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Determining the Property Value Impact of Landfills

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DETERMINING THE PROPERTY VALUE IMPACT OF LANDFILLS

by

OKWUCHUKWU GERALD UBA

A dissertation submitted in partial fulfillment of the
requirements for the degree of

DOCTOR OF PHILOSOPHY
in
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1994

DISSERTATION APPROVAL

The abstract and dissertation of Okwuchukwu Gerald Uba for the Doctor of Philosophy in Urban Studies was presented November 5, 1993 and accepted by the dissertation committee.

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ABSTRACT

An abstract of the dissertation of Okwuchukwu Gerald Uba for the Doctor of Philosophy in Urban Studies presented November 5, 1993.

Title: Determining the Property Value Impact of Landfills

The decline in property value can be due to owner's act or exogenous act from the operation of landfills. Landfill neighbors, especially home owners, perceive landfill operation to pose environmental safety problem such as ground water contamination and methane gas leakage that could affect home value.

Owners of landfills, especially those landfills that accept only dry waste (limited purpose landfill), claim that since their facilities meet the requirements of environmental regulations and the type of waste they accept could not possibly produce methane gas and leachate there is no property value impact of their facilities.

Several studies have shown that landfills do not have impact on property value. However, one recent study found that a large regional landfill have impact on property value.

The property value impact of a limited purpose landfill located in Portland, Oregon, was investigated in this study. Data were gathered for homes in approximately one half mile radius around the landfill for the periods before the landfill opened, during operation, and after closure.

Hedonic estimation technique incorporated in a multiple linear regression was used to control for a key variable (proximity or distance between the landfill and homes) and examine the relationship of this variable and sale price of homes. The results show that distance of homes (the proxy for perception) from the landfill was positively related and statistically significant with sale prices of homes during the period the landfill was in operation. Distance of homes sold in the periods the landfill was not in existence or operation was not positively related nor statistically significant with sale prices. That is, the operational effects of the landfill was capitalized into property value.

With this result, the issue of whether neighbors of landfills should be compensated deserve more attention. The results of this study would be very helpful in negotiating compensation. The results also show that if adequate pollution mitigation measures are in place landfill zoning ordinance should be based on the fact that landfill sites would yield maximum economic benefit to the owner after closure.

DEDICATION

This work is dedicated to my father, Paul Uba-Okoh, and mother, Margaret Nwanyiotube Uba-Okoh, for their faith in me and living through this work with me.

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CHAPTER I
INTRODUCTION
THE PROBLEM

The reason for the existence of local governments has basically been limited to the provision of public goods and services. We have, however, seen the functions of local government grow everyday, as city problems take on new dimensions.

In this paper, the scope of our investigation is narrowed to the controversies surrounding the provision of a special type of public service that necessitates the building of noxious facilities such as landfills and incinerators (Havliceck et al., 1971; Bleich et al., 1991; Nelson, et al., 1992), highways (Burkardt, 1971), mental health (Dear, 1977), nuclear waste (Sun, 1982), hostels for homeless (Burnett and Moon, 1983), and public housing (Rabiega et al., 1984).

A noxious facility such as a landfill provides the essential service of receiving the solid waste we generate. Everybody benefits from the services of this special type of public good. All households are (and expected or required to) consume this special type of public service; the reason being that several government regulations mandate collection and disposal of residential and commercial waste with specified equipment, and disposal of same at approved solid waste disposal

facilities. Illegal dumping of waste carries some penalty in some communities.

Federal and State governments have also enacted laws that aim at guiding and controlling the method of solid waste disposal, and sponsored researches aimed at closing out old dump sites and improving the method of disposal activities.

Since the signing of the National Environmental Policy Act (NEPA) in 1970 there has been unprecedented development of law relating to protection of environment. Two separate Acts, The Freedom of Information Act (which laid down a General rule that all agency data must be available to the public) and The Administrative Procedure Act (which defines and prescribes procedures for two types of formal agency proceedings: adjudications and rule-making), have increased citizens' awareness of the nature of environmental problems and "public interest" litigations to halt environmental degradation (Mills, 1978; Gladwin, 1980). These suits have forced greater sensitivity in neighborhood consideration of the impact of solid waste facilities located close to or in residential neighborhoods.

What is witnessed today is the Not In My Backyard (NIMBY), Group Against Garbage (GAG), Not On Our Street (NOOS), Citizens Against Virtually Everything (CAVE), Not In My Term Of Office

(NIMTOO), Not On Planet Earth (NOPE), Citizens Rebelling Against Pollution (CRAP) and Building Absolutely Nothing Anywhere Near Anything (BANANA) syndrome for communities facing the possibility of becoming hosts of solid waste facilities. Landfills (of all types) are perceived as generators of negative effects such as bad odor, disease carried by insects and rodents, noise (from garbage packer trucks transporting the waste and compactors burying the garbage), dust, visual disamenity, and groundwater contaminant by leachate. These concerns, host communities claim, affect neighborhood environment and, subsequently, propagate property value decline and loss of property tax (Popper, 1981; Johnson and Pettit 1986; Gamble et al. 1982; Nelson et al. 1992). However, engineers, landfill operators and public officials view limited purpose landfills (that accepts only construction and demolition debris) as those facilities that have lesser impact on the environment.

Most of the older general purpose landfills that accept all kinds of garbage are owned by local and county governments and a good proportion of them are located within metropolitan areas (NSWMA, 1988). This is unfortunate. As a public good the decision to locate a landfills is expected to meet the basic criteria of equity (i.e. locating at optimum) and efficiency (i.e., optimum use). Where these criteria are

not met, urban residents bear extra costs of garbage hauling, and cost and tax dollars used in building an under used facility. For example, the location of a new regional landfill for Portland, Oregon waste at a distance over 100 miles contributed over 200 percent increase in garbage disposal cost between 1987 and 1992. Even when the equity and efficiency criteria are met some urban residents may still bear additional costs such as decline in property values.

Three problems which local governments have not found the best way to deal with have just been raised: (1) locate at optimum or within the metropolitan boundary and stir up the NIMBY or CRAP syndrome; (2) locate at non-optimum or outside the metropolitan boundary and stir up high costs, and probably illegal disposal within the metropolitan area (Metro 1991); and (3) locate demolition landfills within metropolitan area and general purpose landfills outside. Finding a solution to the first problem will subsequently resolve the other two problems. Some of the ways of resolving the first problem are making monetary compensation to the host community of landfills (Cox and Johnson, 1982) and enhancing neighborhood aesthetics. However, some landfill owners resist compensation; part of the reason being that several studies of the impact of waste facilities on property value show that there is no such impact (Johnson and Pettit, 1986; U.S. EPA, 1975).

Previous studies of property value impact of landfills have failed to explore equity locational strategies, especially principles of equitable siting process which does not avoid compensation or waste disposal. Moreover, methodologies employed by most of those studies that concluded that there were property value impacts of landfills are inadequate or inferior (Hwang and Rudzitis, 1978). These studies do not also estimate impact to a city block level (Nelson et al. 1992). It has also been pointed out that the methodologies used by these studies failed to estimate the value of those factors not traded on a market (and thus not observable as market prices) which homeowners take into consideration while living close to or away from a landfills (Johnson and Pettit, 1986).

By analyzing a neighborhood housing market before landfill opened, during its operation and after it closed, and employing both linear and non-linear regression equations, the implicit prices of observable and non-observable housing characteristics were estimated in order to determine the premium associated with living close to or away from a landfills. This research studied specifically the premium associated with living in the old Lavele landfill neighborhood in the northeast area of the City of Portland, Oregon (see Figures 1 and 2).

A literature review of property value theory was carried out first. This was followed by a theoretical explanation of the reasons why some landfills are located within the city limits of most U.S. urban communities. An analysis of those empirical studies that have investigated the impact of landfills on property values were treated.

FIGURES 1

Location of SW Facilities in the Portland Metropolitan Area

Location of Lavele Landfill

THE OBJECTIVE OF THE STUDY

The purpose of this study is to determine whether sellers and buyer of residential property in a particular neighborhood perceived a limited purpose landfill in the area as a threat to the value of the area. Determining whether there is a threat is important to neighbors of such facilities, operators of such facilities and local and state governments, because efforts expended arguing on existence of impact can be directed towards settlement. In order to determine how to compensate people affected by a new neighborhood landfill, this study quantified the impact of a landfill as dictated by behavior of sellers and buyers of homes in a neighborhood housing market.

RESEARCH METHODOLOGY

The study looks at the impact of a solid waste landfill in Portland, Oregon on property values in a high density residential neighborhood using hedonic estimation techniques. In order to segregate and capture perception of risks associated with the operation of landfills a closed landfill was used for the study. Unlike most previous studies that compared a landfill to comparable neighborhoods this study focused on how sellers and buyers of residential properties reacted to the existence and/or operation of a landfill.

Three multiple regression models were used to analyze the impact of the site on surrounding residential homes before the landfill opened, during operation of the landfill, and after closure of the landfill.

Using the findings of previous studies, those variables that account for residential property value were regressed against sales prices while controlling for distance of homes away from the landfill. Distance of homes away from the landfill is the proxy for perception of the impact of the landfill on residential property in the surrounding area.

SUMMARY OF FINDINGS

The results of the study confirmed that the operational effects of the Lavele landfill was capitalized into property value. That is to say, the landfill had an impact on property value. During its operation, proximity to the landfill reduced housing pricing \$675 per city block. After the landfill closed, no significant discount to proximity was detected, suggesting that the external costs of proximity to this landfill were short lived and not permanent and that if landfills are properly regulated home prices will likely increase after closure.

CHAPTER II

REVIEW OF LITERATURE: THE THEORETICAL BASIS FOR LANDFILL LOCATION AND HOUSING ATTRIBUTES

The scope of this chapter is to examine the different environmental factors which different studies have shown to affect residential property positively and negatively. Our goal here is to explore the findings of various research on property value and landfill location in order to lay a foundation and theoretical basis for identifying those factors that will be useful in establishing the connections between property value and landfill operation.

The exploration is in three parts. The first part is on literature which deal with factors that account for variations in property value. The second part concentrates on literature which treated those factors that influenced the siting of landfills in our communities. The third part identifies previous empirical studies of landfill impact on property value.

THE THEORETICAL FOUNDATIONS OF PROPERTY VALUE

Our aim in this section is to explore the theoretical foundations of property value in order to determine those utility generating factors not necessarily traded in the market but which homeowners take into consideration while living close to or away from landfills.

This research identified two schools of thought that have contributed much to the study of variables that account for variations in property value among urban neighborhoods. The first school is the classical urban land use market theorists (von Thunen, 1966; Alonso, 1964; Muth, 1969; Waldo, 1974) and the second school is the contemporary professional property appraisers/assessors (Schmutz, 1944; Vaughan, 1984; Rutledge, 1986). The reader should note that the latter school has benefitted more from the work of the former.

In determining the value of a property, appraisers and assessors have always used three standardized approaches; 1) market; 2) income; and 3) cost. These approaches employ similar or same variables. As pointed out by Goulet (1979) and Rutledge (1986) an appraiser can use one or a combination of two or all of the three approaches in an appraisal of one property.

The market approach rests on the premise that investor (or home buyer) behavior produces a range of prices within which a reasonably accurate value estimate can be made (Schmutz, 1944; Kahn et al., 1963; Vaughan, 1984). The market approach is used mostly for residential property -- the type with which this research is concerned. This approach is one in which the property under appraisal is valued on the basis of sales data of comparable properties which have recently

been sold or offers to buy have recently been made. Adjustments are made for dissimilarities in date of sale, size of lot and building, improvements, financing methods, and location in order to arrive at market value.

The second approach is the income method which rests on the premise that the value of real property is equal to the capitalized value of its future cash benefits. This approach, used mostly for income producing properties, restates market value by converting future benefits on losses of property ownership into an expression of present worth. This implies projections for increased or decreased cash flow and derivation of a market rate of return used to estimate future cash benefit or loss of a property.

The third appraisal method is the cost approach. This approach is based on the premise that a property should never be valued at a price above its replacement cost. The procedure requires an estimation of the reduction cost of an identical (or hypothetical) structure, and estimation and deduction of accrued depreciation. Both estimates require use of a variety of complicated indices for the structure and accrued depreciations. Three classes of depreciation that influence property value are physical deterioration (due to structural defects), functional obsolescence (due to effect of inadequate services), and economic

obsolescence (due mostly to exogenous effects to the structure such as noise and inadequate public services).

From the foregoing analysis, we can say that the variables taken into account by the assessors and appraisers are those indirectly reflecting the condition of the property being valued and its environment. Although these approaches require use of extensive data, time and adjustments, a greater portion of the assessors judgment is purely subjective. Take, for example, the case of the cost approach. To the extent that adjustments for physical deterioration can be easily estimated, adjustments for economic and functional obsolescence may be incorrectly or poorly conceived. The proximity of a factory located close to a residential property may be translated into a high utility by the factory employee who intends to buy a property in the neighborhood, whereas the proximity may translate into a disamenity for someone else.

