor, necessary, and worthwhile aspect of the economic benefits they bring to their neighborhoods (Hamilton, 1993). In contrast, off-site TSDFs may

in 1-mile Rings Around 1991–1997 New TSDFs

New On-site TSDFs					New Off-site TSDFs				
1991–97	1991	1993	1995	1997	1991–97	1991	1993	1995	1997
$95,420	$95,081	$93,157	$96,534	$100,208	$91,675	$89,755	$96,357	$85,797	$102,022
2,267	2,580	1,856	1,937	2,116	2,584	2,574	2,932	1,295	2,922
19.5	21.4	18.5	16.9	13.6	18.9	16.3	28.2	19.1	26.0
15.4	17.2	11.2	12.3	17.4	17.4	19.0	10.9	24.4	11.6
39.7	43.3	35.8	32.9	34.1	41.2	39.9	46.4	45.2	43.6
17.3	18.9	15.4	15.1	14.7	17.8	18.0	18.8	17.1	15.9
27.8	30.1	25.4	24.4	23.0	27.5	27.4	29.7	27.5	25.7
26.2	26.6	26.8	24.9	24.8	26.1	25.8	27.7	26.9	26.5
5.7	5.6	5.8	5.7	6.2	5.9	5.9	5.6	6.0	6.0
10.2	8.9	9.8	13.9	13.7	9.3	9.4	8.7	7.5	9.9
51.5	50.4	53.0	51.7	55.3	50.8	49.4	53.2	56.4	56.4
45.5	47.5	44.3	43.9	38.1	48.2	49.9	46.0	53.5	37.2
1.6	1.4	2.8	1.3	1.7	1.7	1.6	1.6	3.4	2.5
432	222	97	70	43	397	298	42	19	38

be perceived as what most dismays people—a business locating nearby solely to bring hazardous waste into the neighborhood. Consequently, prospective opposition to a new TSDF could vary by its type. This theory was operationalized through multinomial logit regression, which uses a dependent variable with multiple categories. In this situation, the dependent variable had three categories: whether a neighborhood contained a new on-site TSDF, a new off-site TSDF, or no new TSDFs.

Under a final theory, people might not just regard new off-site TSDFs as different from new on-site TSDFs, but also as less desirable, and any neighborhood without a new TSDF would be more desirable than a neighborhood with one. Consequently, the prospective opposition to a new TSDF could vary ordinally depending on its type. This theory was operationalized through ordered logit regression, which uses a dependent variable that has multiple ordinally ranked categories. In this situation, the dependent variable again had three categories, but they were ordinally ranked, so that a neighborhood containing a new on-site TSDF was assumed to be more undesirable than a neighborhood without any new TSDFs, and a neighborhood containing a new off-site TSDF was assumed to be most undesirable.

Thus, the data for each of the five time periods were processed using each of these three regression techniques, producing 15 separate sets of results (20 sets of coefficients, because the multinomial logit regression produces coefficients for both types of new TSDFs). The observations in the models obviously included the data from the 1-mile rings around the new TSDFs. Just as obviously, other observations

were needed to represent the neighborhoods where there were no new TSDFs. This raises the inevitable question in environmental equity research of what are the appropriate population units against which to compare the people around TSDFs to determine whether the TSDFs are disproportionately sited near certain types of people. Because these analyses focus on the complete distribution of new TSDFs, rather than just a measure of central tendency, it was necessary to identify a distribution of population units to use as the comparison group. Clearly, it was not feasible to use as a comparison data from all other possible 1-mile rings in the country, as these were essentially infinite.

