

THE EFFECTS ON RESIDENTIAL REAL ESTATE PRICES FROM PROXIMITY TO PROPERTIES CONTAMINATED WITH RADIOACTIVE MATERIALS

A case study of three Superfund sites in New Jersey and how they were affected by single-family residential property sales prices.

by William N. Kinnard, Jr., CRE,
and Mary Beth Geckler

On December 1, 1983, the U.S. Environmental Protection Agency (USEPA) and the New Jersey Department of Environmental Protection (NJDEP) jointly announced that concentrations of radon gas and levels of onsite gamma radiation were well above regulatory standards in three residential neighborhoods in three adjacent towns in northern New Jersey. The elevated levels of radon and gamma radiation resulted from the presence of radium-contaminated fill material on many lots in the neighborhoods.

The three neighborhoods were placed on the National Priorities List and included in the Superfund program in October, 1984. These three Superfund Site Areas (SSAs) are referred to in this article as Towns A, B and C.

Extensive remediation programs were initiated promptly in Towns A and C; these programs were completed during 1985. In Town B, on the other hand, a program to excavate contaminated fill material (and later to replace the material with clean fill) was only partially completed before it was abandoned in September, 1985. Because a disposal site was not available, NJDEP was forced to place the excavated fill material in sealed drums, which were stored openly on the lawns of vacated houses.

The initial announcement of the elevated radon and gamma radiation on the sites received widespread publicity in both print and electronic media. There also was continuous, daily publicity about the open storage of the contaminated fill material. Danger! Radiation signs and radiation warning symbols were displayed on a fence surrounding the sites on which the drums were stored. The drums of contaminated materials were removed in September, 1987, which also generated considerable publicity, and they eventually were shipped out of state. Not until June, 1990, was a USEPA remediation program approved.

Property owners seeking to sell or lease properties within the three SSAs were required by state law to reveal the most recent radon readings (if any) to any potential buyer or tenant.

The Research Assignment

In October, 1989, the Real Estate Counseling Group of Connecticut, Inc., (RECGC) was retained to conduct a market research study of all single-family residential property sales within the three SSAs. In

William N. Kinnard, Jr., CRE, is president of the Real Estate Counseling Group of Connecticut, Inc., (RECGC). He is professor emeritus in real estate and finance at the University of Connecticut and a principal in the Real Estate Counseling Group of America. He also testifies regularly as an expert witness on methodology for real property and personal property valuation.

Mary Beth Geckler is vice president of RECGC and a licensed general appraiser in Connecticut. She was a commercial real estate lending officer at regional banks in Connecticut for nine years after spending nearly a decade in market research and project advising for clients of public agencies and educational institutions.

addition, RECGC was asked to study all residential property sales within a larger study area that extended one mile beyond the outer limits of each SSA.

The study period extended from July 1, 1980, through June 30, 1989, and it included 67 months of post-announcement sales experience. The analysis identified, reported and measured the actual market sales behavior of buyers and sellers. Both the impact on sales prices and the changes in the volume of sales transactions were analyzed.

Questions To Be Addressed

Statistical tests were conducted on the assembled residential property sales transaction data to answer the following questions:

- What was the pattern of inflation-adjusted sales prices per square foot of single-family residences in each town, within each SSA and within selected distance zones up to one mile from the SSA? What was the pattern in the 41 months preceding the public announcement of the existence of radioactive contamination within the SSAs? What was the pattern in the 67 months that followed the announcement?
- What changes in levels of inflation-adjusted sales prices per square foot of living area were identifiable and measurable after the announcement? How did these prices compare with levels of inflation-adjusted unit sales prices before the announcement?
- What patterns of sales volumes of single-family residential properties were observed during the 41 months before the announcement and over the 67 months afterward? What changes in those patterns occurred before and after the announcement?
- How far distant from the outer boundary of an SSA did a residential sales property have to be before there was no measurable negative impact on the inflation-adjusted sales price per square foot of living area or on the volume of sales associated with proximity to the SSA?

Research Project Design

Analytical Models

Three categories of analytical, statistical models were utilized. They provided comparisons of inflation-adjusted price levels and of rates of change in those price levels for single-family properties at varying distances from the three SSAs before and after January 1, 1984. They also provided comparisons of sales volumes within the study areas.

- *Comparison Of Averages.* Arithmetic means of inflation-adjusted prices were calculated and compared by year for each distance zone.
- *Trends.* Percentage changes in levels of inflation-adjusted prices and in volume of sales were calculated and compared.
- *Multiple Regression.* Sales data were assembled into four data sets: one for each of the three towns and one for the combined total. Dependent and independent variables were entered

into regression models in the standard Hedonic Pricing Model format to test the influence and statistical significance of time, location (distance from an SSA) and property characteristics on the inflation-adjusted sales price per square foot of living area. Multiple Linear Regression Analysis (MRA) often is used to identify, measure and evaluate the influence, relative importance and statistical significance of all property, transaction and location characteristics that influence sales prices. In this study, it was used to isolate, measure and test the significance of both distance from an SSA by zone and the likely effects of post-announcement awareness of radon gas and gamma radiation concentrations within the SSAs.

Data Requirements

Certain categories of information were required to apply the analytical models.