According to an interview with the Assessor for Multnomah County, Oregon, the market and cost approaches are still popular. However, there is an increasing demand to apply a statistical approach which takes into account relevant exogenous variables directly reflecting the condition of a property and its environment. The new "statistical appraisal equations" method borrows a lot from the classical land use

market theorists. The rest of our analysis of the theory of property value will dwell more on the contribution made by the classical land use market theorists.

a) Accessibility Attributes of Property Value:

The classical theory of property value which originated in the work of von Thunen traced the variations of agricultural land rents to differences in fertility and location in a hypothetically isolated farm community (von Thunen, 1966). Twentieth century urban and regional economists have applied similar models in their explanation of urban land value. Alonso is one of the neo-classical theorists of urban land value who used von Thunen's work in shedding light on the reasons for variations in both rent and property value within a city.

The central business district (CBD) of the city, Alonso (1964) argues, has all activities, and roads in the city lead to it. Competition of different types of uses, as a result of the convenience of the CBD, drives rental charges higher than in other parts of the city. While land on which to build is plentiful, land with accessibility to the CBD is scarce (Alonso, 1964; Goodall, 1974; Heilbrun, 1981).

In further analysis, neo-classical theorists point out that at the CBD transportation cost is zero, rent per square foot is higher, and a movement outside the CBD implies a substitution of transportation cost

for more consumption of space. This phenomenon generates a site rent gradient for the city that has its peak at the city center and declines as we move away from the center.

Although the city center may be the area of highest property value, the expansion of the city, and subsequent development of suburbs and multi-nuclei centers of activities such as shopping centers have added more peaks to the site rent gradient of the city. The empirical work of Li and Brown (1980) suggests that proximity to certain non-residential land use such as school, recreation areas, river, expressway interchange affects property value by having a positive value for accessibility.

Proximity to employment center reduces the opportunity cost rate of commuting time. The value of time saved is one of the most salient components of the highway user's benefit for which county assessors show concern while evaluating properties close to areas where improvements in transportation systems are occurring (Waldo, 1974).

b) Physical Attributes of Property Value:

Alternative explanations for changes in property values have been addressed from the point of view of physical attributes. In a theoretical treatment of the competitive model of the housing market, Olsen (1969)

portrayed housing as a physical commodity with attributes, each unit yielding some "housing service." The consumer realizes a certain level of housing service by satisfaction trading off or combining housing attributes.

The empirical work of Rosen (1974) on implicit market analysis of hedonic price determination, which borrows heavily from Olsen's housing service approach, shows that most consumers value some housing attributes over others. Consumers in a typical residential neighborhood value floor space and yard space (Rosen, 1974; Brueckner and Colwell, 1983).

The work of Brueckner and Colwell (1983) show also that floor and yard space per house are greater farther from the CBD. Now, in order for the consumer to maximize utility for a property located close to a noxious facility, the marginal rate of substitution between housing attributes must equal the marginal value of the property. Recalling that consumer's choice of property is dependent also on other factors (such as accessibility attributes), the substitution case is based on a wide variety of variables. As a result, in any empirical investigation of the factors that lower or increase property value, there will be either a "many equation system" or an equation comprised of many sub-equations. By performing comparative calculations using varied equation

systems, the effect of one variable, given the existence of a different but comparable variable, can be determined.

c) Neighborhood Attributes of Property Value:

The impact of neighborhood attributes on property value can best be understood by defining and relating them to the structure of residential property value. The attributes derive their definitions from the vital role they play in a neighborhood. Before proceeding to define the attributes we have to answer a question which is proper at this juncture: what is a neighborhood?

The definition of a neighborhood varies depending on the perspectives adopted by its residents. The perspectives include geographic, social (Coleman, 1978; Downs, 1981) and economic (Downs, 1981). That is to say, the attributes of a neighborhood can be grouped into geographic, social and economic variables. A housing market located, say, in a harbor or landfill area could adopt the names "harbor neighborhood" or "name of landfill". The personal relationships among residents are reinforced by harbor activities forming invisible (Downs, 1981) and visible networks that define the neighborhood. These tangible and intangible networks are vital to the "harbor

neighborhood" real estate market as well as to the businesses, streets, and even the garbage collection system in the area.

This approach to defining a neighborhood broadens the geographic and social attributes to include the economic perspective of a neighborhood. A more comprehensive view of defining a neighborhood may include the political perspective; however, the political attributes develop in the later life of a neighborhood, either due to the need to preserve or enhance the growth of the resources in the neighborhood.

To the residents of any community, the most crucial resources in the neighborhood are their property, socioeconomic infrastructure and businesses that provide employment and revenue. (Downs, 1981; Coleman, 1978). The socioeconomic resources include schools and parks. Schools have been empirically investigated and shown to exert some amenity/disamenity capitalized in residential property value (Kain and Quigley, 1970; Harrison and Rubenfield, 1978; Li and Brown, 1980). These studies employed different variables to determine the quality of schools. The results of these studies show that the proxy measures which include racial composition, achievement levels, and expenditures per pupil were found to indicate that home buyers are concerned about the quality of education. Thus, homes in those

neighborhoods with high quality schools would actually compete with each other as alternatives to buyers. Theoretically sellers should attempt to capitalize the quality of education in property value, unless the sellers fail to recognize the quality of education in the neighborhood school.

The link between property and neighborhood attributes have economic as well as social facets. As Aaron (1985) put it:

"When a homeowner or renter chooses a house or apartment he purchases not only housing services, but also a wide range of goods and services - public schools, stores, parks, public transportation, neighbors, and other amenities. Though they cost him nothing beyond the price of housing and attendant property taxes, his satisfaction - indeed, his welfare - depends on these commodities as much as on housing. He does not express in marketplace his demand for housing but for the entire package. Statistics on housing expenditures therefore really measure the value placed by residents on housing and residential services."

These residential services are what makes a neighborhood tick. They are also fragile, hence, there is some susceptibility to future decline (Downs,1981). There are some key economic and social factors that increase the susceptibility to future decline of the neighborhood attributes as pointed out by Downs (1981). These factors include:

1. inability or failure to rehabilitate properties due to absentee owners or house too expensive to maintain;

2. withdrawal of a key local institution;
3. land use changes, such as the building of an expressway;
4. immigration of households different from the average in the area--by income, ethnicity, or socioeconomic status;
5. transition to lower income occupancy in adjacent or nearby neighborhood;
6. large increases in property taxes that force owners to put their houses on the market all at once and thereby depress property values; and
7. declining or inadequate public service, such as infrequent garbage collection, or poor quality public schools.

The factors listed above (except no.3), have one common denominator, money. Lack of money (household income) causes property owners to devote less money for improvement purposes. The additional impact of inflation helps to force some property owners out of a housing market, or out of some locations in the city. When key local institutions close their doors or relocate, unemployment increases, tax revenue goes down, and the proportion of income devoted to home improvement declines. Lack of home maintenance by one homeowner causes his neighbors to worry about negative externalities that appear

as a result of little or no improvement. Lack of and limited public money for rehabilitation loans or grants make the matter worse.

According to economists' externalities violate a condition for the optimality of market equilibrium (Piggou, 1920; Mishan, 1974; Siebert, 1981). In a neighborhood housing market, the production and sale of housing involves market agreements between the seller and buyer determined on the basis of neighborhood attributes including externalities. The equilibrium set of housing prices that emerge from such a system is the result of the combined economic behavior patterns of these two groups of individuals who play in the neighborhood housing market. Any change, say an alteration in the behavior of one or more persons, is able in principle to change the equilibrium set of prices, thereby affecting the utility levels of all persons and the output of housing attributes (see Mishan, 1974). That is to say, if a homeowner's production of housing improvement is low compared to others, the neighborhood housing market will no longer be in equilibrium.

Another neighborhood attribute that disturbs the equilibrium set of housing prices is zoning. The zoning system for an urban location has been shown to have impacts on land and property values. Any attempt to differentiate parts of a metropolitan area for purposes of growth and development must come from the planning and zoning system

(Mandelker, 1974; Sternlieb and Sagalyn 1973). As Ohls et al. (1974) pointed out zoning alters the land markets, making substitution between markets impossible, and thus result in land use markets which alter prices, at the expense of one market to other types of land uses. In another study Maser et al. (1977) concluded that there was no evidence that zoning affected real estate value in Monroe County, New York. However, in another study, Jud (1980) stated that methodological errors in sample design and model specification cloud the results of the study of Maser et al. By using a hedonic housing price model to investigate the effect of zoning on single family residential property values, Jud (1980) showed that zoning-related attributes of a house are the most significant determinants of residential property values.

The location of solid waste facilities or other noxious facilities within or close to residential housing is a result of mixed or flexible zoning. As stated earlier, there have been many claims that the location of such facilities, within a residential neighborhood, exert externalities on housing in close proximity. Our task in this research, of course, is to prove or disprove the claim. Before introducing the reader to a review of the empirical studies of landfills impact on property value, we will first discuss the locational strategies of landfills, and especially the locational factors that contribute to continued siting of landfills within

the growth boundaries of our urban communities. The essence of this detour is to give the reader a better perspective of the link between the theories of property value, landfill location and landfill impact redistribution and compensation.

THEORETICAL FOUNDATIONS OF LANDFILL SITING AND IMPACT

According to Johnson and Pettit (1986) the property impact of landfills will depend largely on the facility's location and the residents' perception of environmental risks and their general attitude towards solid waste facilities. If the foregoing claim is true, one may want to know where landfills are located and why they are located where they were or are now. The topic of this section is derived from the answer to the questions we have just posed.

The decision regarding the location of public facilities are different from those of private sector facilities. For the latter, the choice of location is based on demand function which lays emphasis on and tries to balance equity (consumers choice functions obtained from revealed preference affected by distance) with efficiency (profit maximization). Within the equity context the emphasis is on balancing distance of the location to all possible consumers (Berry 1962; Golledge et al., 1966; Reilly 1931; Gosh and McLafferty, 1982) and posting competitive prices, better quality goods and a large assortment (Gosh and McLafferty 1982; Huff 1981). The efficiency, on the other hand, is measured by the profit of the firm (Gosh and McLafferty, 1982). These measurement parameters do not apply in the location decisions for public facilities, especially noxious facilities such as landfills.

The location decision for a public facility is based on criteria which differ among facilities, whether noxious or not. The issue just raised can be better understood by examining in detail how the services of public facilities are consumed.

Spatial interaction theory differentiates services of public facilities that are delivered from travelled-for services (Lea, 1979). For example, emergency services are delivered services whereas the services of landfills or public library are not delivered. The level of consumption for delivered services such as emergency services influences the location from which the service is provided. In addition, consumers do not have to bear the cost or inconvenience of travel associated with service provision, but through service quality, travelled and distance affects consumption (Thisse and Zoller, 1983).

In the case of travelled-for services such as final disposal of waste at landfill (landfilling) and public library, the same level of service is made available at costs varying with the consumer location (Thisse and Zoller, 1983). The level of consumption may be affected by distance of consumers living at different locations from the facilities. The consumers of landfill services include franchised haulers and citizens who self-haul their waste to the landfill.

In the past century and up to the first half of this century, landfills (or dumps as they were called) were located mostly within the city or metropolitan boundary with little or no opposition partly because self hauling was predominant, hence the use of or consumption of the services of such facilities is affected by distance to the customers. Personally, host neighbors of these facilities traded short self-hauling distance with environmental quality of their neighborhood.

During the 1910s and 1920s cities introduced garbage collection trucks and city-wide collection, and engineers developed the concept of modern landfilling as a method for reclaiming wetlands near cities with layers of garbage, ash and dirt (Melosi 1981). These two factors encouraged the location of landfills within the urban environment of most cities. Infact the continued location of landfills within the metropolitan area was also because local governments were mostly responsible for collection and disposal of solid wastes from homes and, to a limited extent, from commercial and industrial establishments. Locating within their boundaries means keeping down costs associated with disposal of municipal solid wastes.

The Solid Waste Disposal Act of 1965, the Resource Recovery Act of 1970 and subsequent amendments and related Acts, which contain federal government's policy toward solid waste has clearly

revealed the environmental risks associated with solid waste facilities. The other indirect impacts of the Acts are the increase in environmental-sensitive publications by various interest groups and passage of more federal and state legislation that put very stringent measures on landfills design and management. On the other hand, host neighbors who were no longer enjoying the benefits of short self-hauling distance started to have a different view of landfills. The risk and resentment of open dumps, at least in metropolitan areas, and the need to protect human health and the environment prompted federal and state governments to start closing most of the dumps in the country (Mills, 1978).

Despite the concerns being raised by federal and state governments and environmental groups around the country, the choice of waste disposal continue to be landfills as shown in Table 1. Up to 1992, about 69 percent of waste generated in the United States of America were disposed of at landfills, unlike the other 11 and 19 percents of the wastes that were managed through recycling and waste-to-energy respectively.

