Evaluating the Relationship between Residential Property Values and Groundwater Quality

Matthew F. Bingham
Jason C. Kinnell

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1851 Evans Road
Cary, NC 27513
Office: 919.677.8787
Fax: 919.677.8331

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This study evaluates the South Valley area housing market in Albuquerque, New Mexico before, during, and after the closure of a contaminated municipal well. This paper develops a model to measure price changes caused by the discovery of a contaminated well. We focus on the property value impacts of contamination-related information arising from proximity to the well. The integration of temporal and spatial factors by combining local historical research with geographic information system (GIS) tools plays an important role.

Introduction

Groundwater supplies drinking water to 53 percent of the U.S. population. This includes about 35 percent of U.S. public water supplies and 80 percent of rural domestic supplies (American Institute of Professional Geologists 1985). Groundwater is also extracted for use in irrigated agriculture and industrial processes.

To the extent that groundwater supports healthy and abundant surface waters, it also contributes to a variety of services generated by these waters. These services include recreational swimming, boating, fishing, hunting/trapping and plant gathering, and commercial fishing, hunting/trapping, and plant gathering.

Groundwater resides in aquifers. Aquifers may generate non-use or passive use services (Bishop and Welsh 1992; Freeman 1993, Chap. 5). These services may be attributable to the existence of an aquifer, independent of any current or future use. Alternatively, passive use services of providing potable drinking water to future generations may arise from bequest motivations on the part of the current generation.

The many roles of groundwater, combined with increasing pressure on water supplies, underscores the importance of valuing the services associated with groundwater. This study employs a unique data set and situation to evaluate a particular aspect of the value of groundwater. The study group is the South Valley area housing market in Albuquerque, New Mexico before, during, and after the closure of a contaminated municipal well. As the quality of local drinking water is not affected by well contamination, we pay special attention to the effects on property values of information relevant to contamination from proximity to the well, taking into account spatial effects. The spatial and temporal features of this data support identification of impacts via hedonic analysis.

Rosen's (1974) seminal article provides the foundation for hedonic analysis. In housing markets, equilibrium prices are determined such that buyers and sellers are perfectly matched. Property values are influenced by home characteristics, economic conditions, and nearby amenities (or disamenities). In many cases, environmental degradation can directly impact property values. For example, Palmquist, Roka, and Vurina (1997) find that proximity to hog farming operations reduces property values. In this case, farming odors lower the desirability of nearby locations.

Less tangible types of environmental contamination may also impact property values. For example, Kiel (1995) finds a link between proximity to contaminated but inactive wells and home prices. The impact of indirect events on value is often attributed to market perceptions of increased risk. Such effects have been broadly ascribed to the psychological impact of information related to contamination from proximity to the well. The imprecise notion of the motivations underlying information pertinent to contamination from proximity to the well has historically complicated the identification and measurement of indirect effects on property values. In response, economists have begun focusing on more precise and measurable concepts. In particular, the information events underlying market perceptions have assumed an important role. Empirical work supports the link between information releases about contamination and property value diminution. McCluskey and Rausser (2001) find that media coverage of contamination is a substantial factor in value reduction. Gayer, Hamilton, and Viscusi (2000) identify a similar effect. Kohlhase (1991) finds that U.S. Environmental Protection Agency (EPA) news releases are the most important factor influencing property values near an environmental insult. In addition, her analysis demonstrates that plans regarding remediation and the probability of remediation success are important determinants in the value of nearby properties. These studies indicate that identifying an indirect effect requires quantifying the influence of relevant information events on prices. When identified, a linkage between value reduction and relevant information releases is evidence of market perceptions.

This study investigates the influence of proximity to a contaminated municipal well in the South Valley area of Albuquerque on nearby residential property values. A review of local history reveals significant information events, including awareness of contamination, Superfund listing, EPA activities, public meetings, and plugging and abandonment of the well. This combination presents a unique opportunity for investigating the relationship between property values and groundwater quality.