I selected the distribution of the nearly 60,000 U.S. census tracts as the best available representation of neighborhoods. A census tract's typical area and population were close to the typical 1-mile rings around new TSDFs (median area of 2.2 square miles and 3,808 people for census tracts versus 3.1 square miles and 4,524 people for the rings). Thus, these types of units were fairly close in size. Also, census tract boundaries are created taking into account local people's conception of their neighborhoods (U.S. Bureau of the Census, 1994). In addition, the demographic characteristics needed for these analyses were readily available from census data. Consequently, census tracts were used to represent neighborhoods without new TSDFs. The final step was determining which census tracts contained new TSDFs. Census tracts with new TSDFs were omitted from the regression analysis for the year(s) in which they had new TSDFs. Otherwise, the analyses would have counted such neighborhoods twice in contradictory ways, once as having a new TSDF and once as not. Because, as described earlier, the market area for TSDFs appears to be at least regional, all U.S. census tracts were included. Therefore, the observations in each analysis included the demographic data from 1-mile rings around new TSDFs and from census tracts without new TSDFs.

Independent Variables

The independent variables in each model were the population densities and median housing values in the 1-mile rings around new TSDFs and in non-TSDF census tracts, and the proportions of Hispanics, African Americans, poor people, children, well users, government employees, and long-time residents. The proportions of poor and low-income people were almost perfectly correlated, and thus only the former was used to reflect neighborhoods' income levels. Also, the proportions of college graduates and people in owner-occupied housing were highly correlated with other independent variables and thus were excluded to avoid multicollinearity. Because relationships between the variables and new TSDF siting could be nonlinear, the quadratic forms of these variables also were included.

These analyses exclude some variables that others have tested as determinants of TSDF siting, in particular proxies for manufacturing facilities in a neighborhood. Some studies assumed that TSDFs are more likely to locate very close to possible customers. The available information, however, indicates that this is generally implausible. First, because my analyses were not limited to TSDFs that manage other facilities' wastes but rather included those that only managed their own waste, the assumption that TSDFs locate near possible customers could apply only partly

to my analyses. Second, most TSDFs are storage facilities, and proximity considerations are unlikely to be critical to them. Storage facilities would have little reason to locate close to possible customers, because they only pick up or receive customers' waste and store it temporarily before it is shipped elsewhere. Thus, the storage facility is only a way station to the waste's final destination. Whether it is 10 blocks or 10 miles away makes little difference in the cost to customers, as that distance is a small part of the eventual transportation route for the waste.

Third, hazardous waste is an unusual industrial waste, and hazardous waste sent to off-site TSDFs is rarer still. The EPA estimates that over 15 trillion pounds of industrial solid waste are generated annually (U.S. Environmental Protection Agency, 1988), about 40 times the hazardous waste managed by TSDFs in 1995 and over 1,000 times the hazardous waste sent to off-site TSDFs (U.S. Environmental Protection Agency, 1999). Consequently, the notion that TSDFs locate where manufacturing is concentrated is implausible. Hazardous waste—particularly what is shipped off-site—is such an unusual waste stream that locating where manufacturing is intense would offer little assurance that adequate hazardous waste customers would be nearby. Finally, the best evidence that off-site TSDFs do not locate near possible customers is the figures cited previously that over 60% of hazardous waste sent to off-site TSDFs goes to other states and over 80% goes to other counties. Obviously, off-site TSDFs have not located close to their customers. Therefore, there is no reason to believe that local manufacturing levels, especially within census tracts or 1-mile radii, influence where TSDFs locate.

Regression Models' Results

The regression results demonstrated that model structure typically made little difference in the basic effects of the variables or the models' overall performance. This indicates that the relationships are robust, although the sizes of the independent variables' coefficients did fluctuate across the models and years. Thus, for purposes of brevity in this article, Table 3 displays the coefficients of only the multinomial logit model, which, unlike the logit model, differentiated between on- and off-site TSDFs and, unlike the ordered logit model, did not assume any particular ordering of people's preferences towards those TSDFs. To make the coefficients easier to interpret, they are expressed as odds ratios. There are two sets of odds ratios, one each expressing the relationships between the independent variables and the likelihood of a neighborhood containing a new on- or off-site TSDF, respectively. An odds ratio more than 1 means that new TSDFs were more likely to be in neighborhoods where more people or housing units matched the demographic characteristic in question. An odds ratio less than 1 means that new TSDFs were less likely to be in such neighborhoods. Because the independent variables, other than median housing value and population density, were measured on the same scale (proportions), comparing their odds ratios shows the relative importance of their impacts on new TSDF siting. The statistical significance of each variable also is provided, although it does not determine the importance of the results.[5] To facilitate comparisons of the models, Table 4 displays the direction of each independent variable's impact in each model. An "M" means that the more of that type of person or hous-