TABLE 1

HOW IS OUR WASTE MANAGED?
(millions of tons per year)

	1960		1970		1980		1992	
	volume	%	vol.	%	vol.	%	vol.	%
Landfills/Other	31.7	93	112.1	93	124.6	76	119.6	69
Recycling	5.8	7	8.0	7	17.7	11	19.5	11
Waste-to-Energy	-	-	0.4	1	20.3	13	33.4	19
Total	87.5	100	120.5	100	162.6	100	172.5	100

Source: EPA. Report to Congress. Solid waste Disposal in the United States, Washington, D.C., 1988; IRR Facility survey. July, 1989.

Popper (1981) in his well-cited article, "Siting LULUs" (Locally Unwanted Land Uses), explained the spatial configuration of noxious facilities locations and shed more light on the four land-use strategies used successfully by the public sector in their location decisions for noxious facilities including landfills. These strategies are summarized as:

1. deliberate or natural concentration of noxious facilities in underdeveloped area of a city;
2. facilities are dispersed or spread out, as in the case of fair-share of public housing in Dayton, Ohio;

3. deliberate siting of noxious facilities haphazardly (or through a randomization process); and
4. through on-site mitigation strategy, public officials try to mitigate impacts of the facility, thereby reducing the social cost and increasing the social benefit of the project to the community.

Several analyses show also that there are some factors (or variables) that make the four strategies work best. These factors are natural or human-made features such as home-rule or neighborhood sentiment, exclusionary zoning, persuasion (through public hearing or debate, and expert opinion), and economic incentives (through grant, cash payment, improvement in public service, or taxation device) (Popper, 1981; Seley, 1983; Dear, 1992). To the extent that these factors make it possible to realize the objectives of the public official, they represent tools that make it possible to locate noxious facilities in minority and politically underdeveloped communities within the U.S. metropolitan boundaries (Gittel, 1980; Popper, 1981).

As the case may be, some of these tools are becoming less effective due to the current multi-faceted positions taken by NIMBY. As pointed out by Heiman (1990), there exist, on one hand, some environmental groups such as Conservation Foundation and National Wildlife Federation who agree (with public officials) that waste facilities are needed, although there are undesirable neighbors, hence mitigation,

negotiation and compensation are necessary. On the other hand, there are other grassroots environmental populism demanding that government and industry must demonstrate successful waste reduction and recycling efforts before any new negotiation for siting could be initiated. What we are now facing is shift from "Not in My Backyard" to "Not in Anybody's Backyard". We are now witnessing new environmentalists applying new opposition strategies and tactics such as: a) letter-writing campaigns to the facility owner, local politicians, and the media; b) lobbying elected officials; c) vigilante action; d) demonstrations; and e) effective citizen participation through effective presentations in the zoning variance process (Dear 1992).

To recapitulate, we have shown that the strategies used by local governments and landfill sponsors to locate landfills has been effectively challenged by environmental groups and landfill neighbors. The later group demand that governments must come up with better locational strategies that recognize the burden associated with living close to a landfill, and take into account the distribution of the burden to everyone in the society that uses the services of these facilities.

LANDFILL LOCATION AND IMPACT MITIGATION

Now, let us explore the strategies that public and private organizations have used recently to locate facilities such as landfills.

Those public officials who have faith in the liberal planning tradition are seriously engaged in promoting participatory democracy in which host neighborhoods and facility sponsors are brought to the negotiation table during the siting process. Some negotiations resulting from this initiative focus on educating everyone on the potential risks and methods of minimizing the potential burdens of the facility (Metropolitan Service District 1987).

Recently the City of New York developed fair share criteria (rules) for siting municipal facilities, which was required by a new city charter adopted by referendum in Autumn 1989. The inclusion of the fair siting criteria in the charter was as a result of testimonies of community representatives before the Charter Review Commission that their neighborhoods were burdened with unfair shares of objectionable facilities. Hence, the new charter required the Mayor to propose new guidelines for equitable distribution of the burdens and benefits of city facilities. The charter's intent is to distribute among communities the burden and benefits associated with city facilities, including landfills, consistent with community needs for services and efficient and cost-

effective delivery of services, and with due regard for social and economic impacts of such facilities upon the areas surrounding the sites (Weisberg, 1993). The criteria would serve as a set of planning guidelines in the city's comprehensive land use planning and review procedures. For solid waste facilities, the criteria recognizes the need to concentrate them in industrially zoned areas, but requires the degree of concentration to be weighed against considerations for need, cost and service efficiency (Weisberg, 1993). The American Planning Association honored the New York's fair share siting guidelines as an innovative planning tool for conflict resolution before there were actually tested.

The city's fair share criteria has been thwarted by five interrelated obstacles summarized below from Rose's (1993) study:

- a) differing opinions on the definition of fairness;
- b) the process of balancing equity and cost-effectiveness through statistical calculation of localized need, provokes more conflicts than it solves;
- c) the use of 59 community districts as the geographic level of equity evaluation for facility siting is meaningless because these districts differ by land area, population density and community character;
- d) the relative burdens of the different kinds of facilities are not factored into the fair share approach; and

e) no clear provisions (such as compensation or incentives) for implementing siting plans developed through the fair share process.

Rose also pointed out that the criteria are a "dubious proposition that runs counter to the basic principle of good planning" because they negate the basic principles of zoning as a fundamental planning tool for isolating the burden of noxious facilities from the general population. In light of this reasoning, Rose discourages local governments from adhering to the fair share approach, and encourages the concentration of public facilities with business and institutions which offer each other different forms of locational benefits. The problem with Rose's proposition is that his views were derived from careful analysis of the locational problems associated with the siting of public facilities such as shelter for the homeless and homes for mental patients. The characteristic differences between shelters and public facilities such as landfill limits the support for his proposition. Besides, the use of zoning to concentrate similar facilities or to site landfills may not be possible because communities and NIMBY advocates can mobilize to prevent such initiatives.

The use of the same equity and efficiency criteria for locating certain facilities may not be applicable to noxious facilities such as landfills. The failure of the City of New York's highly popularized Fair

Share criteria for siting of public facilities clearly demonstrates the urgent need for a new locational strategy. It must be pointed out that the New York guidelines avoid any form of compensation strategy. It must also be pointed out that the major strategic tool for implementing the New York guidelines is zoning variance. The effectiveness of zoning or zoning variance in land use planning is limited for making location decisions for landfills because of the multi-faceted nature of NIMBY sentiments, pointed out earlier, and the insistence of community and environmental groups that governments should come up with acceptable equity locational strategy or strategies.

As has been shown, local planners, public officials and facility owners have come to grips with reality. Opposition to landfill siting or location is not necessarily a site specific location problem. It is rather an opposition to unfair distribution of the burdens associated with the provision of noxious facilities like landfills. What are these burdens? As has been indicated earlier, neighbors of landfills and noxious facilities claim that because of the proximity their property value are affected negatively, and they run the risk of health problems resulting from the technical risks associated with these facilities.

Several studies of locational conflict involving noxious facilities stress the need for mediation/negotiation and compensation (Dear,

1992; Forester, 1987). Dear states that considerations of neighborhood complaints about noxious facility impacts can really result in valuable improvements to proposed and existing facilities. Hence, he encourages planners to "choose between two alternative approaches: 1) collaboration, implying cooperation between operator and host community; 2) autonomy, acting independently of the host community." The Massachusetts Hazardous Waste Facility Act of 1980 did exactly this by establishing a new siting process that addresses the "acceptance" of such facilities by host communities. As pointed out by Wetmore (1980), the objectives of those who drafted the Act were:

- 1) make those facilities attractive to potential host communities and their neighbors, thereby encouraging the siting of facilities with as few delays as possible;
- 2) increase public confidence in the safe operation of hazardous waste facilities;
- 3) effectively utilize the private sector's existing marketing, management, and development expertise; and
- 4) make the most efficient and effective use of public resources presently being invested in permitting, licensing, environmental analysis, community assistance, and development.

As Dear (1992), Michaels (1990) and Wetmore (1980) point out, those mediation/negotiations that focus on educating the society or facility neighbors on the risk associated with the facility and how the

risks would be minimized, are more likely to prevent the adversarial atmosphere present in most siting efforts and operation.

Metro, a regional government planning agency in Portland, Oregon, was mandated by a state law (Senate Bill 626) to establish its first solid waste facility neighborhood enhancement program (and trust fund) in August 1986. The program is funded by a 50-cent per ton surcharge on disposal fee (directed by the state law), for the purpose of funding projects that improve the image of a solid waste facility neighborhood. Some private companies such as Chambers Development Company, Inc, guaranteed Charles City and County, Virginia, a host fee of at least \$1.14 million per year to open a new landfill, free garbage disposal to the county, and pays a county hired engineer to inspect the landfill (Walls and Marcus, 1993).

The mediation approach adopted in the Metro program (neighborhood enhancement) and Charles City/County program (annual host fees and free disposal) place little or no emphasis on how the risks associated with landfill operation would be minimized. Both programs emphasize and implement actions that would likely offset potential reduction in property value in the host neighborhood.

By relying on higher disposal fees to finance their compensation packages, these programs assume that equity redistribution of landfill

burden is being achieved. The issues that needs to be addressed at this juncture are whether the current methods of compensation described earlier addresses unfair redistribution of landfill burden and whether compensation is limited or goes beyond the impacted area. An argument could be made that the programs are not "robbing Peter to pay Paul," rather those responsible for creating landfill impact should be responsible for paying the cost associated with removing the impact. On the other hand, the willingness of facility owners to propose compensation at the announcement of a new landfill project raises questions about the principles of such progressive compensation approach, and whether the process will lead to equilibrium of compensation.

The premise of the existing compensation programs is flawed. The inadequacy of measuring tools imply that all the consequences of landfill location cannot be fully established. The implications are:

- 1) the compensation is not based on documented evidence of burden, such as decline in property value;
- 2) citizens may be over taxed (through high disposal fee), thus leading to regressive overcompensation;
- 3) level of compensation for host neighborhoods of landfills may be inadequate;
- 4) compensation may not be targeted to impacted groups; and

5) they do not exhibit evidence of equity distribution of landfill burden.

The four foregoing issues are interrelated, hence the solution to the first issue will equally solve the other four issues. That is to say, establishing the existence and amount of burden associated with living close to a landfill will provide the yardstick for determining how to redistribute landfill burden equally or fairly and thus the tools for: a) determining the level of compensation for host neighbors; and b) resolving landfill locational conflict.

Given the foregoing analysis, this study aims to establish the existence and amount of landfill burden on neighbors, even though several studies show that noxious facilities, including landfills, have no impact on property value: Dear (1977) - Mental Health Facilities; Wolpert (1978), Dolan and Wolpert (1982), - Group-Home Residences; Nourse (1963), Schafer (1972), Rabiega, et al (1984), - Public Housing Projects; U.S. EPA (1972, 1975), Metro (1981), Gamble et al. (1982), Palm Beach County Solid Waste Authority (1986), Bleich et al. (1991) - Landfills. Another objective of this study is to provide guidance for demarcating the boundary of the impacted groups or neighborhoods.

The procedure employed in this study for determining the existence and amount of burden resulting from the presence of landfills

is based upon the theory of hedonic prices. The theory of hedonic pricing provides conceptual basis for estimating the demand functions of certain goods such as urban amenities (pure clean air, pure water) not traded in explicit market. The demand functions developed by Rosen (1974) employ housing characteristics that includes urban and neighborhood attributes to estimate prices of explicit housing characteristics and household willingness to demand or pay for a housing trait. As described later in the methodological chapter, the hedonic pricing procedure provides the tools for measuring the amount of landfill burden which could be used as a guide for developing compensation programs and the target groups.

Our goal in this study is to design a methodological framework that can control for neighborhood attributes while using a covariant application of hedonic modelling or a covariant regression equation to determine respectively the price of landfills disamenities or the implicit prices of all variables that contribute to property value increase or decline. Before going into more discussion of the hedonic procedure later in the methodology chapter (III) we will first review previous studies of landfill impact to determine the weaknesses in the methodologies the studies employed.

PREVIOUS STUDIES OF LANDFILL IMPACT

Not a great deal of empirical work has been completed on the subject of landfills impact on property value. In a study of the impacts of solid waste disposal facilities by the Metropolitan Council of the Twin Cities Area (1982), the potential environmental impacts and mitigation measures were enumerated. The environmental impacts include surface water and ground water pollution, air pollution from trucks, dust and gases from truck traffic, noise and litter, and loss of vegetation or wildlife.

Some of the mitigation measures include 1) installing of liners under landfill sites to reduce risk of leachate seepage into the groundwater, 2) installing of leachate collection system, 3) controlling disposal of hazardous waste , 4) oiling or watering access roads to disposal facilities, 5) building buffer around the landfills area, 6) routing traffic through less densely populated areas, 7) limiting operation to certain times of the day, and 8) installing litter control around the site. (Metropolitan Council of the Twin Cities Area, 1982; Metropolitan Service District 1981; GRCDA, 1988).

