

# Estimating Proximate Property Damage From PCB Contamination in a Rural Market: A Multiple Techniques Approach

by Robert A. Simons, PhD

## abstract

Ideally, when there is an environmental condition that affects property values, there is sufficient sales data to estimate a regression model to determine losses to the real estate. In some cases, however, data on sales is not available due to inadequate record keeping or thin sales volume. In these cases damages still need to be assessed. What combination of next-best techniques can be used?

Multiple listing service (MLS) data can be helpful in providing trend data on sales by submarket and sale/list price analysis. Contingent valuation analysis of prospective buyers can also provide guidance.

# W

hen environmental damages occur, theory is available to guide the appraiser or real estate expert in determining the extent of damages to property values. The issue of measurement, however, can become difficult when information is hard to obtain. Ideally, when there is an environmental condition that affects property values, there is sufficient sales data to estimate a regression model to determine losses to the real estate. Sometimes though, data on sales is not available due to a lack of computerized record keeping on thin markets. In such cases damages still need to be assessed. This article addresses the question: What combination of next-best techniques can be used?

In addition to multiple listing service (MLS) data, evidence obtained from market participants can be helpful in providing trend data on sales by submarket. Sale/resale analysis, analysis of transaction rates, and sales/list price ratio analysis may also assist the analyst in forming an opinion. A type of market survey known as contingent valuation analysis (CVA) of prospective buyers can also provide guidance. While individually none of these techniques can provide conclusive evidence, together they can guide the analyst to a reasonable and supportable conclusion. In combination, the set of results can compel the reader to accept the conclusion that value loss has occurred.

The purpose of this research is to set forth a procedure for analyzing property value loss attributable to environmental contamination in real estate markets with limited data, a situation that is typical in many rural areas. A hierarchy of analytical techniques is presented, with an emphasis on using two or more moderately rigorous techniques instead of one strong one. Preferably the results are consistent (although not necessarily identical), allowing the analyst to reach a conclusion linking the offending source to the property value loss in a way that satisfies generally accepted tenets of causality. These tenets include having a

theoretical basis for expecting a value loss, observing that the polluting event occurred prior to the reduction in value, and holding other possible sources of value loss constant in the analysis.

The use of alternative analytical techniques is illustrated with a case study of environmental contamination in Anniston, Alabama. Polychlorinated biphenyls (PCBs), carcinogenic substances often found in transformer fluids and other selected industrial applications, had been manufactured in a plant run by the Monsanto Corporation for many years, and they had been released over several decades, both in the air and through surface water runoff. These releases and the storage of PCB-laden substances in an above-ground landfill, the company buyout of an adjacent neighborhood to extend the industrial property boundary (and avoid residential cleanup costs), and the presence of Environmental Protection Agency (EPA) maps meant that information about PCB contamination was well known. This matter led to litigation, and this study was prepared to determine damages to one property (a named plaintiff) in a group of properties within a mile east of the plant.

### **Brief Review of Environmental Damages Literature**

Proximity to or the presence of environmental disamenities such as petroleum damages, PCBs, and/or releases from industrial plants can readily be analyzed in the context of economic behavior. Economic theory tells us that, all else being equal, buyers would avoid purchasing a property believed to be contaminated or close to a dangerous facility because of potential health risks, difficulty in reselling the property, uncertainty, nuisance associated with environmental damages, potential for recurrence of the release, and stigma. Therefore, properties affected by environmental problems are expected to sell for a discounted price compared with clean properties. In some cases, transaction rates may also be affected. Problems may be considered so severe that no buyers would bid on such a contaminated property. In this case, the property would be considered to have

virtually no asset value and would be useful to the owner only as housing services, either for themselves or potential renters. If those services were accompanied by a severe health risk, the property would have almost no value at all, except to store such items as cars or boats.

The peer-reviewed literature contains numerous studies that quantify the effects of environmental contamination of various types on property values. Representative studies using hedonic regression analysis, which explains the components of sale price and is discussed in more detail later in this article, include Superfund sites, operating petroleum refineries, landfills, and pipeline ruptures.<sup>1</sup> These environmentally undesirable facilities have been shown to reduce the value of residential property one mile or more away from them, with negative effects being higher close to the undesirable land use. These studies are based on actual sales transactions. In particular, values of properties proximate to landfills have been shown to decline by up to about 10% when they are within one mile of a landfill. Regression analysis has also been used to study the effects of leaking underground storage tanks on property values.<sup>2</sup> Notably, there is no empirical evidence in the literature on the effects of PCB contamination on real property.