Data Requirements

The hedonic framework views the home as a composite of characteristics whose total value is reflected in sale price. Data requirements for evaluating impacts of groundwater quality on home values also include homes with differential groundwater quality. The approach taken here identifies an “affected area” and an “unaffected area.” The “unaffected area” is a control area where groundwater quality is unchanged. This control area is similar to the area where groundwater quality is impacted. However, there will be disparities between locations in important home value components, such as construction quality, public services, and school quality. The hedonic approach controls for these differences.

A review of hedonic studies evaluating contamination-related events indicates the importance of employing temporal effects in hedonic analysis. For example, Dale et al. (1999) evaluate the importance of intertemporal information releases about nearby soil contamination. They find that property values rebound after a cleanup. McCluskey and Rausser’s (2001) longitudinal analysis finds that media coverage influences property values. Kiel’s (1995) hedonic analysis finds that location premiums change over time with factors such as discovery and cleanup of contamination. Finally, in summarizing a set of hedonic studies, Farber (1998) recognizes that “the timing of observations across various phases of site use is important in estimating the magnitude of adverse impacts” (p. 9).

Appropriate consideration of location is also important. Gayer, Hamilton, and Viscusi (2000) use distance rings in one-quarter mile increments to assess the effect of proximity to a Superfund site on housing values. Nelson, Genereux, and Genereux (1992) employ concentric zones in one-half mile increments to assess the effects of proximity to landfills on property values. Clark and Allison (1999) use linear distance from a nuclear power plant to assess the effect of proximity to the plant on property values. Dale et al. (1999) incorporate the linear distance from a lead smelter to analyze the impact of proximity to the smelter on property values.

Data

Our primary data set includes prices and characteristics of all single-family homes sold through the multiple-listing service in the South Valley area from the fourth quarter of 1976 to the end of 1997. Characteristics such as house size, lot size, garage space, number of bedrooms, condition, the presence of a fireplace, type of heat, and presence of central air conditioning all are important considerations.

Groundwater quality is not directly observable. For this reason, quantifying impacts is based on temporal delineation of the relevant information. Our chosen hedonic specifications rely upon a historical review of the municipal well (San Jose #6) contamination. From 1978 to 1983, there was substantial publicity about the problem of excess nitrates in the drinking water from private wells in South Valley. In the fall of 1981, San Jose #6 was decommissioned because low levels of organic solvents were detected. San Jose #6 was back in service in 1982. In September 1983, the South Valley Superfund Site was listed on the National Priorities List. In April 1987, a new city water supply well (Burton #4) was completed to replace San Jose #6. EPA held a public meeting about the South Valley Superfund site during the summer of 1988. EPA completed the initial Remedial Investigation/Feasibility Study phase in 1988. San Jose #6 was abandoned and plugged in September 1994 (Salazar 2001; EPA 2008).

We separated the events that are relevant to groundwater quality into four distinct time periods:

- Discovery period 1976–1982
- Superfund designation/increasing awareness 1983–1987
- EPA/New Mexico Environment Department involvement/remediation decisions 1988–1995
- Remedial actions underway 1996–1997.

These time periods form the basis for segmenting home sales into various time periods most likely to reflect information related to groundwater quality arising from proximity to the well.

In part, the spatial specifications of groundwater quality information rely on the traditional zonal segmentation technique discussed earlier. However, our primary specification associates groundwater quality with the neighborhood containing the contaminated well. This specification is appealing for two reasons. The location of municipal well San Jose #6 in the San Jose neighborhood of South Valley ensures that houses in this neighborhood lie in close proximity to the contaminated well. In addition, the neighborhood and the well are identically named. Thus, name recognition of the contaminated well might easily transfer information about groundwater quality to the surrounding neighborhood.

Geographical Factors

Identifying the effect of groundwater quality on property values requires controlling for confounding factors. The proximity of South Valley to Albuquerque International Airport underscores the importance of controlling for airport noise sources. Nelson (1980) published a review of studies about the effect of airports on property values. Most of those studies found a negative effect from being close to an airport or its noise sources. More recent evidence also indicates a negative effect (O'Byrne, Nelson, and Seneca 1985).