Table 3. Multinomial Logit Regression Models Odds Ratios

Independent Variable	On-site TSDFs				
	1991–97	1991	1993	1995	1997
Hispanics	24.79537**	4.515402	62.31411**	7,497.076**	2.380261
Hispanics^2	0.0153242**	0.1131977	0.0048221*	6.18E−07**	2.750142
African Americans	5.646583**	3.997858	1.498757	8.380068	106.6856**
African Americans^2	0.0203228**	0.0140709**	0.0872861	0.0241012	0.0084006
Poor people	93.84833**	9,072.132**	35.23439	0.1578741	0.0354284
Poor people^2	0.00000251**	8.53E−11**	0.00000605	0.0004399	3,420.276
Children	10.27373*	14.07346	218.8308**	0.4781539	0.3807761
Children^2	0.0016948	1.97E−08	0.0000155	14,653.52	0.0022621
Well users	0.0005932**	0.0002469**	0.004361**	0.0003238**	0.0000175**
Well users^2	3,625.306**	21,413.29**	90.16834*	12,053.61**	1.151196
Government employees	0.0001187**	0.0001921**	0.0001118*	0.0005261	0.0000113
Government employees^2	1,156.195	493.1608	1,877.314	8,282.522	7.84E−87
Long-time residents	867.1059**	4,518.473**	4,784.589**	687.3631**	1.324486
Long-time residents^2	0.9825803	1.357594	0.0371417	0.0003084	0.0038244
Population density	0.9997713**	0.9998315**	0.9997056**	0.9996732**	0.9996825**
Population density^2	1 **	1	1 *	1 *	1 *
Median housing value	1.000007**	1.000011**	1.00001**	0.9999968**	1.000001
Median housing value^2	1 **	1 **	1 *	1	1
Pseudo R^2	0.138**	0.152**	0.132**	0.131**	0.085**
N	58,153	58,204	58,261	58,277	58,268

Independent Variable	Off-site TSDFs				
	1991–97	1991	1993	1995	1997
Hispanics	115.7399**	109.3844**	262.8353**	5,628.948**	8.945295
Hispanics^2	0.0016466**	0.0004969**	0.0008618*	0.0003465	0.8243582
African Americans	9.996435**	11.54613**	0.5313546	2.12559	266.3862**
African Americans^2	0.0112316**	0.0102175**	0.0756019	0.1493887	6.45E−08*
Poor people	201.7158**	157.1208**	48,672.02**	0.0321132	153.5091
Poor people^2	1.21E−07**	2.54E−07**	1.80E−14*	12.79468	0.0001297
Children	14.02244*	32.83221**	7,549.977	5.60759	0.0116375
Children^2	9.45E−16**	1.08E−14**	4.98E−63*	16.53882	6.97E−27
Well users	0.0131213**	0.0125057**	0.0940355	0.0000262**	0.2722443
Well users^2	4.254859	2.821932	0.0044861	445,799 *	0.441862
Government employees	0.0002128**	0.0004468**	0.000698	0.00000145	0.0000412
Government employees^2	303.387	0.0596103	−0.001626	1,367,414	1.24E+10
Long-time residents	4,589.551**	21,460.95**	74,242.75**	5,984.566**	2.336357
Long-time residents^2	30.33011	2.410423	4.521587	0.0032211	0.0008365
Population density	0.9998269**	0.9998399**	0.9998908	0.9993922**	0.9998853
Population density^2	1 **	1 **	1	1	1
Median housing value	1.00001**	1.000009**	1.000017**	0.9999981	1.000016**
Median housing value^2	1 **	1 **	1 **	1	1 *
Pseudo R^2	0.138**	0.152**	0.132**	0.131**	0.085
N	58,153	58,204	58,261	58,277	58,268