Governmental Refuse Collection and Disposal Association - GRCDA (1988), one of the leading solid waste associations in the U.S.A., argues that stringent measures introduced by federal and state

environmental agencies have reduced the risks usually associated with solid waste disposal facilities. GRCD A claims the NIMBY syndrome appears not to be related to technical failures but rather to

"....the present weaknesses of the public and their attitude about garbage. They were raised from childhood to consider trash an unpleasant product of human life....carrying out the garbage was an assignment which everyone hated.....The garbage man was considered very low on the social standing totem pole in a community.... Mentally, the public, for generations, has been raised to not like trash....consequently we have a major challenge to overcome the public's mental image of solid waste...." (pp 1-2)

It would seem that the greater portion of the concerns associated with solid waste facilities are psychological and based mostly on perception of their operations. In a study of Potential External Effects at Selected Prototypical Solid Waste Facilities prepared for the Metropolitan Service District (1987) by ECO Northwest, the analysis of citizens' perceptions has been carried one step farther.

In the study ECO Northwest distinguishes the risk associated with solid waste facilities into technical risk and perceived risk. Technical risk is defined as "the best estimate of expected values as determined by technical experts." Perceived risk is defined as the derivative of how people assess risk for themselves, which may depend in a large or small way on how experts assess technical risk associated with operations.

ECO Northwest went on to state that part of the mitigative measures that will reduce perceived risk includes communications with citizens.

Getting the citizens involved in the solid waste management policy-making process reduces their fear of the impact of solid waste facilities because the citizens become more acquainted with the type of stringent measures being taken to keep technical risk at a minimum level. In concept, the relationship between public information and perceived risk is translated into expected value or the value of the technical risks should they occur.

FIGURE 3

Influence of Public Information and Involvement
on Perceived Risks

Technical Risk

		High	Low
Public Information or Involvement	High	Medium Perceived Risk (or Medium Change in Property Value)	Low or No Perceived Risk (or Small or No Change in Property Value)
	Low	High Perceived Risk (or Big Change in Property Value)	Medium Perceived Risk (or Medium Change in Property Value)

As shown in Figure 3, high public information on the operations of a highly technical risk facility (like Nuclear Plant) will yield medium perceived risk or change in property value. As shown also in Figure 3, high public information regarding day to day operations in a low technical risk facility (like Landfills) will pose little or no perceived risk for property value.

It would seem that a superficial approach to determining the probability of a solid waste facility impact is to gauge a facility site against type of waste accepted or the mitigation measures (which include both the extent of public information or involvement and

measures taken to minimize technical risk). Mitigation is a mechanism to reduce, minimize or eliminate predictable, measurable negative impacts, and this means that it is a mechanism to provide support for property values (Metropolitan Service District, 1986; Metropolitan Council of the Twin Cities Area, 1982).

The State of Oregon requirements for mitigation measures differ by landfill mainly because of the type of waste accepted or buried at the site. Until October 9, 1993, the level of mitigation measures required of those landfills that receive dry waste (or waste that does not include food or putricibles) and referred to as "limited purpose landfills" was much lower (Oregon Department of Environmental Quality, 1993). Unlike the limited purpose landfills, those facilities that receive all kinds of waste and generally referred to as "general purpose landfills" are required to meet the requirements of tougher design and operating laws.

Most of the published empirical studies tell us little or nothing about type of waste materials accepted by landfills studies, the actions taken, if any, by operators of the facilities to mitigate those factors that are likely to impact the perception of buyers and sellers of homes located close to landfills. The implication of being mute on these issues is that if the result of an empirical study shows the existence of property value impact whereas good mitigation measures are in place,

researchers would be better-off diverting their energy to measuring something other than perception.

The methodologies applied by previous studies to capture perception will be analyzed below. Two approaches, rigorous and non-rigorous, distinguish the methodologies adopted in the studies reviewed below. The non-rigorous approach to determining the impact of a solid waste facility on property value usually entails the analysis of the sale and resale of the properties surrounding a landfills and a comparable control area, over a specified period of time (Metropolitan Service District, 1981; The Palm Beach County Solid Waste Authority, 1986). In detail the analysis involves 1) adjustments for differences in time of sale, number of bedrooms, garage size, basement areas, and ages between homes in the experimental group and the control group, and 2) a comparison of appreciation or depreciation rates between the experimental group and the control group. Although these studies discuss value indicators (or the theory of property value) in a limited sense, the authors fail to quantify and include the indicators in their overall analysis. Hence, these studies are classified as adopting the non-rigorous approach.

The author does not know of any rigorous empirical study conducted before the work of Havlicek et al (1971) which found that

housing prices varied with the number of degrees a house is from prevailing downwind, and with distances from a landfill site. The Havlicek et al study has been reviewed and dismissed as methodologically inferior. As Hwang and Rudzitis (1978) pointed out Havlicek et al did not specify a clear boundary of the study area nor did it specify the range for which the regression coefficient for downwind and distance hold.

In an attempt to correct the deficiency in Havlicek's study, Hwang and Rudzitis (1978) studied the external effects of 55 landfills sites in the Chicago SMSA. They specified an impact range of three-blocks radius around the landfills and incorporated the various data derived by Havlicek et al in their study. Using the regression coefficients of absolute angle variable of \$24 per angle and the distance variable of \$0.62 per foot of distance, Hwang and Rudzitis derived the estimated external effects of a landfills site on a block basis.

There are two potential problems with the methodology of Hwang and Rudzitis. The first is the conceptual inconsistency and biases in assessed value used in their study. In terms of inconsistency, appraisal of properties usually occur at long irregular intervals of four - ten years. Hence, this introduces a measure of spatial and temporal inflexibility in any assessed property (Morrison, 1977; Saccamanno, 1979). As to

biases, the use of Chicago's assessed value renders the results of Hwang and Rudzitis unreliable. A study by Berry and Bednarz (1975) of the variations in the ratio of property tax assessments to market values for single-family homes in Chicago found that differential assessment of land and improvements were not based on characteristics of the improvements and value of the land, but rather were based on political and other reasons. For example, results of the study suggest 1) that blacks were assessed at higher rates, and 2) there is favoritism on the part of the political machine: low assessment:price ratio in Mayor Daley and "machine" aldermen neighborhoods. The second problem with Hwang and Rudzitis' study is in the application of the coefficients developed by Havlicek et al (in a separate study of four landfills sites) to the 55 landfills sites. In other words, they failed to explain the reason for the generalization of the values of the two coefficients, which are derivatives of some site characteristics that are likely to vary between locations. It is therefore not surprising that Havlicek et al coefficients show decreases in property values located downwind or close to landfills while Hwang and Rudzitis calculate the total external effect per landfills site (of a three-block radius) to be only \$60,000.

In a rigorous investigation of the impact of landfills on property values, Gamble et al (1982) tested the hypothesis of a property price's

relationship to distance to ten landfills in nine counties in southeastern, south central, southwestern, and northwestern Pennsylvania. The study also analyzed the community growth and development effects of landfills. These landfills are located "in farm country" and surrounded by "gently rolling farmland" or "on open land interspersed with a few farm woodlots". Gamble et al study compared changes in residential developments and sales prices of homes in the surrounding areas of the landfills to control area. Their intention was to test the hypothesis by measuring the economic relationship between market price of homes located within a one-mile radius of the landfills and the various characteristics of the homes and their locations, and then comparing the product to that of the control areas.

The measurement is based on the hedonic price model whereby sale prices of the homes are expressed as a function of the quality and quantity of housing (age, square feet of living space, garage spaces) and the disamenities of the location (expressed as distance of homes from the landfills). One of the conclusions of the study is that there was no evidence suggesting that the landfills had any adverse effects on growth or development in the communities in which they are located. However, the data did suggest that there was somewhat less development growth adjacent to the landfills. A separate analysis of single family dwellings

(173) and lot properties (42) which sold in the years 1977 through 1981 in only one of the landfills (Boyertown landfill site) concluded that the "results suggests that the available data can not be used to support the proposition that proximity to the landfills in Montgomery County significantly influences property prices."

There are several problems with the study: 1) data was too small; 2) data was collected for both the study and control areas but price effects were not estimated for characteristics in the control area; 3) the method of measuring distance of homes from the landfills was not presented; 4) only a few characteristics of homes were used (age, square foot of living area and number of garage spaces); 5) the method of controlling for impact of inflation on sale prices was not presented; 6) as admitted by Gamble et al, available cross-sectional samples (18 - 46) are "relatively small and not conducive to much confidence in rejecting the distance to the landfills as influencing property prices;" 7) although the results show \$4,200 reduction in value per mile, the results were not significant; and 8) the low test statistics (test of significance), as also noted by Gamble et al can be attributed to the omission of relevant variables.

To the extent that there are deficiencies in the research design used by Gamble et al, the results may not be too surprising given the

environmental settings in which the study took place. In underdeveloped rural areas the siting of a landfill may be a blessing in disguise because of the infrastructure such as good roads which may come with the landfills. The issue that should be raised here is that in rural areas good roads are not usually abundant as such should be controlled for in a study such as that of Gamble et al. Controlling for good roads in the rural areas may yield a different result.

In another study of a landfill in the north central portion of the San Fernando Valley in Los Angeles, Bleich et al. (1991) compared housing prices in an adjacent neighborhood to housing in two comparable areas one-half to six miles from the landfill. Using regression-based approach, Bleich et al. analyzed 1,628 sales transaction that occurred between 1978 and 1988 in three neighborhoods located within six miles of the landfills. House-specific and neighborhood variables were used in the study. Five of the eight house-specific variables, but none of the neighborhood variables were significant, thus Bleich et al. concluded that "a landfill, if well-designed and managed, can be good neighbor and have no statistically measurable negative impact on surrounding property values."

The most recent study of landfill impact was conducted by Nelson et al. (1992) on Anoka regional landfill in Ramsey, Minnesota. The

study used sales data of 708 homes between 0.35 and 1.95 miles of the landfill, sold during 1979 to 1989 period. Unlike previous studies, the results of Nelson et al. study show that the landfill had nearly \$5,000 impact on homes for each mile away from the landfill. It should be pointed out here that whereas Nelson et al. studied a multi-purpose landfill that accepts all kinds of garbage, this particular research focused only on a limited purpose landfill that accepted only dry wastes. To reiterate, limited purpose landfills are characterized as less harmful to the environment.

From the empirical studies reviewed, there are several lessons to be learned about estimating property value impact of landfills. First, the property and neighborhood characteristics that impact property value must be selected with care and intention to specify the best model that will explain spatial and aspatial patterns of impact. Second, proximity or distance of homes from the landfill must be well defined and measured. Third, the implication of the preceding statement is that a variety of rigorous regression equations may be necessary in order to determine the best fit model(s) that is(are) adequate for estimating prices of property and neighborhood characteristics. Fourth, although some of the studies reviewed suggest the use of comparable control area, the reason for using control area, if necessary, and the method of

selecting control area must be explained. Fifth, the effect of inflation on the dependent variable (sale price) must be controlled for or taken away.

SUMMARY

From the foregoing literature review we can conclude that the theoretical structure from which property values are determined results in at least seven classifications: quality of house, quantity of house, neighborhood land use, neighborhood socioeconomic status, neighborhood socioeconomic infrastructure, accessibility of neighborhood, and neighborhood housing market. Factors which determine where a landfill is sited, or where a specific type of landfill should be sited in a community include ownership (especially by jurisdictions that cater only to its residents), and transportation costs.

Increased awareness of the environmental impact of landfills have led citizens to disregard or appreciate the savings in transportation costs associated with proximity to the facilities. Although we have seen several studies conclude that there is no property value impact of landfills on property value, resistance to sitting of landfill is all time high. Only one study of a large regional multi-purpose landfill has shown negative impact associated with sales prices. It is our hope that the

results of this study will add or increase our knowledge in this area and how current and future landfill owners should deal with Nimbysm.

CHAPTER III

METHODOLOGY

To reiterate, the purpose of this study is to provide insight to the arguments between landfill owners and host neighbors of landfills regarding especially the economic and social impacts of such facilities. Most of the previous studies that investigated these issues employed comparable approaches in which variables of one or several landfills and comparable neighborhoods were analyzed with least square regression (Gamble et al. 1982; Bleich et al. 1991) and without regression models (Metropolitan Service District, 1981; Palm Beach County Solid Waste Authority, 1986). Few studies focused on variables of a particular landfill and the characteristics of surrounding area using time-series data and least square regression (Nelson et al. 1992).

As mentioned earlier, the hedonic pricing approach is employed in this study to determine the true price of living close to or far from a landfill. As pointed out by Rosen (1974), at any particular location in the urban area, housing can be viewed as a package of goods consisting of structural and non-structural characteristics that home buyers take into account when they make an offer on a home. A household can buy different quantities of housing characteristics it likes by choosing

different locations. While the price paid is a whole, the marginal hedonic prices of the structural and non-structural characteristics of the house can be estimated and then used to determine household willingness to demand/pay for a certain characteristic (Blomquist and Worley, 1981; Butler, 1982; Freeman, 1979). In this study our objective is to estimate prices of housing characteristics (including neighborhood and environmental characteristics) and does not include further estimation or determination of the demand for the characteristics.