Interstate 25 runs nearly due north-south through the study area and passes within two-tenths of a mile of the contaminated well. A 1987 study by the Albuquerque Environmental Health Department found that Albuquerque residents considered noise from interstate traffic to be a major source of dissatisfaction. In fact, 44 percent of those living in the high-traffic study area considered moving because of noise. Nelson, Genereux, and Genereux (1992) find a substantial negative effect of close proximity to the interstate, while Blomquist and Worley (1980) find that nearness has a positive effect. Kiel and McClain (1995) find positive convenience effects and negative noise and pollution effects arising from proximity to an interstate. Sewage treatment plant #1 located near the San Jose neighborhood was in operation from 1958 to 1985. Throughout this period, numerous citizen complaints indicate that the plant's operation may have adversely impacted nearby property values.

Environmental disamenities likely to affect the study area include noise pollution from the airport, I-25 interstate, and railroad tracks as well as odors from sewage treatment plant #1. A complete hedonic specification requires consideration of each of these factors. For identification of information related to groundwater quality, it is particularly important to correctly capture disamenities with time variant effects. For example, the airport noise contours changed in 1985 and in 1996. We control for the effect of airport noise on home values by appropriately designating noise contour membership over the analysis period. The following section describes how we used a GIS tool, ArcView, to appropriately incorporate environmental factors in a hedonic analysis.

GIS Encoding

The analysis began with a unique data set of nearly 1,800 observations on home sales from the South Valley area. ArcView GIS was used to reference street addresses to GIS coordinates. As part of this process, ArcView assigns a score to each observation. (The spelling sensitivity was set to 80, which is ArcView's default setting. The minimum score to be plotted was 75.) An observation with a score between 75 and 100 is generally considered a good match by ArcView's standards. In the model analysis, we employ only observations with a score above 75, leaving 1,762 observations.

ArcView also captured the location of likely environmental and neighborhood effects. The location information used is as follows:

- San Jose #6
- Sewage treatment plant 1 (STP1), which was in operation from 1958–1985
- Sewage treatment plant 2 (STP2), which began operating in 1962 and is still in operation today
- Railroad lines
- I-25 Interstate
- Rio Grande River
- 1983 and 1985 airport noise contours.

Points for San Jose #6, STP1, and STP2 were entered using their addresses and ArcView GIS software in a manner similar to geocoding of MLS home sales. We also added variables to indicate whether the properties lay within a certain distance of these points. Location information on the railroad lines (from the U.S. Census Bureau Tiger System 2001), the I-25 Interstate, the Rio Grande river, the 1983 and 1985 noise contours around the nearby airport, and the historical neighborhoods in this area were derived from appropriate geocoding of latitude and longitude information. Variables were then created, indicating whether the properties lay within these areas or if the properties were within certain distances of the railroad or Interstate.

Data Description

Independent variables fall into one of four attribute categories: housing characteristics, location, historic neighborhoods, and temporal. A brief description of each variable is found in Table 1.

In spatial data analyses, values observed in one location often depend on the values at neighboring locations. Spatial autocorrelation implies that observations in cross-sectional, spatially organized data are not independent. Of interest is the effect of the explanatory variables after removing the spatial autocorrelation effects. This model is appropriate when there is no theoretical or apparent spatial interaction between any house and its neighboring observations and the modeler is interested only in correcting the potentially biasing influence of spatial autocorrelation by using data with spatial features.

The area under consideration consists of 14 distinct and recognized neighborhoods. The analysis controls for spatial autocorrelation by designating membership in a neighborhood. Polygons representing neighborhoods (Salazar 2001) were drawn in ArcView and dichotomous variables were created to represent a particular property’s neighborhood.