- *Sales Price Data.* Every transaction had to have a recorded sales price to be used in the study. Sales prices were deflated to December, 1983, dollars through the use of the All Urban Households Consumer Price Index. The result of this deflation was the adjusted sales price (ADJSP). Because *size* (square feet of living area) is one of the most important determinants of sales price, the ADJSP was refined to incorporate square

FIGURE 1

List of Variables for Multiple Regression Analysis

Dependent Variables	
Inflation-adjusted sales price per square foot	(ADJSPSF)
Independent Variables	
Deed date (year, month)	(DDATE)
After January 1984 (Yes-No)	(BEFAFT)
Square feet of living area	(SFLIVARE)
Square feet of lot area	(LOTSIZE)
Age in years at time of sale	(AGE)
Number of stories of residence	(#Stories)
Shingle/wood siding (Yes-No)	(SHINGLES)
Brick exterior finish (Yes-No)	(BRICK)
Stucco exterior finish (Yes-No)	(STUCCO)
Stone exterior finish (Yes-No)	(STONE)
Number of garage/carport stalls	(GARSTALS)
Attached garage (Yes-No)	(ATTACHED)
Detached garage (Yes-No)	(DETACHED)
Carport (Yes-No)	(CARPORT)
Basement garage (Yes-No)	(BASE GAR)
Within Zone A (Yes-No)	(A ZONE)
Within Zone B (Yes-No)	(B ZONE)
Within Zone C (Yes-No)	(C ZONE)
Within Zone D (Yes-No)	(D ZONE)
Within Zone E (Yes-No)	(E ZONE)
Within Zone F (Yes-No)	(F ZONE)
Within Superfund site (Yes-No)	(S ZONE)

footage. The adjusted sales price per square foot (ADJSPSF) was the dependent variable used in this study.

- *Time.* The date of sale was recorded for every sales transaction by year and month. Two measures of time and its possible influence on ADJSP or ADJSPSF were employed. The first was the date of the deed (DDATE), which indicated the year and month of the execution. The second measure of time (BEFAFT) indicated whether the deed was recorded *before* or *after* January 1, 1984. For the purposes of this study, any deed recorded during December, 1983, was excluded because it did not represent a sale that was affected by the announcement.
- *Property Characteristics.* All properties in the study were single-family residences. Two of the most important influences on the sales prices of residential properties are size (square feet of living area) and age (in years) at the time of sale. Data on size and age therefore were gathered on all sales transactions. Any sales transaction for which either the size or the age of the residence could not be obtained from an official source was excluded from further analysis.

Because it was not possible to identify retroactively the condition of the property at the time of sale, age at the time of sale served as a proxy for the condition of the property. In addition, data on lot size, type of garage, number of parking stalls, number of stories of residence and exterior finish were obtained. Data were not available on the number of rooms, number of bedrooms or number of bathrooms.

- *Location: Distance From The Superfund Site Area.* The focus of the research project was to ascertain any impact from or effect of proximity to the SSAs on sales prices (adjusted for inflation and size). Therefore, particular attention was paid to the location and distance from an SSA for each sales transaction property. The measure of distance was obtained by identifying the distance zone in which each sales property was located.

Data Collection And Data Recording

Data Sources. Listings of all property sales coded as residential were obtained for each fiscal year (July 1–June 30) from 1980-81 through 1988-89. These data came from SR1A forms on which local assessors report all bona fide, arm's-length real estate sales transactions for the year.

Additional information came from Real Estate Data Incorporated (REDI). This subscription service summarizes sales transaction data within communities in northern New Jersey quarterly and monthly. REDI listings provided the street addresses of most sales properties, which were correlated with the block and lot number provided in the SR1A summaries.

The major source of information was assessor's property cards for each of the three townships. The property cards frequently provided corroboration of

data obtained from other sources as well. If critical information was missing from the assessor's property cards and could not be obtained from other sources, the property was not included in the data base.

Finally, visual inspections of the exterior of all sales properties were conducted to check and verify (or correct, as necessary) the information obtained from REDI and the assessor's property cards.

Mapping And Distance Zone Identification. The distance of each sales transaction property from the pertinent Superfund site in its town had to be identified. Since the Town B Superfund site extends into Town C, some properties that are relatively distant from the Town C Superfund site are actually relatively close to the Town B Superfund site.

To identify distance from or proximity to each SSA, distance zones were established. (The zone definitions are summarized in Table 1) Every sales transaction property was mapped, and its zone location was recorded.

Data Screening And Usable Data Sets.

A total of 2,317 sales were identified from the SR1A forms as likely candidates for analysis. It was necessary, however, to eliminate those sales transactions and properties that did not meet the eligibility standards of the research study.

First, a complete data file was necessary for the sales transaction to be included in the study. Any file without data on square feet of living area, date of construction of the dwelling (to provide age at the time of sale) or the number of families (only single-family residential property sales were usable) had to be eliminated. Table 2 shows that 88 sales transactions were eliminated because of unavailable record data.

Ninety-eight sales were eliminated because more precise measurement on large-scale maps revealed that they were located more than one mile from an SSA. One sale that occurred prior to July 1, 1980, also was eliminated.

TABLE 1

Identification of Distance Zones

Zone	Distance from SSA*
S	Inside SSA
A	1–250 feet
B	251–500 feet
C	501–1000 feet
D	1001–1500 feet
E	1501–2500 feet
F	2501–3500 feet
G (Control area)	3501–5280 feet

*Distance from the SSA is the linear distance of the nearest portion of the sales transaction property to the outer boundary of the closest SSA.

TABLE 2

Summary of Sales Data Screening Process (by Town, by Reason)

	Town A	Town B	Town C	Total
Total unscreened sales	541	831	945	2317
Less: Outside limits of property characteristic parameters				
Located beyond 1 mile	15	13	70	98
Bought before 7/1/80	0	1	0	1
More than 5,500 square feet	4	28	5	37
Not a single-family dwelling	7	316	347	668
Subtotal: Outside limits	26	358	422	804
Balance	515	473	523	1513
Less: Record data missing				
Square foot of living area	21	23	27	71
Year built	7	0	8	15
Number of families	0	1	1	2
Subtotal: Data missing	28	24	36	88
Screened, usable sales	487	449	487	1425

The SR1A reports include both one-family and two-family properties in the "2" property coding for sales transactions. As Table 2 shows, 668 two-family (or other non-one-family) sales had to be removed.

Finally, no property was included in the final data set if one of three major characteristics was outside the 99% confidence interval around the mean for that characteristic: square feet of living area, age at the time of sale, and lot size. This eliminated another 37 sales as non-representative outliers.