* $p < 0.05$
** $p < 0.01$

ing in a neighborhood, the more likely it was to host a new TSDF. An "L" means that the more of that type of person or housing in a neighborhood, the less likely it was to host a new TSDF.

Because of the small number of new TSDFs during this time, the probability of a neighborhood hosting a new TSDF was between 0.014 and 0.001, depending upon the time period in question. Thus, even large odds ratios do not make it very likely in absolute terms that new TSDFs were located in neighborhoods with disproportionate demographic characteristics. Also, including the quadratic form of each variable makes it important to consider the nonlinearity of the relationship between a demographic characteristic and the presence of new TSDFs.

The directions of the odds ratios (i.e., above or below 1) for the variables were largely consistent across models—7 of the 18 variables were completely consistent across the 20 odds ratios in the models; 2 each were consistent in the directions of 19 and 18 of their odds ratios, respectively; 3 were consistent in 16 of their odds ratios; and 1 each was consistent in 17, 15, 13, and 12 of their odds ratios, respectively. If only statistically significant variables were compared, no inconsistencies existed.

The directions of the odds ratios were almost completely consistent with the Table 2 results. More Hispanics, African Americans, and long-time residents in a neighborhood essentially always were associated with higher probabilities of having a new TSDF. More poor people and children typically were associated with higher probabilities of having a new TSDF. More well users and government employees and a denser population always were associated with lower probabilities of having a new TSDF. Thus, the race and income groups long assumed to bear the brunt of environmental inequity do in fact appear to be more likely to have new TSDFs near them even after a decade of concern about their siting. The groups expected to possess greater political power and motivation to resist new TSDFs are associated with lower probabilities of having new TSDFs nearby. A major inconsistency with my hypotheses was the positive relationship between higher-priced housing and new TSDFs. This variable's effect, however, was minuscule—housing values would have to be enormously different from the U.S. average to have any meaningful impact on the probability that new TSDFs would be present. Another inconsistency with my hypotheses was the generally positive relationship between the presence of children and of new TSDFs, but this variable was one of the least consistent in its effects across the models. Finally, the positive relationship between the presence of long-time residents and new TSDFs also contradicted my hypothesis.

As indicated by the pseudo $R2$'s, however, the models explained modest amounts of the variation in locations of new TSDFs. The race and income variables alone never explained over 2% of the variation, similar to the performance of the environmental concern variables (i.e., well users and children), whereas the political activism variables alone explained at least four times as much variation. Therefore, regardless of the variables' impacts, these results indicate that the demographic characteristics of neighborhoods do not explain much about the locations of new TSDFs. Thus, although many variables relevant to environmental equity and neighborhood activism do have substantial relationships with new TSDFs' locations,

Table 4. Effect of Independent Variables on Likelihood of Neighborhood Hosting New TSDF