Some researchers caution the choice of specification for the relationship between hedonic process and implicit markets because of the inherent bias in functional form of hedonic regression used to estimate demand of a housing characteristic. As Blomquist and Worley (1981) pointed out, if households can repackage characteristics by relocating, then marginal price of characteristics would not vary across sites and the functional form of the hedonic regression is simply linear. On the other hand, if households can not repackage housing characteristics across sites then the functional form is nonlinear. Nevertheless, Butler (1982) explains that since the hedonic function must be limited to housing characteristics, the question of which characteristic must be included in the determination of market price is

not easily answered by including all characteristics in a simple linear or nonlinear hedonic regression equation. Butler also emphasize the need to check for multicollinearity problem that would likely arise.

In taking the foregoing cautions into consideration, the choice of variables for housing in the Lavele neighborhood and the landfill in particular, and the functional form will be limited to a simple linear equation that incorporates the most salient attributes of housing and neighborhood environment in the study area for which data is available.

STATEMENT OF HYPOTHESIS

Notwithstanding the problem of few studies, the review of both the empirical and theoretical researches has delineated paths to issues and variables commonly associated with property value impacts. The intention in this particular research is also to scrutinize and find answers to the following issues and hypothesis through secondary data analysis within the confines of a small research budget. The issues are:

- 1) the property value impact of landfills in operation located in a high density single family residential neighborhood; and
- 2) the property value impact of a closed landfills site located in a high density single family residential neighborhood.

These research questions imply the following hypotheses:

- 1) the property value impact of a landfill located in a densely populated single family residential neighborhood diminishes

with distance away from the landfill. (That is to say, because of the odor, noise and visibility factors associated with a landfills, it is possible that property in close proximity to the landfills will experience declining value. Those properties further away from the facility may never have to encounter these traits, with the net effect that they may not experience a decline in value);

- 2) the property value impact of a closed landfills will be lower than the property value impact of a landfills in operation because of the lack of odor, noise, and visibility inherent in landfills operation;
- 3) household willingness to pay for improvement in neighborhood quality is greater than zero since host neighbors of a landfills seek compensation or closure of the facility; and
- 4) the regression coefficient would be the same for the three study periods (if sale prices are adjusted to the price level of the period before the landfill started operation).

The basic assumption is that buyers and sellers of homes in the study area are well informed of both the characteristics of the homes and neighborhood.

GENERAL CHARACTERISTICS OF THE STUDY AREA

To test the foregoing hypothesis, the focus of the research was narrowed to a location that is easily assessable by the author so that past operators of the landfill can be easily reached for undocumented information. The ease of finding data on sale prices and housing characteristics was another factor considered in choosing a study area.

The old Lavele landfill in Portland, Oregon was chosen to test the validity of the hypotheses of this study. The landfill is located in the northeast section of the city, on a 23 acres of 33.5 acre site. It started operation in late 1972 and closed doors to garbage trucks in late 1982. Ownership of the landfill changed during operation but operation of the landfill was managed by one company. An interview with one of the previous owners revealed that the landfill closed because the owner raised the lease to a point unacceptable to the operator. The landfill is buffered on the north and west with a fence, on the south with Oregon Athletic Club, and on the east with trees. Neighbors were allowed to dispose their garbage at the site for free. The Oregon Department of Environmental Quality (DEQ) permitted the landfill to operate as a demolition landfill - accepting only building materials, soil, rock, concrete or asphalt.

Population in the two census tracts shared by the landfill changed a little before the landfill opened in 1970 and 1980 when the landfill closed. During this period, total population in the area decreased by three percent. The population of African-Americans in the area remained at one percent during the period, while that of whites decreased slightly from 99 percent to about 89 percent. The population

of families with children under 18 years old decreased by nine percent during the same period.

The proportion of high school graduates in the same area in 1970 was about 70 percent, and decreased slightly to 69 percent in 1980. The employment level for persons 16 years and older declined from 80 percent to about 70 percent between 1970 and 1980. However, mean income level increased from approximately \$11,000 to \$12,800 during the same period.

Housing units in the same two census tracts area increased by five percent during the same period. Only one percent of the total units were vacant in 1970 while all the units were occupied in 1980. Owner occupied units in the same two census tract area declined from 69 percent in 1970 to 66 percent in 1980, while renter occupied units increased from 31 percent to 34 percent during the period.

In 1983 the Oregon Legislature passed law requiring owners of landfills that closed after January 1, 1980 to obtain closure permit from the DEQ. This closure permit must be maintained after the site closes, even though solid waste is no longer received at the site, until DEQ determines that the disposal site no longer poses a threat to the environment. DEQ issued a closure permit for the Lavele landfill in December 1984 stipulating that the permitted activities at the site

include bi-weekly program of monitoring the methane monitoring wells, proper service of monitoring and methane extraction system equipment, erosion control, drainage, maintenance of perimeter fence, and litter control. The landfill experienced gas (methane) migration into homes closer to the north boundary in 1983. Thereafter an active gas collection system was installed and gas migration stopped (DEQ, 1986).

An interview with officials of the Oregon Department of Environmental Quality and one of the former operators of the landfill also revealed that there was little or no complaints by neighbors during the period the landfill was in operation. There was no action, therefore, to educate any concerned citizen (or public officials) of the extent of mitigation measures in place during operation, if any.

More than 90 percent of a two-mile radius around the landfills was zoned high density single family residential during the period the landfill was in operation. However, in 1973 and 1975 minor zone change were approved for construction of 8-unit apartments and a craft store respectively. The apartments are located 14 blocks away (west) from the landfill. There is no information on the number of owner-occupied and absentee landlords for the homes in the study area.

In 1983-84 the comprehensive designation of the area was changed from single-family to light manufacturing and light industrial. In 1984 the owner of the landfill, Rose City Sand and Gravel Company applied to the City of Portland for a zone change that would allow it to build on the site (The Oregonian, February 1984). The application could not have been granted because the DEQ issued a closure permit later that year that stipulated monitoring of the landfills site until October 1994.

CONCEPTUAL AND OPERATIONAL MODEL

Our previous analysis has shown that: 1) residential property prices are affected by various factors; and 2) the study area is 100% developed, hence our concern here is not with the supply of new residential housing but rather with improvements and demand for the existing housing.

A general demand analysis for housing recognizes that when classes of prices are introduced into housing each monetary figure (payment) simply represents a certain quantity of utilities or values. The value distribution is dependent upon many variables (property characteristics, etc.) that influence the amount paid for a house. Some

variables will satisfy owners' needs and others will hinder owners' satisfaction.

Following our earlier theoretical exploration, the basic equation that can explain the value distribution of single family residential property price is:

$$PH = f(QL, QU, NP, NA, NS, NM, NL)$$

where

PH = the sale price of the house

QL = the quality of the house

QU = the quantity of services offered by the house

NP = the public service in the neighborhood

NA = the extent of accessibility in the neighborhood

NS = the socioeconomic condition of the neighborhood

NM = the housing market condition of the neighborhood

NL = the physical location of the neighborhood

The above relationship can be estimated with the multiple regression technique that yield products of a covariate analysis of linearly combined property specific variables and before-after landfills proxy variables. An F-test was carried out to determine the joint significance of all independent variables.

The linear approach was applied by drawing references from many studies of the property value impact of various types of facilities such as public housing (Rabiega et al., 1984), and landfill (Gamble et al., 1982). A number of property specific variables were entered into a linearly specified multiple regression model so as to remove their effect and isolate those of before and after the landfills operation periods. The measurement tools of property specific variables are some of those shown in Table 2. The distance impact hypothesis was treated by including variables that represent sales before, during, and after the landfills closed.

TABLE II

Variables For Property Value Impact of Landfills

Category of Attributes	Sub-set of Attributes	Variable (measurement tools)
Property Value		<ul style="list-style-type: none"> • Individual assessed value of property • Individual sale transactions of property • Owner estimated value of property
Property	Quantity	<ul style="list-style-type: none"> • Lot size • Number of rooms • Number of bedrooms • Basement • Garage
	Quality	<ul style="list-style-type: none"> • Age • Interior space • Fireplace
Neighborhood	Accessibility	<ul style="list-style-type: none"> • Travel time to CBD • Travel time to major freeways • Travel time to employment centers
	Public Service	<ul style="list-style-type: none"> • School expenditure • Pupil-teacher ratio • Improved reading score • Success in college admissions • Local recreation expenditure • Quality of fire protection • Road and street expenditure
	Socioeconomic	<ul style="list-style-type: none"> • Median family income
	Location	<ul style="list-style-type: none"> • Existence of landfill at time t • Proximity of property to landfill • Proximity of property to road used by garbage trucks • Size of landfill • Land use
	Housing Market	<ul style="list-style-type: none"> • Number of sales in impact area • Number of repeat sales

The form of the quantitative estimation of the linear equation is as follows:

$$P_i = a + b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + b_{10}X_{10} + b_{11}X_{11} + e$$

where

P_i	=	a base year constant dollar sales price
a	=	an intersection to be estimated;
$b_1..b_{11}$	=	the coefficients to be estimated (or the unit contributions of each variable);
X_1	=	age of house at time of sale;
X_2	=	lot size in square feet;
X_3	=	house size in square feet;
X_4	=	number of bedrooms in the house;
X_5	=	number of bathrooms in the house;
X_6	=	height of house in stories;
X_7	=	presence of garage (dummy variable);
X_8	=	presence of fireplace (dummy variable);
X_9	=	presence of basement (dummy variable);
X_{10}	=	distance of home from landfills in blocks (city blocks); (represents how neighborhood is perceived)
e	=	an error term (to allow for possibility that relevant characteristics have been excluded and random disturbances].

Most of the property specific variables are expected to be positively related to sale price. However, the age variable was expected to be negatively related to sale price, except in the case where older houses benefit from historic preservation programs or may have better construction and landscaping.

It is in order to state the assumptions of the above regression equation which must be maintained. These assumptions of the above regression equation are: 1) the data to be used must be representative of the variables; 2) a normal distribution of the variables; 3) the independent variables must be linearly independent of each other; and 4) all the data must be measured at interval ratios. Where any of these assumptions are violated, we will employ any of the available theoretically justified correction techniques.

VARIABLE MEASUREMENT AND DATA SOURCES

The type of data collected for operationalizing the association of dependent and independent variables are shown below.

The Dependent Variable

The dependent variable is operationalized as follows:

SPRICE - Sales Price of individual homes before the Lavele landfills opened (1971), during the time the landfills was in operation (1979), and after the landfills closed (1986). All sales price will be adjusted to a 1972 base year.

The Independent Variable

The study postulates that the following independent variables will be associated with the sale prices of homes in the Lavele landfill neighborhood.

QL - Property Quality variables:

AGE	-	Age of house at sale
HSIZE	-	Interior Space (House Size) in square feet, at sale
GARAGE	-	Garage at sale (a dummy variable; 1 = a garage; 0 = no garage)
FRPL	-	Fire-place at sale (a dummy variable; 1 = a fire-place; 0 = no fire-place)

BATH - Number of bathroom, at sale

QU - Property Quantity Variables:

LSIZE - Lot Size in square feet, as sale

BDROOM - Number of Bedrooms, at sale

HEIGHT - Number of stories, at sale

BASEM - Basement (a dummy variable; 1 = a basement;
0 = no basement)

NL - Neighborhood Location Variables:

DIST - Straight line distance (in feet) between the site of the
landfills and site of the house sale.

Distance of homes from the landfill was based on the distance between center of the landfill and the nearest homes. This distance is approximately 250 feet and corresponds roughly with the width of city blocks directly on the southern portion of the study area. Homes located directly north or east or west of the landfill were grouped into 240 feet length of "blocks". That is to say, all homes within 240 feet range from the landfill were grouped into the first (or one) block, whereas homes with 241 feet 480 feet from the landfill were grouped

into the second block. Homes located diagonally in the 45 degree angle of the northeast, northwest southeast and southwest sections of the study area were also grouped into 240 feet block ranges. The City of Portland street map microfiche file containing detailed diagram of the study area and street dimensions was used to measure the distance of homes from the landfill as described above.

Data Sources for Dependent and Independent Variables

Data for the dependent variable (sale prices) was obtained from the Oregon Multiple Listings (MLS), Volumes 1,2,3,4, for 1971, 1979 and 1986. For the independent variables, data for the key control variable - distance - was computed by the author. Data for the rest of the independent variables was obtained from the MLS volumes listed earlier and the Multnomah County, Oregon, Tax Assessor's files.

SUMMARY

The chapter has focused on the statistical method used to determine empirically the property value impact of landfills. The research questions and hypotheses were formulated, with a description of the area in which the hypotheses were tested. A complex multiple regression equation was specified for the test. The predictor variables

and the dependent variable were also specified. The assumptions of the regression equation were stated. Finally, the method of determining distance of homes away from the landfill was clearly stated.

CHAPTER IV

DESCRIPTIVE ANALYSIS OF LANDFILL NEIGHBORHOOD HOUSING DATA

The analysis of the data is presented in this chapter. To reiterate, a hypothesis was generated to investigate the property value impact of landfill. Some research questions were also generated. This chapter is divided into two sections. The first section is an explanation of the spatial distribution of homes measured by typical length of the smallest city block (240 feet) in the study area. The second section is an analysis of the housing market in the study area during the three periods.