Table 2 shows that the final total usable data set for all three towns contained 1,425 sales. The sales were almost evenly divided among the three towns, with 487 usable sales in both Towns A and C and 449 sales in Town B.

Variables For Multiple Regression Analysis.

MRA requires the identification of both a dependent variable and the independent variables that will be used in the analysis. The dependent variable used in this study was inflation-adjusted sales price per square foot of living area (ADJSPSF). In each MRA run, only one time variable was used: either the date of deed (DDATE) or before-after January 1, 1984 (BEFAFT). Figure 1 identifies, explains and lists the dependent variable and independent variables that were used in the MRA models.

Research Findings

Average Property Characteristics

Average of property and transaction characteristic values provided a basis for comparison as well as indications of what is typical or representative of the market.

Inflation-Adjusted Sales Price (ADJSP). The average ADJSP in each zone for each year was compared within the three-town usable sales data set and the data set for each town. A notably consistent

pattern of findings emerged. First, during the years 1980-83 (before the announcement), the average ADJSP in Zones S (the SSAs), A and B was typically lower than the average ADJSP in more distant zones. Some exceptions were found in Zone B. Although there was no absolute decrease in average ADJSP, rates of increase in Zones S, A and B were lower than those in the other zones after 1984. ADJSP in general was lower in 1989, regardless of zone.

Size Of Dwelling (Square Feet Of Living Area).

In the three-town total, the houses in Zones S, A and B were typically smaller than those in other zones both before and after January 1, 1984. In Town A, the smallest houses were in Zones S, A and B. In Town B, the houses in Zones S and A also averaged the smallest. In Town C as well, the houses in Zones S, A and B were well below average in size. Part of the explanation for lower average ADJSP in Zones S, A and B is the smaller (below-average) size of houses in those zones in each of the three towns. This was true both before and after the December, 1983, announcement.

Age Of Dwelling At The Time Of Sale. The study areas in the three towns tended to be concentrated in older neighborhoods. The average age of dwellings at the time of sale for the 1,423 total usable sales was 64 years. The lowest average age of dwelling at time of sale was in Zones S and A.

The same general pattern of average age distributions appeared in each of the three towns. Generally, the houses in Zones S, A and B averaged 60 years old or less. Average ages tended to increase for houses that were more distant from a Superfund site. The one exception was in Town C, where the lowest average ages at the time of sale were in Zones F and G. However, age of dwelling at the time of

sale did not help explain the generally lower average ADJSP in Zones S, A and B.

Lot Size (Square Feet Of Land Area). The average lot size for the three-town data set was 10,700 square feet. Throughout each of the three towns and in the three-town total, lot sizes in Zones S, A and B were consistently smaller on average; the smallest average sizes usually were in Zone S.

Therefore, in Zones S, A and B (especially Zone S), average house sizes were smallest, and these smaller houses were located on smaller lots. The combination of smaller houses on smaller lots helped to explain in part the lower average ADJSP found in Zones S, A and B both before and after the December, 1983, announcement.

These observable and measurable size and age differences suggested strongly that simple comparisons of averages by zone over time probably would fail to capture enough of the influence of proximity to an SSA on ADJSP. That is why comparisons of averages and of trends were supplemented with multiple regression analysis.

Sales Volume (Number Of Sales). One indicator of changing market conditions is a change in the number of sales that occurs in a given area or zone over a specified time period. This reflects changing buyer attitudes toward owning and living in that location. One important way for potential buyers to react negatively to a given market situation is to withdraw from the market and refrain from purchasing.

The sales data in the study showed an overall decline in residential real estate market activity in all three towns (and in the county) after 1985. This is the context within which sales volumes in the three study areas were examined and analyzed.

There was an across-the-board decrease in residential property sales volume after 1985, but there was no perceptible or measurable decrease in sales volume in 1984 and 1985, the two years immediately following the December, 1983, announcement. This suggested that there was no negative reaction to residential property purchase in the three-town total. Moreover, sales volume actually increased in Zones A and B in 1984 and 1985. There was a very modest decline in sales in Zone S in 1984, but sales recovered again in 1985. In 1989, sales volumes in Zones S, A and B declined more than in the more distant zones.

Buyer reactions to proximity to the three SSAs apparently varied considerably from one town (and SSA) to another. Proximity to the Town B SSA appeared to be more of a deterrent to would-be buyers than was proximity to the SSA in either Town A or Town C.

Inflation-Adjusted Sales Prices Per Square Foot Of Living Area. Table 3 shows average inflation-adjusted sales price per square foot of living area (ADJSPSF) by zone and by year for each town studied and for the three-town total data set.

For the three-town total, levels and trends of average ADJSPSF in Zones A through D were roughly similar. Averages were higher in Zone E, especially in 1988 and 1989. The average for Zone S followed essentially the same pattern as that for every zone except E.

In the individual towns, there was considerably more variation in average ADJSPSF by zone from year to year. There also were gaps for those zones in which no sales occurred during the given years.

The total pattern of levels and variations in average ADJSPSF by zone suggested that some measurable negative impact probably occurred in Zones S, A and B in Town B and possibly in Town C; no such negative impact occurred in Town A.

Before-After Changes

Comparisons of average ADJSPSF and of sales volume by zone and by town before and after January 1, 1984, helped to clarify whether any discernible negative impact on average ADJSPSF or sales volume was evident after the announcement. (The results of these comparisons are presented in Tables 4, 5 and 6.)

Average ADJSPSF By Zone, Before And After January 1, 1984. Table 4 shows the percentage changes in average ADJSPSF by zone.

For the three-town total set of usable sales, Zone A exhibited the lowest percentage increase, suggesting some possible negative impact. The percentage increase in average ADJSPSF for Zone S was approximately equal to the average for all study areas.