Table 1
Variable Descriptions of Variables Used in Analysis

Variable	Description
Dependent Variable:	
Sale Price	Logged sale price adjusted by New Mexico Housing Price Index.
Housing Characteristics:	
Surface area (logged)	Logged surface area of the house.
Lot size (logged)	Logged lot size of the house.
Missing lot size information	Equal to 1 if lot size information is missing, 0 otherwise.
Garage stalls	Number of garages.
Number of bedrooms	Number of bedrooms.
Handyman special	Equal to 1 if house is listed as a "handyman special," 0 otherwise.
Fireplace	Equal to 1 if there is a fireplace, 0 otherwise.
Gas heating	Equal to 1 if use gas for heating, 0 otherwise.
Central forced air	Equal to 1 if use central forced air for heating, 0 otherwise.
Mortgage rate	Average Contract Rate on Commitments for Fixed-Rate First Mortgages.
Repeat sale over time period	Equal to 1 if house was sold more than once from 1976 to 1997, 0 otherwise.
Location:	
Close to railroad	Equal to 1 if ¼ mile from the railroad, 0 otherwise.
Close to interstate	Equal to 1 if ¼ mile from the I-25 Interstate, 0 otherwise.
Historic Neighborhoods:[a]	
Barelas	Equal to 1 if in Barelas neighborhood, 0 otherwise.
Downtown	Equal to 1 if in Downtown neighborhood, 0 otherwise.

[a] Historic neighborhood variables capture the character and location of each of the 14 historic neighborhoods. Neighborhood designation may be important in its own right. However, this designation may also proxy for missing information such as approximate age of surrounding homes, crime rates, and proximity to unidentified amenities/disamenities.

Table 1
Variable Descriptions of Variables Used in Analysis, continued

Variable	Description
Historic Neighborhoods:	
Downtown neighborhood	Equal to 1 if in Downtown Neighborhood area, 0 otherwise.
Hunting Highland	Equal to 1 if in Hunting Highland neighborhood, 0 otherwise.
Las Lomas	Equal to 1 if in Las Lomas neighborhood, 0 otherwise.
Martinez Town	Equal to 1 if in Martinez Town neighborhood, 0 otherwise.
Santa Barbara	Equal to 1 if in Santa Barbara neighborhood, 0 otherwise.
Sawmill	Equal to 1 if in Sawmill neighborhood, 0 otherwise.
Silver Hills	Equal to 1 if in Silver Hills neighborhood, 0 otherwise.
South Broadway	Equal to 1 if in South Broadway neighborhood, 0 otherwise.
University Heights	Equal to 1 if in university Heights neighborhood, 0 otherwise.
Atrisco	Equal to 1 if in Atrisco neighborhood, 0 otherwise.
Old Town	Equal to 1 if in Old Town neighborhood, 0 otherwise.
San Jose	Equal to 1 if in San Jose neighborhood, 0 otherwise.
Temporal:	
30-Year Conventional Mortgage Rate	Average Contract Rate on Commitments for Fixed-Rate First Mortgages.[b]
½ mile of sewage treatment plant (1976–1985)	Equal to 1 if within ½ mile from the first sewage treatment plant (STP1), 0 otherwise.
1983–1984 Noise contour (60 dB)	Equal to 1 if within the estimated 1983 LDN 60 noise contour from 1983 to 1984, 0 otherwise.
1985–1995 Noise contour (65 dB)	Equal to 1 if within the estimated 1985 LDN 65 noise contour from 1985 to 1995, 0 otherwise.
Within San Jose from 1983 to 1987	Equal to 1 if within San Jose neighborhood from 1983 to 1987, 0 otherwise.
Within San Jose from 1988 to 1995	Equal to 1 if within San Jose neighborhood from 1988 to 1995, 0 otherwise.
Within San Jose from 1996 to 1997	Equal to 1 if within San Jose neighborhood from 1996 to 1997, 0 otherwise.

[b] These data were used as a proxy for mortgage interest rates due to many missing values for interest rate in the MLS data. Source: Economic Research Federal Reserve Bank of St. Louis (2008).