Independent Variable	Logistic Models					Multinomial Logit Models: On-site TSDFs					Multinomial Logit Models: Off-site TSDFs					Ordered Logit Models				
	'91–97	'91	'93	'95	'97	'91–97	'91	'93	'95	'97	'91–97	'91	'93	'95	'97	'91–97	'91	'93	'95	'97
Hispanics	M**	M**	M**	M**	M	M**	M	M**	M**	M	M**	M**	M**	M**	M	M**	M**	M**	M**	M
Hispanics^2	L**	L**	L**	L**	L	L**	L	L*	L**	M	L**	L**	L*	L	L	L**	L**	L**	L**	L
African Americans	M**	M**	M	M	M**	M**	M	M	M	M**	M**	M**	L	M	M**	M**	M**	M	M	M**
African Americans^2	L**	L**	L	L	L**	L**	L**	L	L	L	L**	L**	L	L	L*	L**	L**	L	L	L**
Poor people	M**	M**	M**	L	M	M**	M**	M	L	L	M**	M**	M**	L	M	M**	M**	M**	L	M
Poor people^2	L**	L**	L**	L	M	L**	L**	L	L	M	L**	L**	L*	M	L	L**	L**	L**	L	M
Children	M**	M**	M**	L	L	M*	M	M**	L	L	M*	M**	M	M	L	M**	M**	M**	L	L
Children^2	L	L**	L	M	L	L	L	L	M	L	L**	L**	L*	M	L	L**	L**	L*	M	L
Well users	L**	L**	L**	L**	L**	L**	L**	L**	L**	L**	L**	L**	L	L**	L	L**	L**	L**	L**	L**
Well users^2	M**	M**	M	M**	M	M**	M**	M*	M**	M	M	M	L	M**	L	M**	M**	M	M**	M
Government employees	L**	L**	L*	L*	L**	L**	L**	L*	L	L	L**	L**	L	L	L	L**	L**	L*	L*	L**
Government employees^2	M*	M	M	M	M	M	M	M	M	L	M	L	L	M	M	M	M	M	M	M
Long-time residents	M**	M**	M**	M**	M	M**	M**	M**	M**	M	M**	M**	M**	M**	M	M**	M**	M**	M**	M
Long-time residents^2	M**	M	L	L	L	L	M	L	L	L	M	M	M	L	L	M	M	L	L	L
Population density	L**	L**	L**	L**	L**	L**	L**	L**	L**	L**	L**	L**	L	L**	L	L**	L**	L**	L**	L**
Population density^2	M**	M**	M	M**	M	M**	M	M*	M*	M*	M**	M**	L	M*	L	M**	M**	M	M**	M
Median housing value	M**	M**	M**	L	M*	M**	M**	M**	L	M	M**	M**	M**	L	M**	M**	M**	M**	L	M*
Median housing value^2	L**	L**	L**	L	L*	L**	L**	L**	L	L	L**	L**	L**	L	L*	L**	L**	L**	L	L*

Note: M: More likely to host a new TSDF * $p < 0.05$
L: Less likely to host a new TSDF ** $p < 0.01$

too much of the latter is left unexplained to consider these variables the major determinants of TSDFs' decisions.[6]

Conclusions

Numerous studies have examined factors related to the locations of existing TSDFs. This article analyzes a related, but more specific, issue—whether demographic characteristics representing potential neighborhood activism were related to where new TSDFs located during the 1990s. As these analyses demonstrated, there is no consistent, substantial evidence that the demographic characteristics of neighborhoods around new TSDFs affected their location decisions. The overall composition of neighborhoods around new TSDFs indicates that there are disproportionately high concentrations of minority and lower income people around these TSDFs and disproportionately fewer people who were more likely to be politically active and concerned about new TSDFs. The skew towards more minorities was overwhelmingly due, however, to a relatively small number of new TSDFs in heavily populated neighborhoods with high minority proportions. Thus, there was only a modest pattern of new TSDFs being sited in disproportionately minority neighborhoods.

To the extent that this clustering of substantial minority people around some new TSDFs creates concerns about the risks to those people, the fact that only a relatively small number of new TSDFs account for most of the nearby minority people makes it easier to address these concerns. For example, these few TSDFs could be inspected more frequently to better prevent mishaps, thereby more efficiently reducing risks to more people in these groups. Also, special efforts could be made to publicize the pending permit applications of TSDFs seeking to locate in such areas, so that nearby people can use their opportunity for public participation. In addition, such permit applications could be particularly scrutinized, consistent with the Clinton executive order on environmental justice.