Virtually the same pattern in average ADJSPSF by zone was exhibited in Towns A and B. In Town C, on the other hand, the percentage increase after January 1, 1984, was lowest in Zone S. This finding indicated a possible further negative impact.

Number Of Sales By Zone, Before And After January 1, 1984. A different pattern was shown for changes in sales volume (Table 5). For the three-town total, the smallest percentage increase was found in Zone S. The largest percentage increase in sale volume occurred in Zone A, and the third highest percentage increase occurred in Zone B.

A spotty pattern of percentage increase in sales volume by zone appeared when before and after sales volumes were compared from town to town. This pattern suggested that any negative market response was confined to the SSAs themselves.

Percentage Distribution Of Number Of Sales, By Zone And By Year. Table 6 expresses the number of sales in each zone as a percentage of total sales for that year.

For the three-town total, no consistent pattern of relative change emerged among the zones closest to the SSAs. That inconsistency became even more evident when data for the individual towns were considered. There was substantial variation over time by zone from town to town. Moreover, the evidence suggested a short-term (1984-1985) avoidance of

TABLE 3

Average Inflation-Adjusted Sales Price per Square Foot (by Year, by Zone)

Three-Town Total Zone									
Year	S	A	B	C	D	E	F	G	All
1980	\$ 48.66	\$ 55.30	\$ 37.15	\$ 54.04	\$ 45.83	\$ 41.49	\$ 48.15	\$ 39.37	\$ 45.90
1981	52.78	57.58	48.59	49.68	45.47	45.19	40.36	39.99	46.38
1982	49.40	45.88	49.80	43.37	36.65	48.91	44.74	53.64	47.64
1983	50.27	54.56	47.81	53.39	43.74	57.31	47.18	42.46	48.94
1984	56.53	57.87	61.85	61.20	51.86	55.32	62.12	54.22	56.89
1985	71.25	66.75	72.02	66.75	68.60	64.86	68.97	63.40	67.31
1986	90.25	92.25	87.55	97.49	85.81	89.99	81.60	78.98	87.59
1987	102.50	103.87	103.29	94.97	97.93	101.43	94.06	104.57	100.37
1988	112.75	100.81	106.19	106.90	112.54	116.73	98.92	101.41	107.71
1989	97.50	92.42	90.49	103.25	100.32	129.34	101.77	98.12	104.39
All	74.34	76.43	74.38	76.29	74.77	72.92	68.00	66.99	72.24

Town A Zone									
Year	S	A	B	C	D	E	F	G	All
1980	\$ 52.31	\$ 63.79	\$ 48.01	\$ 65.80	\$ 51.75	\$ 39.68	\$ 43.57	\$ 46.78	\$ 51.42
1981	55.89	61.49	49.19		45.02	55.64	42.73	45.60	52.79
1982	53.97	57.35	64.17	38.25	45.08	53.38	47.87		53.42
1983	54.68	59.35	65.97	63.87	55.78	79.66	49.46	50.53	56.74
1984	61.89	76.74	62.89	132.60	55.29	63.78	61.00	52.44	62.88
1985	81.47	80.23	90.10	66.26	82.89	80.05	79.86	65.59	78.62
1986	103.65	109.48	123.57	102.00	104.47	97.28	102.05	83.83	101.37
1987	104.71	122.80	158.01	108.46	113.99	109.06	101.02	103.02	108.30
1988	116.49	110.61	115.97	114.13	117.50	126.36	99.69	95.72	112.06
1989	108.79		107.37	87.36		108.08	92.81	119.30	106.02
All	81.09	87.48	89.21	86.55	82.18	82.15	72.78	70.39	80.14

Town B Zone									
Year	S	A	B	C	D	E	F	G	All
1980	\$ 22.99	\$ 62.83		\$ 45.86	\$ 30.64	\$ 41.61	\$ 40.31	\$ 37.49	\$ 41.13
1981	35.36			23.58	47.81	39.70	43.70	30.21	38.87
1982	40.36	37.16	\$ 40.23	43.38	43.56	50.75	44.67	54.60	47.85
1983	37.05	39.21	50.46	48.14	38.00	46.16	45.51	39.85	42.17
1984	45.08	47.20	48.87	44.78	48.87	51.79	62.71	46.38	51.35
1985	55.09	46.57	62.07	75.97	47.61	54.79	61.18	65.44	59.64
1986	61.77	79.56	78.73	96.04	80.42	91.14	69.84	65.82	78.54
1987	87.42	82.32	126.54	83.41	70.49	97.67	82.79	89.91	88.17
1988	84.85	91.84			86.54	81.61	96.97	99.12	92.66
1989			59.06	124.95	58.19	136.38	108.23	100.74	106.46
All	52.68	62.77	63.63	68.84	58.66	64.89	64.23	59.71	62.18

Town C Zone									
Year	S	A	B	C	D	E	F	G	All
1980	\$ 46.28	\$ 35.05	\$ 35.34	\$ 50.46	\$ 47.69	\$ 45.99	\$ 60.56	\$ 32.09	\$ 44.74
1981	58.67	38.02	48.41	54.03	40.27	41.38	31.31	44.17	44.99
1982	48.59	47.86		44.64	33.58	40.57	44.20	50.76	44.22
1983	45.86	56.51	43.65	46.85	36.89	40.41	20.13	24.65	42.06
1984	51.48	46.37	67.64	50.21	50.32	47.78	63.29	62.61	55.29
1985	64.33	57.46	70.41	60.51	66.62	64.07	66.68	56.92	63.58
1986	76.12	83.17	82.22	95.00	84.07	79.81	74.94	88.92	83.39
1987	104.80	95.28	92.15	90.57	94.16	98.27	105.43	116.23	100.25
1988	98.67	93.85	100.60	104.19	115.19	122.50	104.80	108.89	109.36
1989	86.21	92.42	92.92	99.32	142.44	136.49	78.44	75.73	101.88
All	69.63	70.09	72.34	75.24	79.34	73.55	67.98	76.15	73.63