SPATIAL DISTRIBUTION OF HOUSING

The distribution of homes sold by distance (in city blocks) during the three periods are shown in Table III. Data in the table show that more than 50 percent of the homes were sold during the landfill operation period are one to five blocks away from the landfill. Whereas less than 30 percent of the homes were sold before the landfill started operation and after the landfill quit operation.

TABLE III
HOME SALE BY DISTANCE FROM LANDFILL

Distance in Block*	Year and number of homes		
	1971	1979	1986
1	4	8	3
2	3	11	4
3	6	11	8
4	10	16	6
5	6	8	7
6	9	8	9
7	5	4	10
8	4	4	8
9	3	1	7
10	4	5	9
11	1	-	4
12	1	2	-
13	-	1	1
TOTAL	56	79	76

* One block in this study is equal to 240 feet.

The mean distance in 1971, 1979 and 1986 are 5.5, 4.7 and 6.5 blocks respectively. Mean distance for the three periods depicts that the distance spread of homes sold when the landfill was not in operation is smaller than the distance spread of homes sold when the landfill was

in operation. These results do not necessarily support the hypotheses that most homes sold in 1979 are closer proximity to the landfill.

PERFORMANCE OF THE HOUSING MARKET

In both relative and absolute terms, the housing market was more active in 1979 than 1971 and 1986. A summary of house sales in the Lavele landfill neighborhood is presented in Table IV.

TABLE IV
HOME SALE BY STUDY PERIOD

Number of Room	Year and number of homes		
	1971	1979	1986
1	6 (11%)	2 (3%)	5 (7%)
2	18 (32%)	34 (43%)	38 (50%)
3	18 (32%)	38 (48%)	30 (39%)
4	14 (25%)	4 (5%)	2 (3%)
5	-	1 (1%)	1 (1%)
TOTAL	56 (100%)	79 (100%)	76 (100%)

During the three periods studied, there were more homes sold in the period the landfill was in operation. The number may not necessarily depict home buyers dislike of the neighborhood. A

comparison of addresses of home sales data show that four of the homes that sold in 1971 were resold in 1979. Another three of the homes sold in 1971 were resold in 1986. Three of the homes sold in 1979 were resold in 1986.

The mean sale prices during the three periods are \$18,090 for 1971, \$48,275 for 1979, and \$42,632 for 1986. These mean sale prices are consistent with those in the entire northeast area of Portland. For example, the sale price of a typical 740' home built in 1947 was \$48,950 in 1979 and \$43,000 in 1986 (Metropolitan Real Estate Report, 1981 and 1988).

The range of age of homes sold during the three study periods is shown in Table V. Most of the homes sold in 1986 are older (31 years and over) than those sold in 1971 and 1979. This seems to be a reflection of a built up neighborhood where only very few new houses were built during the three study period.

TABLE V
HOME SALE BY AGE OF HOUSE

Age	Year and number of homes		
	1971	1979	1976
1 - 10	2	6	2
11 - 20	15	9	2
21 - 30	19	30	4
31 - 40	4	15	40
41 - 50	6	3	6
over 50	10	16	22
TOTAL	56	79	76

The mean age of homes sold in 1971, 1979 and 1986 are approximately 31, 33, and 44 respectively.

House size distribution of homes sold during the study periods is shown in Table VI. Most of the homes sold in the three periods are below 1000 square feet. The smallest (520 square feet) and largest (4,250 square feet) size of homes were sold in 1971.

TABLE VI
HOME SALE BY HOUSE SIZE

House Size (square feet)	Year and number of homes		
	1971	1979	1986
below 1000	25	38	41
1001 - 1500	20	33	30
1501 - 2000	10	6	5
over 2000	1	2	-
TOTAL	56	79	76

Summary of simple statistics of data for the three periods showing the mean, standard deviation, minimum and maximum values of variables are presented in Table VII. The mean performance shown in Table VIII measures the central tendency of the observations while the standard deviation measures the dispersion of the observations for individual variable. A high standard deviation indicates that the observations for an individual variable are grouped inside a wide range around the mean. A low standard deviation indicates the observations are grouped closer to the mean (Krueckerberg and Silver, 1974).

TABLE VII
COMPARISON OF MEAN PERFORMANCE

Variable		N	Mean	Std. Dev.	Minimum	Maximum	Sum
Sale Price	1971	56	18,090	10,646	6,500	70,000	1,013,050
	1979	79	48,275	12,160	25,000	117,000	3,813,750
	1986	76	42,632	11,781	16,250	79,000	3,240,060
Distance	1971	56	5.5179	2.7236	1	12	309
	1979	79	4.7089	2.8741	1	13	372
	1986	76	6.4605	2.9003	1	13	491
Lot Size	1971	56	5,977	1,953	2,000	13,000	334,720
	1979	79	5,932	1,658	2,000	10,764	468,596
	1986	76	5,863	1,633	3,900	12,000	445,567
House Size	1971	56	1,184	557.9950	520	4,250	66,300
	1979	79	1,083	330.2353	520	2,538	85,583
	1986	76	1,050	270.5382	600	1,943	79,764
Age	1971	56	31.2321	15.5528	7	62	1,749
	1979	79	32.8481	16.4979	2	68	2,595
	1986	76	43.7895	18.3669	2	78	3,328
Bedroom	1971	56	2.7143	0.9670	1	4	152
	1979	79	2.6073	0.6872	1	5	206
	1986	76	2.4211	0.7351	1	5	184
Bath	1971	56	1.2500	0.6105	1	4	70
	1979	79	1.2911	0.4844	1	3	102
	1986	76	1.2105	0.4709	1	3	92
Height	1971	56	1.0179	0.1336	1	2	57
	1979	79	1.0253	0.1581	1	2	81
	1986	76	1.0132	0.1147	1	2	77
Basement	1971	56	0.6071	0.4928	0	1	34
	1979	79	0.6709	0.4729	0	1	53
	1986	76	0.6053	0.4920	0	1	46
Fireplace	1971	56	*	*	*	*	*
	1979	79	0.6203	0.4884	0	1	49
	1986	76	0.2368	0.4280	0	1	18
Garage	1971	56	1.0179	0.7004	0	2	57
	1979	79	1.3038	0.4628	1	2	103
	1986	76	1.3026	0.4624	1	2	99

* No fireplace in homes sold in 1971.

The Pearson Correlation Matrix showing all zero-order level of relationship among the independent variables for the three periods are presented in Tables VIII, IX, and X.

TABLE VIII
1971 DATA

Correlation Analysis

Pearson Correlation Coefficients / Prob > |R| under Ho: Rho=0 / N = 56

08

	SPRICE	DIST	LSIZE	HSIZE	AGE	BDROOM	BATH	HEIGHT	BASEM	GARAGE
SPRICE	1.00000 0.0									
DIST	0.11393 0.4031	1.00000 0.0								
LSIZE	0.53584 0.0001	-0.18265 0.1779	1.00000 0.0							
HSIZE	0.83056 0.0001	0.12499 0.3587	0.52649 0.0001	1.00000 0.0						
AGE	-0.45832 0.0004	0.22331 0.0980	-0.22291 0.0987	-0.27410 0.0409	1.00000 0.0					
BDROOM	0.56057 0.0001	-0.10849 0.4261	0.34643 0.0089	0.52661 0.0001	-0.37995 0.0039	1.00000 0.0				
BATH	0.083640 0.0001	0.16129 0.2350	0.38420 0.0035	0.68236 0.0001	-0.29919 0.0251	0.43117 0.0009	1.00000 0.0			
HEIGHT	0.66344 0.0001	0.22391 0.0971	0.28023 0.0365	0.74762 0.0001	-0.20324 0.1330	0.18091 0.1821	0.61287 0.0001	1.00000 0.0		
BASEM	0.04812 0.7247	0.03241 0.8125	0.01332 0.9224	0.02595 0.8494	0.01923 0.8881	0.14172 0.2975	0.09065 0.5064	-0.16763 0.2169	1.00000 0.0	
GARAGE	0.13560 0.3190	0.10944 0.4220	0.19980 0.1398	0.06988 0.6088	0.16318 0.2295	0.16874 0.2138	0.11693 0.3908	-0.19772 0.1441	0.02069 0.8797	1.00000 0.0

TABLE IX
1979 DATA

Correlation Analysis

Pearson Correlation Coefficients / Prob > |R| under Ho: Rho=0 / N = 79

87

	SPRICE	DIST	LSIZE	HSIZE	AGE	BDROOM	BATH	HEIGHT	BASEM	FRPL	GARAGE
SPRICE	1.00000 0.0										
DIST	0.22689 0.0443	1.00000 0.0									
LSIZE	0.27263 0.0151	-0.01249 0.9130	1.00000 0.0								
HSIZE	0.70065 0.0001	0.23010 0.0413	0.11098 0.3302	1.00000 0.0							
AGE	-0.45858 0.0001	0.12613 0.2680	-0.21332 0.0591	-0.22198 0.0493	1.00000 0.0						
BDROOM	0.26305 0.0192	0.19457 0.0857	0.00463 0.9677	0.52320 0.0001	-0.23036 0.0411	1.00000 0.0					
BATH	0.55149 0.0001	0.03404 0.7659	-0.03031 0.7909	0.63347 0.0001	-0.22058 0.0508	0.34758 0.0017	1.00000 0.0				
HEIGHT	0.52319 0.0001	0.21395 0.0583	0.06236 0.5851	0.52242 0.0001	-0.14106 0.2150	0.09262 0.4169	0.40475 0.0002	1.00000 0.0			
BASEM	0.15396 0.1755	0.01349 0.9061	0.09875 0.3866	0.13493 0.2358	0.29752 0.0077	-0.00799 0.9443	0.03188 0.7803	-0.05861 0.6079	1.00000 0.0		
FRPL	0.35829 0.0012	0.14855 0.1913	-0.05081 0.6565	0.44002 0.0001	-0.05180 0.6503	0.31427 0.0048	0.41908 0.0001	0.12610 0.2681	0.17355 0.1261	1.00000 0.0	
GARAGE	0.45768 0.0001	0.09626 0.3987	0.06287 0.5820	0.40104 0.0002	-0.20879 0.0648	0.25869 0.0213	0.45818 0.0001	0.24398 0.0303	0.11122 0.3292	0.46016 0.0001	1.00000 0.0

TABLE X
1986 DATA

Correlation Analysis

Pearson Correlation Coefficients / Prob > |R| under Ho: Rho=0 / N = 76

	SPRICE	DIST	LSIZE	HSIZE	AGE	BDROOM	BATH	HEIGHT	BASEM	FRPL	GARAGE
SPRICE	1.00000 0.0										
DIST	-0.2816 0.8092	1.00000 0.0									
LSIZE	0.34109 0.0026	-0.07594 0.5144	1.00000 0.0								
HSIZE	0.70388 0.0001	0.04691 0.6874	0.27217 0.0174	1.00000 0.0							
AGE	-0.45456 0.0001	0.33650 0.0030	-0.20673 0.0732	-0.26218 0.0221	1.00000 0.0						
BDROOM	0.47585 0.0001	0.02041 0.8611	0.06585 0.5719	0.61053 0.0001	-0.21357 0.0640	1.00000 0.0					
BATH	0.59322 0.0001	0.12332 0.2886	0.12919 0.2660	0.56218 0.0001	-0.26767 0.0194	0.35680 0.0016	1.00000 0.0				
HEIGHT	0.14669 0.2061	-0.01846 0.8743	-0.04716 0.6858	0.31729 0.0052	-0.05563 0.6332	0.24968 0.0296	0.19487 0.0916	1.00000 0.0			
BASEM	0.27965 0.0144	0.17580 0.1288	0.15124 0.1922	0.09073 0.4357	0.14855 0.2003	0.06015 0.6058	0.01817 0.8762	-0.14298 0.2179	1.00000 0.0		
FRPL	0.20778 0.0717	-0.05682 0.6259	0.05974 0.6082	0.12455 0.2837	-0.03767 0.7466	0.18738 0.1051	0.08009 0.4916	-0.06433 0.5809	0.25994 0.0234	1.00000 0.0	
GARAGE	0.65404 0.0001	0.06370 0.5846	0.29097 0.0108	0.42756 0.0001	-0.25298 0.0275	0.28694 0.0120	0.43825 0.0001	0.17528 0.1299	0.18042 0.1189	0.10460 0.3685	1.00000 0.0

CHAPTER V

FINDINGS OF THE REGRESSION MODELS

This chapter presents the type of models that were operationalized and the results of the models. An outline of the seven multiple regressions used for the empirical analysis are presented along with the reasons for using them. The first section is an explanation of the step-by-step procedure used to estimate property value impact of the Lavele landfill during the time it was in operation. The main findings of the three cross sectional multiple regression results are presented in the second section of this chapter. The casual relationship between sale price and distance in the three periods is analyzed. A discussion of the casual relationship between sale price and housing specific variables is also added. Finally, a summary of major findings of this research is discussed.