Table 1
Variable Descriptions of Variables Used in Analysis, continued

Variable	Description
Temporal:	
1976	Equal to 1 if sold in 1976, 0 otherwise.
1977	Equal to 1 if sold in 1977, 0 otherwise.
1978	Equal to 1 if sold in 1978, 0 otherwise.
1979	Equal to 1 if sold in 1979, 0 otherwise.
1980	Equal to 1 if sold in 1980, 0 otherwise.
1981	Equal to 1 if sold in 1981, 0 otherwise.
1982	Equal to 1 if sold in 1982, 0 otherwise.
1983	Equal to 1 if sold in 1983, 0 otherwise.
1984	Equal to 1 if sold in 1984, 0 otherwise.
1985	Equal to 1 if sold in 1985, 0 otherwise.
1986	Equal to 1 if sold in 1986, 0 otherwise.
1987	Equal to 1 if sold in 1987, 0 otherwise.
1988	Equal to 1 if sold in 1988, 0 otherwise.
1989	Equal to 1 if sold in 1989, 0 otherwise.
1990	Equal to 1 if sold in 1990, 0 otherwise.
1991	Equal to 1 if sold in 1991, 0 otherwise.
1992	Equal to 1 if sold in 1992, 0 otherwise.
1993	Equal to 1 if sold in 1993, 0 otherwise.
1994	Equal to 1 if sold in 1994, 0 otherwise.
1995	Equal to 1 if sold in 1995, 0 otherwise.
1996	Equal to 1 if sold in 1996, 0 otherwise.

Empirical Results

We evaluated several hedonic models. All models include relevant housing characteristics as well as environmental variables. In addition, all models are tested for heteroskedasticity and multicollinearity. Tests indicate that multicollinearity is inconsequential in every specification. However, Cook-Weisberg tests indicate that heteroskedasticity is present in all specifications; thus, all further discussions concern only models that are corrected for heteroskedasticity using White's correction. Models vary according to the specification used to evaluate the effect of proximity to San Jose #6 during relevant time periods and the consideration of potentially confounding variables.

The first three models evaluate whether an effect on property values, caused by decreased groundwater quality, is associated with the San Jose neighborhood. Model 1 defines all areas outside the San Jose neighborhood as a reference area. As shown in Table 2, all housing characteristics and location variables generally have the expected signs and are statistically significant. The model produces an r^2 of 0.84. (As housing characteristics and location variables have the correct sign and are statistically significant across all specifications, this result is not discussed further.)

This model demonstrates that holding other factors constant, the property values in the San Jose neighborhood are lower than other properties with similar characteristics over the entire period. The model does not identify a statistically significant effect on home values in the San Jose neighborhood from the Superfund designation in 1983 or increased public awareness of groundwater contamination from 1988 onward.

We also estimate a specification that defines all areas beyond 2 miles from San Jose #6 as a reference area (Model 2). This model produces an r^2 of 0.85. This more restrictive reference area controls for the possibility that some properties outside the San Jose neighborhood, but inside the two-mile area, affected the previous reference area. This model shows that a more conservative reference area specification does not indicate any statistical relationship between publicity surrounding San Jose #6 and property values in the San Jose neighborhood.

Finally, we evaluate the consistency of these results relative to the possibility that a time trend in San Jose housing prices influenced the identification of groundwater quality information on property values (see Model 3). This model indicates no separate trend in San Jose prices and no link between San Jose housing values and significant events surrounding San Jose #6. Thus, the set of models evaluating whether groundwater quality from San Jose #6 is associated with the San Jose neighborhood indicates that the presence of groundwater contamination in the South Valley area has not had a significant impact on home values in the San Jose neighborhood.