TABLE 4

Inflation-Adjusted Sales Prices per Square Foot (by Zone) Before 1/84 and After 12/83

Three-Town Total (1,423 Sales)									
	Zone								
Time	S	A	B	C	D	E	F	G	All
Before	\$ 50.41	\$ 53.53	\$ 45.75	\$ 50.21	\$ 43.25	\$ 48.87	\$ 45.48	\$ 44.10	\$ 47.45
After	86.91	82.91	84.79	89.49	85.57	83.32	79.35	77.66	83.09
Percent Change	+72	+55	+85	+78	+98	+70	+74	+76	+75
Town A (487 Sales)									
	Zone								
Time	S	A	B	C	D	E	F	G	All
Before	\$ 54.45	\$ 60.82	\$ 56.78	\$ 61.67	\$ 50.55	\$ 60.94	\$ 47.64	\$ 48.18	\$ 54.36
After	96.18	97.23	101.37	97.21	93.13	89.97	86.16	79.76	91.73
Percent Change	+77	+60	+79	+58	+84	+48	+81	+66	+69
Town B (449 Sales)									
	Zone								
Time	S	A	B	C	D	E	F	G	All
Before	\$ 36.28	\$ 46.40	\$ 42.79	\$ 44.14	\$ 41.64	\$ 46.04	\$ 44.09	\$ 42.74	\$ 43.41
After	64.26	68.54	69.58	89.43	68.28	76.21	74.13	71.33	73.19
Percent Change	+77	+48	+63	+103	+64	+66	+68	+67	+69
Town C (487 Sales)									
	Zone								
Time	S	A	B	C	D	E	F	G	All
Before	\$ 48.95	\$ 44.03	\$ 42.73	\$ 49.50	\$ 40.05	\$ 41.31	\$ 44.42	\$ 43.40	\$ 44.24
After	77.05	74.53	83.68	85.65	89.16	84.12	79.28	83.79	82.82
Percent Change	+57	+69	+96	+73	+123	+104	+78	+93	+87

TABLE 5

Number of Usable Sales (by Zone) Before 1/84 and After 12/83

Three-Town Total									
	Zone								
Time	S	A	B	C	D	E	F	G	All
Before	73	28	28	41	36	77	67	83	433
After	139	99	77	81	105	178	133	178	990
Percent Change	+36	+253	+175	+98	+192	+131	+99	+115	+129
Town A									
	Zone								
Time	S	A	B	C	D	E	F	G	All
Before	47	15	6	9	9	21	25	19	151
After	83	41	16	21	26	57	47	45	336
Percent Change	+77	+173	+167	+133	+189	+171	+88	+137	+123
Town B									
	Zone								
Time	S	A	B	C	D	E	F	G	All
Before	12	6	4	15	13	36	30	50	166
After	17	17	14	18	23	60	61	73	283
Percent Change	+42	+183	+250	+20	+77	+67	+103	+46	+70
Town C									
	Zone								
Time	S	A	B	C	D	E	F	G	All
Before	14	7	18	17	14	20	12	14	116
After	39	41	47	42	56	61	25	60	371
Percent Change	+179	+486	+161	+147	+300	+205	+108	+328	+220

TABLE 6

Number of Sales as a Percentage of Each Year's Total (by Zone)

Three-Town Total Zone									
Year	S	A	B	C	D	E	F	G	All
1980	16.25%	8.75%	8.75%	11.25%	8.75%	13.75%	15.00%	17.50%	100.00%
1981	17.31	5.77	8.65	6.73	9.62	23.08	11.54	17.31	100.00
1982	15.24	5.71	4.76	10.48	6.67	20.95	17.14	19.05	100.00
1983	18.06	6.25	4.86	9.72	8.33	13.89	17.36	21.53	100.00
1984	12.43	8.65	7.03	3.78	5.95	23.24	14.59	24.32	100.00
1985	12.39	11.50	7.08	7.52	11.50	19.03	14.60	16.37	100.00
1986	14.03	12.22	9.05	10.41	11.76	14.03	13.57	14.93	100.00
1987	19.14	8.02	5.56	8.02	11.73	16.05	15.43	16.05	100.00
1988	13.43	11.94	8.21	8.21	14.18	17.16	8.21	18.66	100.00
1989	12.90	1.61	12.90	16.13	6.45	19.35	11.29	19.35	100.00
All	14.90	8.92	7.38	8.57	9.91	17.92	14.05	18.34	100.00

Town A Zone									
Year	S	A	B	C	D	E	F	G	All
1980	32.14%	10.71%	3.57%	10.71%	3.57%	10.71%	14.29%	14.29%	100.00%
1981	33.33	12.82	5.13	0.00	7.69	17.95	7.69	15.38	100.00
1982	41.18	5.88	11.76	5.88	5.88	23.53	5.88	0.00	100.00
1983	26.87	8.96	1.49	7.46	5.97	10.45	25.37	13.43	100.00
1984	19.70	9.09	6.06	1.52	6.06	25.76	16.67	15.15	100.00
1985	18.42	17.11	3.95	6.58	11.84	15.79	15.79	10.53	100.00
1986	25.35	14.08	4.23	9.86	5.63	12.68	14.08	14.08	100.00
1987	32.76	8.62	1.72	6.90	10.34	13.79	13.79	12.07	100.00
1988	27.78	12.96	7.41	5.56	5.56	14.81	9.26	16.67	100.00
1989	36.36	0.00	9.09	9.09	0.00	27.27	9.09	9.09	100.00
All	26.69	11.50	4.52	6.16	7.19	16.02	14.78	13.14	100.00