THE REGRESSION MODELS

Several regression runs were used in the analysis that follows in the next section. The regression models were used for different purposes.

The regression models are as follows:

Model 1: Linear regression of 1971 data.

Model 2: Linear regression of 1979 data.

Model 3: Linear regression of 1986 data.

- Model 4: Linear regression of combined unadjusted 1971, 1979 and 1986 data.
- Model 5: Linear regression of 1979 data (sale price adjusted to 1971 price level).
- Model 6: Linear regression of 1986 data (sale price adjusted to 1971 price level).
- Model 7: Linear regression of combined 1971, 1979 and 1986 data (sale price for 1979 and 1986 adjusted to 1971 price level).

The purpose of models 1,2 and 3 was to estimate the quantitative impacts of each independent variable on price of single family homes in the Lavele landfill neighborhood. Of utmost importance is to estimate the price effect of the distance variable on sale price of homes before the landfill opened, during the landfill operation, and after the landfill closed.

Models 4, 5, 6, and 7 were employed for the purpose of determining if there is a difference in structural and non-structural changes in the Lavele landfill neighborhood that occurred in the three time periods. Determining such differences is important especially to confirm if there is a difference in how the neighborhood was perceived before the landfill began operation and after it closed. Using data from these four models a Chow Test was operationalized to test the hypothesis that there were differences between the regression coefficients of the models.

INTERPRETATION OF REGRESSION RESULTS

In order to understand how distance from the old quarry site (which later became the Lavele landfill) affected prices of homes before the landfill started operation, multiple regression procedures were used. Distance of homes sold in 1971 from the landfill was used to represent how the neighborhood was perceived before the landfill started operation. The independent variables which includes distance and house characteristics (lot size, house size, age, number of bedrooms, number of bath, height, basement, fireplace and garage) were regressed against sale prices of the homes. However, fireplace was absent from all the homes in the study area that were sold in 1971. Hence, fireplace is absent from Model 1 (the 1971 regression equation).

As shown in Table XI, the regression estimating price effect of distance for all homes sold in 1971 had an adjusted coefficient of determination (R^2) which is 0.8540 with an F-ratio of 36.75. The results show that all the independent variables jointly explained 85.4 percent of all the variations in sale prices of homes sold before the landfill started operation.

We have to remember that the methodology of this research implies estimating the quantitative impact of each independent variable on sale prices. However, our main purpose is to estimate the quantitative impact of distance which will help us understand how home buyers and sellers

perceived the characteristics of the Lavele neighborhood. The regression results show that mean property value rose with respect to distance from the landfill. The increase is estimated at \$200 per block away from the landfill.

TABLE XI

REGRESSION RESULTS FOR THE THREE PERIODS
Parameter Estimates and Analysis of Variance

Dependent Variable = Sale Price			
Independent Variables	1971 (Before)	1979 (During)	1986 (After)
Intercept	- 10074 (-1.270)	16453 (2.207)	16568 (2.167)
Distance	200.2874 (0.871)	675.8605 (2.323)	- 165.0572 (- 0.606)
Lot Size	0.5924 (1.654)	0.8929 (1.814)	0.2752 (0.572)
House Size	5.9060 (2.783)	14.6419 (3.709)	16.2432 (4.040)
Age	- 136.8730 (-3.317)	- 281.8343 (- 5.134)	- 150.0718 (- 3.298)
Bedroom	888.9424 (1.145)	- 2906.6269 (- 2.071)	620.9696 (0.495)
Bathroom	7131.2993 (5.226)	3454.0527 (1.541)	4395.0062 (2.262)
Height	8029.9949 (0.991)	12426 (2.010)	- 5098.5247 (- 0.752)
Basement	164.1152 (0.137)	4770.9980 (2.616)	4885.4162 (3.050)
Fireplace	*	1091.5975 (0.561)	1053.9359 (0.597)
Garage	1179.4304 (1.272)	2484.6345 (1.224)	7811.6183 (4.205)
DF - Regression	9	10	10
Sum of Squares - Regression	5472417109.5	8398080507.4	7952932898.9
Mean Square - Regression	608046345.5	839808050.74	795293289.89
F-ratio	36.754	18.212	21.042
P	0.0001	0.0001	0.0001
N	56	79	76
R-Square	0.8779	0.7281	0.7640
Adjusted R-Square	0.8540	0.6882	0.7277

* t-value in parenthesis

** No fireplace in homes sold in 1971

However, distance coefficient turned out to be negatively associated with sale prices. That is to say, there is no evidence that property value rose with distance. The distance coefficient was not significant at 0.05 percent level of two-tailed test. In this instance, the hypothesis that the property value impact of a landfill diminishes with distance from the landfill is not supported by statistical results of this study.

All the independent variables in the 1971 model had the expected signs. Among the independent variables house size, age and bathroom relate positively with sale price, whereas height and basement turned out to be negatively associated with sale prices. Bathroom was statistically significant at the 0.05 level, and house size and age were significant at the 0.10 level.

The correlation analysis show that lot size, bedroom, and height are correlated with sale price at 0.05 significant level. Basement and garage are not correlated with sale prices nor with any other variable. The correlation analysis show also that lot size, bedroom and height were highly correlated with house size and therefore added no new information to the equation.

The same independent variables including fireplace were regressed against sale prices of homes sold in 1979. The regression results show that the adjusted coefficient of determination (R^2) is 0.6882 with an F-ratio of 18.21. This result show that all the independent variables jointly

explained 68.82 percent of all the variations in sale prices of homes sold in the period the landfill was in operation.

The results of the regression further show that the mean property value rose with respect to distance from the landfill. The increase which was estimated at \$676 represents the amount at which home values rises for each block the home is located away from the landfill. Using the mean sale price data for 1979 (\$48,275) and the parameter estimate for distance the percentage increase in mean home value was estimated to be one percent per block away from the landfill.

Unlike the 1971 results, the distance coefficients was positively associated with sale price. That is to say, there is a very strong evidence that property value rose with distance away from the landfill. The distance coefficient was significant at the 0.05 percent level of two-tailed test. Among the independent variables in the 1979 model, only bedroom does not have the expected sign. Lot size, house size, age, height and basement relate positively with sale price. The correlation analysis show that house size, age, bathroom, height and garage are correlated with sale price at 0.05 significance, whereas lot size, bedroom and fireplace are correlated with sale price at 0.10 significance level of two tail test. The correlation analysis show also that bedroom, height, bathroom, and fireplace are correlated house size and therefore added no new information to the equation.

The same independent variables including fireplace were regressed against sale prices of homes sold in 1986. The regression results show that the adjusted coefficient of determination (R^2) is 0.7277 with an F-ratio of 21.04. The result show that all the independent variables jointly explained 72.77 percent of all the variations in sale prices of homes sold after the landfill closed.

The estimated coefficient for the distance variable on sale prices is very different from those of 1971 and 1979. The parameter estimate was negative. That is to say, the mean property value did not rise with respect to distance; instead the mean property value declined by \$165 per block away from the landfill. However, this result of the distance coefficient turned out to be negatively associated with sale prices. Although there is no association between distance and sale prices, one can infer that the proposed conversion of the landfill into an amenity (golf range) before the landfill closed could have strengthened the housing market for homes in the landfill neighborhood.

Among the other independent variables in the 1986 model, height does not have the expected sign. House size, age, bathroom, basement and garage relate positively with sale prices, whereas lot size, bedroom, and fireplace turned out to be negatively associated with sale prices. The positive relationship between sale price and house size, and garage is significant at the 0.05 level, whereas the positive relationship between sale

price and age, bathroom, and basement is significant at the 0.10 level.

The correlation analysis show that bedroom, bathroom and garage were correlated house size and therefore added no new information to the equation.

POOLED MODEL RESULTS

As stated earlier in this chapter, the price adjusted Models number 4, 5, 6, and 7 were employed for the general purpose of establishing whether the separate models were necessary to capture or quantify perception on property prices before, during and after operation of the landfill. The following Chow Test (Chow, 1960) formula was used for the assessment:

$$F = \frac{RRSS - URSS/(k + 1)}{URSS/(n1 + n2 + n3 - k + 3)}$$

where:

RRSS = restricted residual sum of squares derived from the regression of the pooled data of the three periods.

URSS = unrestricted residual sum of squares derived from the separate three regressions of the three periods.

n1 = number of cases for the period before the landfill opened.

n2 = number of cases for the period the landfill was in operation.

n3 = number of cases for the period the landfill closed.

k = number of parameters or regressors.

$$\text{Reading: } F = \frac{(63769407161.1 - 2551950001.5)/11}{6353313456/179}$$

$$F = 9.79 > F_c = 1.87$$

$$F > F_c$$

where: F_c is the critical F

The result, F ratio of 9.79 is greater than the critical f ratio of 1.87 at the 5 percent significance level. For this particular test, this implies that there are significant differences in the coefficients. Therefore, the hypothesis that there are no differences in the coefficient is rejected. The conclusions that can be draw from this assessment are: a) that the impact of the operation of the landfill dissipated when all models/data are combined and regressed to 1971 price level; and b) that values of all homes would have rose in the long-run (as anticipated by the owners) in the absence of the operation of the landfill. It is therefore statistically appropriate to separate the period of operation and no operation in order to capture the perceived impact of the landfill on property value.

SUMMARY

The research hypothesis were supported in the three main models employed in this study. By exploring the casual relationship between property value and landfill it was determined that Lavele landfill was perceived by home buyers and sellers as an environmental risk, and their general attitude was reflected in the sales prices of homes in the period the landfill was in operation. Proximity to the landfill when it was in operation was found to be important determinant of sale price. Statistically significant association was found between distance away from the landfill and sale prices. On the other hand, the relationships between sale prices and distance away from the landfill before it opened and after it closed were found to be statistically insignificant. Despite the findings of other studies as outlined earlier in Chapter II, the result of this study goes to support the allegations of citizens group such as CRAP and GAG, that operation of all kinds of landfill will affect property value.

CHAPTER VI

CONCLUSIONS AND RECOMMENDATION

It is important to note that landfills are classified as noxious facilities. Despite the need and importance of such facilities in our society, their existence in or near residential areas or neighborhoods has not been welcomed since citizens became aware of negative externalities associated with their operations. Improvements in the technology of landfilling have been remarkable, especially at new big regional landfills and show that most of the negative environmental impacts associated with landfills can be controlled (U.S EPA 1991). The technological improvements are not readily capitalized into the property value of homes in the vicinity of such landfills. Educating citizens and public officials, including Tax Assessors about technological improvements associated with a landfill operation is very important otherwise their perception and belief about operation of a landfill will not be accurately reflected in residential property value. The results of this study will be very helpful in guiding how we discount landfill proximity to residential property.

THE SIGNIFICANCE OF THIS STUDY

The literature suggests that the location of landfills are partly determined by existing land use regulation and environmental requirements

that aim at minimizing operational and technical risks. The level of success in minimizing technical risk is location dependent. Landfilling on porous soil increases the chances of ground water contamination whereas landfilling on soil that is rich in clay minimizes ground water pollution. However, the level of perceived risk is not necessarily tied to any geographical area or certain locations.

The literature suggests that the perceived risk associated with landfill operation are common: air pollution from garbage trucks, noise, litter, surface water and ground water pollution. The literature also suggests there are certain mitigation measures which landfill operators can use to minimize or reduce perceived risk. Increasing citizens and public officials' awareness of the existence of mitigation measures used by landfill operators will most likely minimize perceived risks associated with landfills, especially at limited purpose landfills.

The perceived risks associated with the landfill investigated in this study could equally be minimized if citizens and public officials alike are aware of the mitigation measures used by the operators. The findings of this study, therefore, may be generalized for the perception of the impact of landfill proximity to residential property.

As the literature suggests, the use of various compensation strategies by facility owners or sponsors to diffuse neighborhood opposition to landfill operation and siting tend to equate the strategies to

equity redistribution of landfill burden. This study pointed out the problem with this approach and showed why it is necessary to measure first the magnitude of landfill burden and then use the later as a tool for determining how to redistribute landfill burden equitably.

The focus of the methodology of this research which is on the Lavele landfill neighborhood and not extended to a comparable area represents an important departure from most of the previous studies. This study and that of Nelson et al. (1992) focused mainly on the study area and coincidentally the results of both show landfills do impact property value. Although the methodology and type of landfill investigated in this study and that of Nelson et al. are different, it is important for future studies of landfill impact to consider seriously not to use comparable approach or methodology.

Although the most important independent variable in this study was distance between the landfill and homes, the relationship between the other independent variables and sales prices, and among themselves are consistent with the findings of Bleich et al. (1991). For example, the results of the three models show that bedroom and bathroom and lot size are correlated with house size. These results suggests that the bigger the size of the house, the more likely it will have more bedrooms, bathroom, stories and a fireplace.