Table 2
Hedonic Models

Variable	Model 1 (r^2 = 0.84)	Model 2 (r^2 = 0.85)	Model 3 (r^2 = 0.84)	Model 4 (r^2 = 0.84)	Model 5 (r^2 = 0.84)	Model 6 (r^2 = 0.85)
Housing Characteristics:						
Sq ft (logged)	0.56 ***	0.60 ***	0.56 ***	0.56 ***	0.56 ***	0.55 ***
Lot size (logged)	0.08 ***	0.06 ***	0.08 ***	0.08 ***	0.08 ***	0.08 ***
Missing lot size information	0.01	0.01	0.01	0.01	0.01	0.01
Garage stalls	0.05 ***	0.04 ***	0.05 ***	0.05 ***	0.05 ***	0.05 ***
Bedrooms (#)	0.01	0.02	0.01	0.01	0.01	0.01
Handyman	-0.33 ***	-0.35 ***	-0.33 ***	-0.33 ***	-0.33 ***	-0.32 ***
Fireplace	0.04 ***	0.04 **	0.04 ***	0.04 ***	0.04 ***	0.04 ***
Gas heating	-0.00	-0.01	-0.00	0.00	0.00	0.01
Central forced air	0.10 ***	0.09 ***	0.10 ***	0.10 ***	0.10 ***	0.10 ***
Mortgage rate	0.02	0.00	0.02	0.02 *	0.02 *	0.01
Repeat sale	0.02	0.00	0.02	0.02	0.02	0.02
Location:						
Railroad ¼ mi	-0.05 *	-0.07 *	-0.05 *	-0.06 **	-0.04	-0.03
Interstate ¼ mi	-0.04 *	-0.06 **	-0.04 *	-0.05 **	-0.04 *	-0.03
Historic Neighborhoods:						
Barelas	-0.17 ***	-0.08	-0.17 ***	-0.17 ***	-0.18 ***	-0.17 ***
Downtown	-0.14 *	-0.18 **	-0.14 *	-0.13 *	-0.15 **	-0.17 **
Downtown nbh	0.22 ***	0.17 **	0.22 ***	0.22 ***	0.21 ***	0.18 **
Hunting Highland	0.14 ***	0.11 ***	0.14 ***	0.15 ***	0.13 ***	0.11 ***
Las Lomas	0.40 ***	0.37 ***	0.40 ***	0.40 ***	0.39 ***	0.37 ***
Martinez Town	-0.23 ***	-0.25 ***	-0.23 ***	-0.23 ***	-0.25 ***	-0.27 ***
Santa Barbara	0.18	0.19	0.18	0.19	0.16	0.13
Sawmill	-0.16 **	-0.18 **	-0.16 **	-0.16 **	-0.18 **	-0.20 ***
Silver Hills	0.19 ***	0.16 ***	0.19 ***	0.19 ***	0.19 ***	0.16 ***

*** Significant at the 1% level
** Significant at the 5% level
* Significant at the 10% level

Table 2
Hedonic Models, continued

Variable	Model 1 ($r^2 = 0.84$)	Model 2 ($r^2 = 0.85$)	Model 3 ($r^2 = 0.84$)	Model 4 ($r^2 = 0.84$)	Model 5 ($r^2 = 0.84$)	Model 6 ($r^2 = 0.85$)
Historic Neighborhoods:						
South Broadway	-0.15 ***	-0.14 ***	-0.15 ***	-0.14 ***	-0.16 ***	-0.14 ***
University Hts	0.24 ***	0.21 ***	0.24 ***	0.24 ***	0.24 ***	0.21 ***
Atrisco	-0.01	-0.02	-0.01	-0.00	-0.01	-0.04
Old Town	0.19	0.14	0.19	0.19	0.18	0.16
San Jose	-0.29 ***	-0.31 ***	-0.29 ***	-0.28 ***	-0.23 ***	-0.23 ***
Temporal:						
STP1 .5 mi 76-85	-0.32 **	-0.30 *	-0.32 **	-0.35 ***	-0.34 **	-0.34 **
Airport Noise 83–84 (60 db)	-0.12	-0.11 **	-0.12	-0.12	-0.12	-0.12
Airport Noise 85–95 (65 db)	-0.14 ***	-0.21 **	-0.14 ***	-0.14 ***	-0.10 ***	-0.11 ***
San Jose 83-87	0.04	0.07	0.03	na	na	na
San Jose 88-95	-0.01	0.01	-0.03	na	na	na
San Jose 96-97	0.12 *	0.13 *	0.09	na	na	na
Ring[a] 83-87	na	na	na	0.05	-0.06	0.08 **
Ring 88-95	na	na	na	-0.12	-0.11 ***	-0.00
Ring 96-97	na	na	na	0.07	0.00	0.07 *
Ring 76-97	na	na	na	0.10	0.02	-0.10 ***
San Jose Trend	na	na	0.00	na	na	na
1976	-1.38 ***	-1.30 ***	-1.38 ***	-1.39 ***	-1.38 ***	-1.36 ***