Town B Zone									
Year	S	A	B	C	D	E	F	G	All
1980	3.85%	7.69%	0.00%	11.54%	3.85%	26.92%	15.38%	30.77%	100.00%
1981	11.54	0.00	0.00	3.85	19.23	19.23	23.08	23.08	100.00
1982	5.36	3.57	5.36	10.71	1.79	23.21	23.21	26.79	100.00
1983	8.62	3.45	1.72	8.62	10.34	18.97	12.07	36.21	100.00
1984	5.77	3.85	5.77	1.92	3.85	25.00	21.15	32.69	100.00
1985	6.58	6.58	5.26	6.58	6.58	22.37	19.74	26.32	100.00
1986	5.56	6.94	6.94	11.11	13.89	19.44	19.44	16.67	100.00
1987	10.81	5.41	2.70	5.41	5.41	18.92	29.73	21.62	100.00
1988	4.55	13.64	0.00	0.00	9.09	18.18	22.73	31.82	100.00
1989	0.00	0.00	4.17	8.33	8.33	20.83	20.83	37.50	100.00
All	6.46	5.12	4.01	7.35	8.02	21.38	20.27	27.39	100.00

Town C Zone									
Year	S	A	B	C	D	E	F	G	All
1980	11.54%	7.69%	23.08%	11.54%	19.23%	3.85%	15.38%	7.69%	100.00%
1981	5.13	2.56	17.95	15.38	5.13	30.77	7.69	15.38	100.00
1982	18.75	9.38	0.00	12.50	15.63	15.63	12.50	15.63	100.00
1983	15.79	5.26	26.32	21.05	10.53	10.53	5.26	5.26	100.00
1984	10.45	11.94	8.96	7.46	7.46	19.40	7.46	26.87	100.00
1985	12.16	10.81	12.16	9.46	16.22	18.92	8.11	12.16	100.00
1986	11.54	15.38	15.38	10.26	15.38	10.26	7.69	14.10	100.00
1987	11.94	8.96	10.45	10.45	16.42	16.42	8.96	16.42	100.00
1988	3.45	10.34	12.07	13.79	24.14	18.97	1.72	15.52	100.00
1989	14.81	3.70	22.22	25.93	7.41	14.81	3.70	7.41	100.00
All	10.88	9.86	13.35	12.11	14.37	16.63	7.60	15.20	100.00

properties in Zone S. The small numbers of sales in individual zones in each town in each year made it both difficult and potentially misleading to draw further general conclusions.

Multiple Regression Analysis

The dependent variable used in all MRA models was inflation-adjusted sales price per square foot of living area (ADJSPSF). Two time variables were employed: DDATE (date of deed: year and month) and BEFAFT, which indicated whether the deed was recorded before January 1, 1984, or after December 31, 1983. If the recording occurred after December 31, 1983, BEFAFT was assigned a value of 1; if the sale occurred prior to January 1, 1984, the value of BEFAFT was 0.

The price influence of all reported distance zone locations was compared with that of Zone G, the most distant zone from each SSA. Therefore, the values or coefficients for each of the reported seven zone variables (S and A through F) represent dollar differences in comparison with the price effects of a Zone G location. A negative coefficient meant that the dollar level of price influence for the zone in question was *lower* than that for Zone G. A positive coefficient meant that it was *higher* than that for Zone G.

Adjusted Sales Price Per Square Foot As The Dependent Variable. MRA was applied separately to the three-town total data set and to the Town A, Town B and Town C data subsets.

The results were impressive statistically. The coefficient of multiple determination (R-squared), which indicated the percent of variance in ADJSPSF explained by the independent variables, was at acceptable to high levels. Moreover, the high F ratios in the models mean that it was almost totally unlikely that the results occurred by chance.

Both DDATE and BEFAFT were highly significant and *positive*, which indicated a continuing (implicitly linear) increase in ADJSPSF over the entire study period. Lot size and square feet of living area were next most significant, followed by number of garage stalls and age at the time of sale.

In Town A, *none* of the zone variables was statistically significant. Moreover, they all were positive. In Town B, on the other hand, *all* zone coefficients were negative. Coefficients for Zones S, B and D were statistically significant. These results indicated a probable negative influence on ADJSPSF associated with Zones S, B and D (and possibly Zone A) locations relative to Zone G.

In Town C, as in Town A, *none* of the zone variables was statistically significant. The Zone S coefficient was negative in both time models, but there was a high probability that this was a chance occurrence.

In summary, there was no evidence of negative price impacts from locations in Zones S, A and B in

Town A; there was a small but almost totally insignificant negative impact in Zone S in Town C. In Town B, on the other hand, the negative influences of proximity to the Superfund site (Zones S, A and B as well as D) were both apparent and statistically significant.

Time-Distance Interactions. The MRA models discussed above took into consideration the separate price influences of both time and distance from the pertinent SSA in each town. Other property and transaction characteristics also were included in the analysis with ADJSPSF as the dependent variable.

RECGC made further tests in an attempt to identify and measure the *combined* or *joint* effects of time and distance zone location on ADJSPSF. Special emphasis was placed on "time" after January 1, 1984.

In MRA models, any existing joint or combined effect can be identified and measured through the use of an interactive variable. In this instance, the interactions of the time and location variables were calculated and tested.

(Table 7 shows the interactions of the deed date with each of the distance zone indicators to produce the seven time-distance interactive variables included in the models. Similarly, Table 8 shows the results of using before-after/distance zone interactive variables. Tables 7 and 8 identify the same highly significant variables: DDATE or BEFAFT, SFLIVARE and LOTSIZE. AGE and GARSTALS also are significant.)

All of the distance zone variables were not significant in the three-town total data set. Similarly, all the time-distance interactive variables were not significant except for D/BEFAFT (which was positive). Only the interactive variable for Zone B in Table 7 was negative; all the others in both models were positive. For the three-town total data set, therefore, no post-announcement negative effect of any consequence on ADJSPSF was associated with proximity to the SSAs.