From a theoretical point of view, the findings of this research have contributed to the study of variables accounting for variations in property value. Landfills should be seen as a neighborhood attribute that could have economic as well as social implications. Theoretically sellers and buyers of residential property attempt to capitalize neighborhood attributes into property value (Li and Brown, 1980; Jud and Watts, 1981; Aaron, 1885). The housing prices that emerge from the capitalization represents the results of combined perception of the externalities that could alter the equilibrium set of prices in a neighborhood housing market. The results of this research will help to minimize the alteration in the behavior of sellers and buyers in a "landfill neighborhood housing market".

The findings of this research have implications for the theory of value-based planning that influence existing land use regulation. The theory asserts that land should be used to yield its maximum economic benefit to the owner. This theory assumes and implies that land used for landfills will not yield its maximum economic benefit to the owner. Results of this research has shown that the operational effect of a landfill as perceived by sellers and buyers of residential property are just short term and do not include long term effects such as (potential) underground contamination in the area. The findings also suggest that if landfills are properly regulated (with sound operating and post-closure requirements) and converted into other uses (such as recreation facilities) prices of homes

in the vicinity will likely increase after closure. If properly zoned or regulated land used for landfill would yield maximum economic benefit to the owner.

POLICY IMPLICATIONS

As shown in this research, local governments confronted by NIMBY or GAG or CRAP have debated whether there could indeed be any perceived risk when technical risk associated with landfills is considerably reduced. Public and private landfill operators, as well as state legislatures and host neighbors of landfills have grappled with type of compensation to propose or provide in order to offset any impact of landfills. A leading scholar of compensation theory, O'Hare (1977) and others such as Kunreuther and Kleindorfer (1986), Sullivan (1990) and Swallow et al. (1992) advocate auctioning the facility to the community demanding the least compensation.

Some public agencies and private parties who are eager to site new landfills or expand existing landfills and pay compensation are asking questions such as: how much compensation is fair for host neighbors of landfill? how much should the disposal fees be increased in order to raise enough money to support a neighborhood enhancement fund? how is such fund to be spent?

From a policy standpoint, state and local governments believe that offering so called "host fees" collected and distributed to host neighbors of landfills or to communities willing to accept a new landfill will ease the shortage of landfills or landfill capacity. A policy question that arises from the Metro or Chamber and Charles City/County compensation arrangements is whether the royalty is enough, not enough or too high. If auctioning or negotiating for a royalty is acceptable as a means of eliminating property value impact and easing shortage of landfill capacity, then state and local governments should adopt the following policies:

- 1) all risks associated with landfill engineering and operation, including spatial and aspatial distribution of the risks must be studied and made available to the public;
- 2) all possible methods of eliminating the risks, including engineering, economic and social approaches should be studied and made available to the public;
- 3) disposal fees must include the estimated costs for mitigating all known risks associated with landfill engineering and operation; and
- 4) host fees or neighborhood enhancement funds should not be larger or smaller than estimated cost of mitigating the economic and social risks.

The results of this study will guide compensation researchers in estimating the true cost of mitigating economic and social risks associated with landfill operation. The results of this research will also guide policy makers in understanding how economic and social disamenities associated

with landfill operation could be factored into host fees or surcharge on disposal fees so that an equity distribution of landfill burden can be achieved. It must be noted that if the compensation or host fee offered by an operator or demanded by home owners is too high the entire users of the landfill will likely bear the burden of high disposal fees needed to finance the compensation unless the compensation is financed by a special fee or surcharge on waste from outside the host jurisdiction of the landfill.

Other policy areas in which the results of this research will be very useful are land use regulation and the valuation of homes by Tax Assessors and appraisers. Results of this study can be used jointly with those of other studies of property impact to determine the appropriateness of various land use regulations in the vicinity of demolition or limited purpose landfills. Results of this research will be useful to Tax Assessors and real estate appraisers in estimating the impact of a limited purpose landfill on property value.

SUGGESTIONS FOR FUTURE RESEARCH

Based on the conclusions of this research, compensation theorists have not established a clear link between amount of compensation demanded and the potential impact of landfills on property value. There is need for further research to establish compensation formula/s that could be applied to host neighborhoods of landfills.

This research has also concluded that the conversion of a limited purpose landfill site into an amenity such as golf range may have been instrumental in restoring the stability in the neighborhood housing market. There is still need for further research on the type or range of amenities that could stabilize the housing market after closure of a landfill, especially for multi-purpose landfills.

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APPENDIX

- A. Regression of Model 1: 1971 data
- B. Regression of Model 2: 1979 data
- C. Regression of Model 3: 1986 data
- D. Regression of Model 4: Combined 1971, 1979 and 1986 data
- E. Regression of Model 5: 1979 data - sale price adjusted to 1971 price level
- F. Regression of Model 6: 1986 data - sale price adjusted to 1971 price level
- G. Regression of Model 7: Combined 1971, 1979, 1986 data - sale price for 1979 and 1986 adjusted to 1971 price level

FINDINGS FOR 1971 MODEL

Model: Model 1

Dependent Variable: PRICE

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	9	5472417109.5	608046345.5		
Error	46	761009988.74	16543695.407		
C Total	55	6233427098.2		36.754	0.0001

Root MSE	4067.39418	R-square	0.8779
Dep Mean	18090.17857	Adj R-sq	0.8540
C.V.	22.48399		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
INTERCEP	1	-10074	7929.5339986	-1.270	0.2103
DIST	1	200.287408	229.83232184	0.871	0.3880
LSIZE	1	0.592478	0.35824526	1.654	0.1050
H SIZE	1	5.906037	2.12188663	2.783	0.0078
AGE	1	-136.873000	41.26231510	-3.317	0.0018
BDRROOM	1	888.942385	776.10331422	1.145	0.2580
BATH	1	7131.299353	1364.6167848	5.226	0.0001
HEIGHT	1	8029.994971	8103.4470791	0.991	0.3269
BASEM	1	164.115248	1200.2973852	0.137	0.8918
GARAGE	1	1179.430474	926.93170128	1.272	0.2096

FINDINGS FOR 1979 MODEL

Model: Model 2

Dependent Variable: SPRICE

Source	Analysis of Variance				Prob>F
	DF	Sum of Squares	Mean Square	F Value	
Model	10	8398080507.4	839808050.74	18.212	0.0001
Error	68	3135603859.7	46111821.466		
C Total	78	11533684367			

Root MSE	6790.56857	R-square	0.7281
Dep Mean	48275.31646	Adj R-sq	0.6802
C.V.	14.06634		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
INTERCEP	1	16453	7454.1310868	2.207	0.0307
DIST	1	675.860525	291.00115746	2.323	0.0232
LSIZE	1	0.892990	0.49220981	1.814	0.0741
H SIZE	1	14.641902	3.94722507	3.709	0.0004
AGE	1	-281.834370	54.89916039	-5.134	0.0001
BDR00M	1	-2906.826993	1403.3157561	-2.071	0.0421
BATH	1	3454.052702	2242.1491031	1.541	0.1281
HEIGHT	1	12426	6180.6848500	2.010	0.0484
BASEK	1	4770.998083	1823.8216509	2.616	0.0110
FRPL	1	1091.597499	1946.6450514	0.561	0.5768
GARAGE	1	2484.634552	2030.1199571	1.224	0.2252

FINDINGS FOR 1986 MODEL

Model: Model 3

Dependent Variable: PRICE

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	10	7952932098.9	795293209.89		
Error	65	2456699606.8	37795378.566	21.042	0.0001
C Total	75	10409632506			
Root MSE		6147.79461	R-square	0.7640	
Dep Mean		42632.36842	Adj R-sq	0.7277	
C.V.		14.42049			

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for HO: Parameter=0	Prob > T
INTERCEP	1	16568	7646.2329130	2.167	0.0339
DIST	1	-165.057208	272.45505776	-0.606	0.5467
LSIZE	1	0.275292	0.48101530	0.572	0.5691
HSIZE	1	16.243274	4.02034229	4.040	0.0001
AGE	1	-150.071844	45.50979057	-3.298	0.0016
BDRROOM	1	620.969621	1253.6037747	0.495	0.6220
BATH	1	4395.006231	1942.7699400	2.262	0.0270
HEIGHT	1	-5098.524762	6782.4056020	-0.752	0.4549
BASEH	1	4685.416255	1601.5653416	3.050	0.0033
FRPL	1	1053.935900	1763.9407545	0.597	0.5523
GARAGE	1	7811.618307	1857.8789004	4.205	0.0001

FINDINGS OF COMBINED 1971, 1979 and 1986 MODEL

Model: Model 4

Dependent Variable: SPRICE

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	10	28922088505	2892208850.5	10.415	0.0001
Error	200	31412856331	157064281.65		
C total	210	60335744916			

Root MSE 12532.52894 R-square 0.4794
Dep Mean 38231.56398 Adj R-sq 0.4533
C.V. 32.78058

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
INTERCEP	1	-7034.540670	8729.2301383	-0.806	0.4213
DIST	1	196.505524	319.05271717	0.616	0.5387
LSIZE	1	1.170298	0.55229946	2.119	0.0353
HSIZE	1	2.546706	3.65930976	0.696	0.4873
AGE	1	-105.777348	55.97813255	-1.890	0.0603
BOROOH	1	-1332.623828	1363.9874870	-0.977	0.3297
BATH	1	5582.061853	2267.6314469	2.462	0.0147
HEIGHT	1	19721	7831.7305695	2.518	0.0126
EASEM	1	2380.759417	1893.1139969	1.258	0.2100
FRPL	1	13419	1992.4612907	6.735	0.0001
GARAGE	1	7234.781529	1737.7060132	4.163	0.0001

FINDINGS FOR 1979 MODEL
(Sale Price Adjusted to 1971 Price Level)

Model: Model 5

Dependent Variable: PRICE

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	10	3200059795.2	320005979.52	18.213	0.0001
Error	68	1194777057.5	17570250.846		
C Total	78	4394836852.7			
Root MSE		4191.68830	R-square	0.7281	
Dep Mean		29799.12658	Adj R-sq	0.6882	
C.V.		14.06648			

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
INTERCEP	1	10156	4601.2927770	2.207	0.0307
DIST	1	417.217174	179.62945759	2.323	0.0232
LSIZE	1	0.551227	0.30383172	1.814	0.0741
HSIZE	1	9.038287	2.43654666	3.709	0.0004
AGE	1	-173.973876	33.88820336	-5.134	0.0001
RDRQOM	1	-1794.232057	866.24001878	-2.071	0.0421
BATH	1	2132.345391	1384.0358256	1.541	0.1280
HEIGHT	1	7670.085012	3815.2187326	2.010	0.0484
BASEM	1	2945.129112	1125.8102777	2.616	0.0110
FRPL	1	673.758616	1201.6268174	0.561	0.5768
GARAGE	1	1533.616701	1253.1542827	1.224	0.2252

FINDINGS FOR 1986 MODEL
Sale Price Adjusted to 1971 Price Level

Model: Model 6

Dependent Variable: PRICE

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	10	1929946610.4	192994661.04		
Error	65	596162955.24	9171737.7729		
C Total	75	2526109565.7		21.042	0.0001

Root MSE	3028.48770	R-square	0.7640
Dep Mean	21000.63158	Adj R-sq	0.7277
C.V.	14.42094		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
INTERCEP	1	8160.750309	3766.6389051	2.167	0.0339
DIST	1	-81.327281	134.21508763	-0.606	0.5467
LSIZE	1	0.135597	0.23695472	0.572	0.5691
HSIZE	1	8.002064	1.98047560	4.040	0.0001
AGE	1	-73.925153	22.41874524	-3.297	0.0016
BDRROOM	1	305.797407	617.54236407	0.495	0.6221
BATH	1	2165.070070	957.03307188	2.262	0.0270
HEIGHT	1	-2511.345457	3341.1057577	-0.752	0.4550
BASEH	1	2406.659956	788.95299078	3.050	0.0033
FRPL	1	519.200187	868.94133987	0.598	0.5522
GARAGE	1	3848.081198	915.21655524	4.205	0.0001

FINDINGS FOR 1971, 1979 and 1986 MODEL
Sale Price for 1979 and 1986 Adjusted to 1971 Price Level

Model: Model 7

Dependent Variable: SPRICE

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	10	12025632905	1202563290.5	37.716	0.0001
Error	200	6376940716.6	31884703.583		
C Total	210	18402573621			
Root MSE	5646.65419	R-square	0.6535		
Dep Mean	23522.41232	Adj R-sq	0.6361		
C.V.	24.00542				

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
INTERCEP	1	-2861.370242	3933.0405060	-0.728	0.4678
DIST	1	4.241118	143.75234016	0.030	0.9765
LSIZE	1	0.695430	0.24884395	2.795	0.0057
HSIZE	1	5.708510	1.64873801	3.462	0.0007
AGE	1	-123.860292	25.22149826	-4.911	0.0001
BOROOM	1	-352.172205	614.55797948	-0.573	0.5673
BATH	1	3879.150795	1021.7036545	3.797	0.0002
HEIGHT	1	10537	3528.6632468	2.986	0.0032
EASEM	1	1989.670533	852.96113340	2.333	0.0207
FRPL	1	5928.274370	897.72303385	6.604	0.0001
GARAGE	1	2165.733033	782.94053763	2.766	0.0062