Aside from potential health and environmental risks due to mishaps at TSDFs, it is possible that the mere presence of a TSDF could degrade the surrounding community by lowering property values, discouraging other economic development, or undermining the general quality of life, such as through increased truck traffic or diminished aesthetics. As noted earlier, however, studies of property values around environmentally regulated facilities have rarely involved TSDFs, and thus it is uncertain what, if any, impact they have. Also, because the overwhelming majority of TSDFs do not receive wastes from off-site facilities, truck traffic in the area typically should not be substantially affected. In addition, because most TSDFs are businesses managing their own production waste, the mere presence of a hazardous waste management unit at a facility should not discourage other economic development or undermine the general quality of life in the area any more than the facility would if it had no such unit. Thus, there is no compelling evidence that policies are needed to address concerns unrelated to health and environmental risks.

The regression analyses were largely consistent with my initial analyses. More minority and lower-income people in a neighborhood were associated with higher probabilities of new TSDFs locating there, whereas more people who might

be more likely and better able to resist TSDFs locating nearby typically were associated with lower probabilities of hosting new TSDFs. These demographic characteristics, though, explained little of the variation in where new TSDFs located. Therefore, although certain neighborhood characteristics are associated with new TSDF siting, they help little in explaining those decisions. In at least one sense this is desirable because it lessens the likelihood that particular population groups will be treated inequitably in the siting process. Consequently, although some of the patterns in the data were intriguing and consistent with most of my hypotheses, overall too much of what influences the location of new TSDFs was unexplained to draw firmer conclusions.

Because of the relatively small number of new TSDFs in recent years and because the market for TSDFs is overwhelmingly at least regional, it is likely that many fairly idiosyncratic legal, economic, geographic, and competitive factors affect the TSDF-siting process. Creating a comprehensive model of TSDF demand and supply would require longitudinal facility-level data on many variables that are difficult, if not impossible, to obtain. Including such variables could change the magnitude and/or direction of the coefficients of the variables in my analyses and presumably would explain much of the remaining variation in new TSDFs' locations. They would not, however, change the fact that these demographic variables explained little about new TSDFs' locations. Thus, although there is some racial and economic imbalance in new TSDF siting, it does not appear to be a result of neighborhoods' demographic characteristics.

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Notes

The data used in this article are in the Inter-University Consortium for Political and Social Research publication-related data archive.

[1]Because I focus on newly operating TSDFs, obviously I would not include TSDFs that were not actually using their hazardous waste management units.

[2]Analyzing only new TSDFs in the 1990s avoids the analytical problem of which came first, the TSDF or the people who live around it. Because new TSDFs began no earlier than 1990, when the census data were collected, the people nearby always were there before a TSDF's decision to operate.

[3]The software used a TSDF's coordinates as the center of the ring and included as part of that ring all census block groups that had their centroids within the specified radius of the ring.

[4]A true median housing value for categories of new TSDFs could not be calculated because that required the individual housing values in a ring around a new TSDF. Because

these are unavailable, the median housing value for a category of new TSDFs was the weighted average of those values for the rings around that category's new TSDFs, with each ring's median housing value weighted by its proportion of the total number of owner-occupied housing units around the new TSDFs in that category. For purposes of comparability, the U.S. figure also was calculated in this manner.

[5]Statistical significance is irrelevant because these analyses use the population, rather than a sample, of census tracts and of new TSDFs. Consequently, any numbers, or differences between them, are real, rather than subject to sampling error. For the purposes of this article, measures of statistical significance are provided (for readers who consider them useful), but they do not determine the importance of results.

[6]In addition, I did similar regression analyses using $^1/_2$-mile rings around TSDFs. These results were largely consistent with those for the 1-mile rings (76% of the $^1/_2$-mile ring models' odds ratios (96% of those that were statistically significant) were in the same direction as those in the 1-mile ring models and the models explained similarly modest amounts of the variation in new TSDFs' locations.

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