[a] Ring refers to a concentric circle around Municipal Well #6. Model 4 is a one-mile ring, Model 5 is a 1.5 mile ring and Model 6 is a 2 mile ring.

*** Significant at the 1% level
** Significant at the 5% level
* Significant at the 10% level

Table 2
Hedonic Models, continued

Variable	Model 1 (r^2 = 0.84)	Model 2 (r^2 = 0.85)	Model 3 (r^2 = 0.84)	Model 4 (r^2 = 0.84)	Model 5 (r^2 = 0.84)	Model 6 (r^2 = 0.85)
Temporal:						
1977	-1.27 ***	-1.24 ***	-1.27 ***	-1.28 ***	-1.29 ***	-1.25 ***
1978	-1.04 ***	-0.96 ***	-1.04 ***	-1.05 ***	-1.06 ***	-1.01 ***
1979	-0.98 ***	-0.95 ***	-0.97 ***	-0.98 ***	-1.00 ***	-0.94 ***
1980	-0.78 ***	-0.68 ***	-0.78 ***	-0.79 ***	-0.80 ***	-0.78 ***
1981	-0.79 ***	-0.66 ***	-0.79 ***	-0.80 ***	-0.81 ***	-0.75 ***
1982	-0.76 ***	-0.64 ***	-0.76 ***	-0.76 ***	-0.78 ***	-0.73 ***
1983	-0.72 ***	-0.67 ***	-0.72 ***	-0.73 ***	-0.73 ***	-0.73 ***
1984	-0.67 ***	-0.59 ***	-0.67 ***	-0.67 ***	-0.68 ***	-0.67 ***
1985	-0.59 ***	-0.54 ***	-0.59 ***	-0.60 ***	-0.59 ***	-0.60 ***
1986	-0.46 ***	-0.43 ***	-0.46 ***	-0.46 ***	-0.46 ***	-0.47 ***
1987	-0.43 ***	-0.41 ***	-0.43 ***	-0.44 ***	-0.44 ***	-0.45 ***
1988	-0.48 ***	-0.42 ***	-0.48 ***	-0.48 ***	-0.48 ***	-0.47 ***
1989	-0.47 ***	-0.42 ***	-0.47 ***	-0.48 ***	-0.47 ***	-0.46 ***
1990	-0.53 ***	-0.45 ***	-0.53 ***	-0.53 ***	-0.53 ***	-0.53 ***
1991	-0.46 ***	-0.44 ***	-0.46 ***	-0.47 ***	-0.46 ***	-0.46 ***
1992	-0.36 ***	-0.33 ***	-0.36 ***	-0.36 ***	-0.36 ***	-0.35 ***
1993	-0.26 ***	-0.26 ***	-0.26 ***	-0.26 ***	-0.25 ***	-0.25 ***
1994	-0.17 ***	-0.16 ***	-0.17 ***	-0.17 ***	-0.16 ***	-0.16 ***
1995	-0.02	-0.04	-0.02	-0.02	-0.02	-0.01
1996	-0.01	-0.00	-0.01	0.00	-0.01	-0.00