Very similar results were found for Town A. Only the Zone C/DDATE interactive variable in Table 7 was negative. All others, especially for Zones S, A and B, were *positive*. Moreover, only the positive interactive variable for Zone F in Table 7 was statistically significant. None of the BEFAFT interactions was statistically significant.

In Town B, on the other hand, the interactive variables for Zones A and D in Table 7 and for Zones S, A, B and D in Table 8 were all *negative*. All others were positive. None of the interactive variables for Town B was statistically significant, however.

In Town C, only the interactive variables for Zones B and C in Table 7 were negative, but both zones were quite insignificant. *All* interactive variables were positive in Table 8. *No* interactive variable was statistically significant in either Table 7 or 8.

TABLE 7

Comparison of MRA Coefficients and t Values Time-Distance Interactions¹

Variable	Three-Town Total	Town A	Town B	Town C
SFLIVAREA	-0.01 (14.67)**	-0.01 (-6.85)**	-0.01 (-6.56)**	-0.03 (-12.49)**
AGE	-0.16 (-4.47)**	-0.16 (-2.49)*	-0.25 (-4.40)**	-0.16 (-2.56)*
DDATE	8.30 (15.04)**	8.14 (9.21)**	7.74 (9.51)**	7.97 (7.39)**
LOTSIZE	.0007 (16.01)**	.0008 (4.66)**	.0007 (7.68)**	.0011 (15.55)**
GARSTALS	6.64 (5.56)**	2.60 (1.37)	5.66 (2.74)**	9.99 (5.07)**
Zone S	-60.55 (-0.88)	-95.68 (-1.06)	-113.72 (-0.66)	-51.23 (-0.37)
Zone A	-29.59 (-0.34)	-87.86 (-0.76)	49.55 (0.26)	-51.03 (-0.34)
Zone B	18.66 (0.22)	-111.46 (-0.78)	-160.13 (-0.64)	50.16 (0.42)
Zone C	-0.05 (-0.0007)	15.78 (0.12)	-132.78 (-0.90)	32.48 (0.26)
Zone D	-100.61 (-1.27)	-215.06 (-1.53)	151.70 (1.08)	-163.19 (-1.30)
Zone E	-76.04 (-1.14)	-162.86 (-1.57)	-111.82 (-1.08)	-74.62 (-0.61)
Zone F	-79.97 (-1.11)	-234.42 (-2.11)*	-36.98 (-0.35)	-5.23 (-0.04)
S*DDATE	0.71 (0.88)	1.13 (1.07)	1.13 (0.55)	0.58 (0.36)
A*DDATE	0.35 (0.35)	1.09 (0.81)	-0.60 (-0.32)	0.59 (0.33)
B*DDATE	-0.23 (-0.23)	1.36 (0.81)	1.68 (0.58)	-0.56 (-0.39)
C*DDATE	0.03 (0.04)	-0.12 (-0.08)	1.54 (0.88)	-0.36 (-0.25)
D*DDATE	1.16 (1.25)	2.55 (1.55)	-1.91 (-1.16)	1.94 (1.33)
E*DDATE	0.90 (1.15)	1.96 (1.61)	1.27 (1.04)	0.84 (0.59)
F*DDATE	0.95 (1.12)	2.77 (2.13)*	0.38 (0.31)	0.09 (0.05)
R-Squared	0.62	0.69	0.62	0.71
F Ratio	80.91	35.80	24.25	39.18
Standard Error of Estimate	20.75	17.29	21.14	20.19
Durbin-Watson	1.54	1.79	1.58	1.83
Number of Sales	1,403	485	445	473

1. Time is deed date; ADJSPSF is the dependent variable. 2. Numbers in parentheses are t-values

* = Significant at the .05 level

** = Significant at the .01 level

These interactive variable findings showed a clear and reasonably consistent pattern. Any negative effects that could be identified and measured in association with proximity to one of the SSAs after January 1, 1984, were confined to Town B. Even the negative effects in Town B were not statistically

significant, however; they could easily have occurred by chance. In Towns A and C, no measurable or discernible negative effect from proximity to the SSA was indicated, especially after January 1, 1984. Moreover, the interactive model results indicated that the passage of time after the announcement did not

TABLE 8

Comparison of MRA Coefficients and t values Time-Distance Interactions: Before-After January 1, 1984¹

Variable	Three-Town Total	Town A	Town B	Town C
SFLIVAREA	-0.01 (13.78)**	-0.01 (-5.30)**	-0.01 (-7.01)**	-0.03 (-11.41)**
AGE	-0.10 (-2.36)*	-0.10 (-1.24)	-0.23 (-3.54)**	-0.09 (-1.18)
BEFAFT	30.00 (9.12)**	30.36 (5.06)**	29.94 (6.79)**	26.69 (3.63)**
GARSTALS	5.88 (4.14)**	0.94 (0.38)	6.90 (2.93)**	8.23 (3.43)**
LOTSIZE	.0008 (15.19)**	.0009 (4.40)**	.0008 (7.22)**	.0011 (14.58)**
Zone S	-4.94 (-1.19)	-7.74 (-1.22)	-19.78 (-2.51)*	-4.30 (-0.44)
Zone A	-1.99 (-0.36)	-2.94 (-0.37)	-11.80 (-1.13)	0.30 (0.03)
Zone B	-7.29 (-1.34)	-3.11 (-0.30)	-17.58 (-1.41)	-4.01 (-0.45)
Zone C	-2.02 (-0.42)	-1.87 (-0.21)	-9.63 (-1.35)	-0.15 (-0.02)
Zone D	-8.75 (-1.76)	-5.98 (-0.67)	-9.84 (-1.29)	-5.41 (-0.57)
Zone E	-1.37 (-0.34)	-0.02 (-0.00)	-6.00 (-1.13)	-7.35 (-0.81)
Zone F	-3.43 (-0.85)	-3.29 (-1.22)	-7.87 (-1.42)	-6.65 (-0.68)
S*BEFAFT	7.12 (1.47)	13.58 (1.89)	-1.08 (-0.11)	4.59 (0.43)
A*BEFAFT	2.25 (0.36)	7.69 (0.86)	-0.39 (-0.03)	0.22 (0.02)
B*BEFAFT	9.33 (1.47)	8.96 (0.75)	-1.51 (-0.11)	12.02 (1.21)
C*BEFAFT	10.35 (1.81)	11.21 (1.06)	10.51 (1.13)	8.43 (0.84)
D*BEFAFT	11.62 (2.02)*	8.74 (0.84)	-2.62 (-0.28)	16.78 (1.63)
E*BEFAFT	1.32 (0.28)	3.05 (0.37)	0.09 (0.01)	6.04 (0.62)
F*BEFAFT	5.81 (1.18)	8.38 (1.03)	3.45 (0.50)	10.70 (0.95)
R-Squared	0.47	0.49	0.51	0.58
F Ratio	43.37	15.34	15.22	21.47
Standard Error of Estimate	24.60	22.18	24.10	24.51
Durbin-Watson	1.70	1.96	1.66	1.95
Number of Sales	1,403	485	445	473