*** Significant at the 1% level
** Significant at the 5% level
* Significant at the 10% level

A second set of models evaluates whether an effect of contamination-related information on property values caused by San Jose #6 is associated with linear distance from the well. The first of these models evaluates the effect of information related to contamination on the value of all homes within one mile of San Jose #6 (see Model 4). Areas outside a one-mile radius of San Jose #6 are the relevant reference area. The model r2 of 0.84 indicates high explanatory power similar to that found in earlier models. This model shows that property values within one mile of San Jose #6 are not significantly different from other properties with similar characteristics over the entire period. In addition, the model shows no significant impact on home values within one mile of San Jose #6 from the Superfund designation in 1983 or increased public awareness of groundwater contamination from 1988 onward.

The second linear distance specification evaluates the effect of contamination-related information on the value of all homes within one and one-half miles of San Jose #6 (see Model 5). This model produces an r2 of 0.84 as well. It indicates that property values within one and one-half miles of San Jose #6 are not significantly different from other properties with similar characteristics over the entire period. In addition, the model shows no significant impact on home values within one and one-half miles of San Jose #6 from the Superfund designation in 1983. There is a slight diminution in values from 1988 to 1995. This effect is not present in 1996 and 1997.

The final linear distance model specifies within two miles and beyond two miles from San Jose #6 as analysis and control areas, respectively (see Model 6). This model produces an r^2 of 0.85. It shows that property values within two miles of San Jose #6 are valued slightly lower than other properties with similar characteristics over the entire period. The model shows a statistically significant increase in home values within two miles of San Jose #6 between 1983 and 1987. There is no statistically significant effect for the 1988 to 1995 or 1996 to 1997 periods.

Overall, the models demonstrate high levels of statistical performance and reliability. Geographic areas evaluated for effects from information relating to contamination include the San Jose neighborhood as well as areas within varying distances of San Jose #6. Of these models, only Model 5 (1.5 mile linear distance model) identifies property value impacts from groundwater contamination. Specifically, Model 5 indicates that after controlling for other factors, homes within 1.5 miles of San Jose #6 decreased in value between 1988 and 1995. Because this time period is associated with increased public awareness of groundwater contamination, it appears reasonable to attribute these losses to contamination-related information. It is also possible that this effect may be caused by unaccounted airport noise. The Federal Aviation Administration currently relies on a 65 dB noise threshold for residential compatibility. However, there is growing pressure to define land-use compatibility criteria around airports based on the 60 dB DNL noise contour. The 60 db airport noise contours for Albuquerque International Airport from 1985 to 1995 are unavailable. However, the location of the 65 db contour indicates that the unavailable 60 db contour encompassed many properties within one and one-half miles of San Jose #6 between 1988 and 1995. The identified value diminution may be attributable to this specification difficulty. The smaller affected area of the

San Jose neighborhood specifications diminishes the likelihood of such specification difficulties. However, it also diminishes the sample of impacted properties. This tends to lower the likelihood that a statistically significant impact will be identified.

Conclusions

Residential properties that are located above contaminated groundwater cannot easily be distinguished from those that are not. In the South Valley area of Albuquerque, New Mexico, there was significant, recurring news coverage about groundwater contamination from an abandoned well. This paper has applied a technique to evaluate environmental impacts to residential properties attributable to groundwater quality.

Important features include specification of affected and control areas, timing of relevant information releases, and consideration of potentially confounding factors. Characterization of groundwater quality modeled local information regarding the timing, extent, and severity of contamination. Hedonic models that use the reference areas not directly adjacent to the affected area (see Model 2) provide a means for testing sensitivity to specification of the affected area. Results do not indicate a strong relationship between groundwater quality and property values. Designating a small, easily identifiable affected area provides a model that is more robust to specification difficulties arising from poor information or data constraints. However, this advantage comes at the expense of sample size, which tends to reduce the likelihood of identifying statistically significant impacts.

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