1. ADJSPSF is dependent variable. 2. Numbers in parentheses are t values

* = Significant at the .05 level

** = Significant at the .01 level

enhance or exacerbate any negative effects that a location close to the SSA in Town B already had on ADJSPSF.

Summary

A total data set of 1,423 usable sales of single-family residential properties in three towns in northern New Jersey was studied over the period July 1, 1980,

through June 30, 1989. Detailed property and sales transaction information was gathered from public records, published sources and field inspections. The location of each sales property was identified by distance zone from the boundaries of a Superfund site (SSA) in each town. Sales within the SSAs themselves, both before and after January 1, 1984, also were included.

The data sets were subjected to a series of statistical tests to provide a basis for reaching judgments about: (1) whether proximity to a known SSA had a negative effect on residential property values in any of the three towns; (2) how far away from the SSA any negative price effect was felt; and (3) how persistently any such negative effect was felt over time. Three statistical procedures were employed:

- Simple comparisons of averages resulted in graphs depicting the movement of average ADJSPSF in different distance zones.
- Percentage changes were calculated by comparing averages of ADJSPSF before and after January 1, 1984. Trends in sales volume were similarly tested and compared. In addition, changes in the percentage mix of sales by zone for each year within each town were compared.
- Multiple regression analysis received major emphasis. ADJSPSF was the focal dependent variable.

Within MRA, the standard Hedonic Pricing Model was applied using two time measures: (1) deed date, a continuous variable; and (2) before-after January 1, 1984, a binary variable. The coefficients for all reported distance zones represented incremental differences from the price of the most distant zone (G) which served as a control.

Finally, the Hedonic Pricing Model was modified to incorporate time-distance interactions of both deed date and before-after time in combination with distance zone.

Conclusions

The results of the statistical tests and their findings led to the following conclusions.

Only in Town B was there any systematic, significant negative effect on ADJSPSF and on sales volume for properties close to the SSA. In Towns A and C, where remediation and cleanup were completed promptly, no systematic or significant negative effect was evident except in sales volume in 1989. The period of this decline in sales was too brief to provide a basis for generalization.

After January 1, 1984, patterns of negative effects on ADJSPSF were spotty, un-systematic and generally insignificant. The only consistent negative impacts appeared in Town B, in Zones S, A, B and D. Even there, negative interactive time-distance variables were not significant. Most consistent was a lower rate of increase in average ADJSPSF in Zone S generally and in Zones A and B in Town B.

Sales volumes in the distance zones closest to the SSAs did not decline perceptibly in the years immediately following the December, 1983, announcement. Any decreases that did occur were quite temporary. In 1988 and 1989, however, when

the general level of residential sales volume decreased throughout the market area, the declines were much sharper in Zones S, A and B. No direct association with proximity to the SSAs was demonstrated, however.

No measurable negative impact beyond the SSA was evident in Towns A and B. Even there, the post-announcement effects were not significant. In Town B, on the other hand, negative price (and sales volume) effects were found with properties located at least 500 feet from the outer boundary of the SSA through Zone B. It is arguable that the negative impact extended through Zone D (1,500 feet away from the SSA) in Town B, even though the measurable effects in intervening Zone C was *positive*.

Standard MRA using the Hedonic Pricing Model supported and clarified these conclusions based on comparisons of averages and comparisons of trends. Negative statistically significant coefficients associated with location were found in Town B only. There the coefficients for Zones S, A and B were both negative and statistically significant. There was no such impact in Town A or Town C.

The foregoing conclusions also were reinforced when interactive time-distance variables were incorporated into the Hedonic Pricing Model. The negative impacts noted in Zones S, A and B in Town B were generally not significant; nevertheless, there was a continuing negative impact associated with property locations in Zones S, A and B after January 1, 1984, in Town B only, through at least June, 1989.

Any continuing, significant negative price impacts associated with proximity to an SSA were limited to Town B. The SSA within Town B was the site within which barrels of radioactive soil were prominently stored in the open for more than two years with attendant continuing publicity. Several contaminated properties in this town were fenced off, and danger signs warning of radiation hazards were prominently displayed.

The Superfund sites in Towns A and C, on the other hand, were cleaned up expeditiously, and they had none of the adverse publicity that persisted in Town B. As a result, their potential negative impacts were effectively eliminated. Accordingly, no significant negative effects on ADJSPSF or sales volume emerged. Indeed, with the exception of properties within the Superfund site itself in 1988 and 1989, no negative price effect was identified in Towns A and C.

Therefore, the market response to proximity to a known SSA was a direct function of the speed and apparent effectiveness of any remediation or cleanup effort. These results were generally consistent with findings from other, similarly designed and executed statistical studies in other states.