In theory, properties can experience a loss in value without being sold. In addition to the reduction in the sale prices of those properties that make it to the transaction stage, owners of property perceived to be threatened with contamination or actually contaminated may also experience difficulty in selling the property due to delayed or failed transactions. Potential buyers may also face difficulty in getting financing for contaminated property. The peer-reviewed literature indicates several ways that property owners experience a loss in value without a sale.<sup>3</sup> These include loss of commonly held property rights such as the right to enjoy and the ability to dispose of a property. This last item implies an unrealized capital loss because homeowners are unable to access capital tied up in their residential asset. Because of the present value of funds received, delay of sale is itself a modest loss. Finally, proper-

1. Patrick Flower and Wade Ragas, "The Effects of Refineries on Neighborhood Property Values," *Journal of Real Estate Research* (9:3, 1994): 319-338; Katherine Kiel, "Measuring the Effect of the Discovery and Cleaning of Identified Hazardous Waste Sites on House Values," *Land Economics* (November 1995): 428-435. J. Kohlhase, "The Impact of Toxic Waste Sites on Housing Values," *Journal of Urban Economics* (30, 1991): 1-26. Arthur Nelson, J. Genereux, and M. Genereux, "House Price Effects of Landfills," *Land Economics* (68: 4): 359-365; Alan Reichert, "The Persistence of Contamination Effects: A Superfund Site Revisited," *The Appraisal Journal* (July 1999): 126-135; Robert A. Simons, "The Effects of Oil Pipeline Ruptures on Non-Contaminated Easement-Holding Property," *The Appraisal Journal* (July 1999): 255-263; and Robert A. Simons, Kimberly Winson-Geideman, and Brian Mikelbank, "The Effects of an Oil Pipeline Rupture on Single Family House Prices," *The Appraisal Journal* (October 2001): 410-418.
2. Robert A. Simons, William Bowen, and Arthur Sementelli, "The Effect of Leaking Underground Storage Tanks on Residential Sales Price," *Journal of Real Estate Research* (14: 1/2 1997): 29-43; and Robert A. Simons, William Bowen, and Arthur Sementelli, "The Price and Liquidity Effects of UST Leaks from Gas Stations on Adjacent Contaminated Property," *The Appraisal Journal* (April 1999): 186-194.
3. Robert A. Simons, Bowen and Sementelli, April 1999, *Ibid.*

ties believed to be contaminated because they are in proximity to contaminated property, or have not had environmental tests performed, or for other reasons may experience stigma, especially before they are remediated. The price reduction can be exacerbated if contamination is not well documented if there is a large amount of adverse publicity, or, if the responsible parties have not offered to indemnify impacted parties.<sup>4</sup>

While it is widely acknowledged that the value discount for contaminated property can be substantial, there is no available direct evidence in the peer-review literature of the effect of PCBs on property value. Therefore, it is best to rely on a more general market survey study of contaminative sources and property values. Such a study was conducted by Paul Syms in the United Kingdom. It found that contamination from high-hazard substances would reduce property values by 58% prior to remediation, declining to 15% postremediation. Losses from very high-hazard substances would be 90% preremediation, and 54% postremediation.<sup>5</sup> PCBs and some of the other compounds that appear to have been released into the environment would be considered hazardous substances, and the discount that real estate participants place on properties affected by them in the marketplace can be expected to fall within the ranges described above.

Potential for a future occurrence, in and of itself, can have a negative effect on property value. In a study evaluating the effects of a 1993 pipeline rupture in Reston, Virginia, on noncontaminated, easement-holding residential property in Fairfax County, it was found that properties within two miles of the pipeline rupture sold for about 5% less than comparable properties off the pipeline.<sup>6</sup> Other residential property farther away but in the same county sold for about 2% less. These losses were due primarily to the potential for a recurrence of the contaminating event. This experience is relevant to the case study example because of the history of repeated releases from the Monsanto facility coupled with the fact that the plant remains open and continues to operate.

### **Ideal Data Collection and Analysis**

Ideally, hedonic regression provides the best quality results in determining the effects of environmental contamination on property values. Hedonic regression is a

form of multiple regression analysis that is a popular and well-accepted technique that has been widely discussed in the literature. (See earlier citations.) It always provides a measure of sale price (the dependent variable) explained by its component parts of value (i.e., unit, lot, and neighborhood characteristics and other independent variables). The unit of analysis is the individual sale. If done correctly, hedonic regression and closely related techniques can provide evidence supportive of a causal relationship between contamination and property value diminution. Causality requires three main components. The first is a theoretical basis for expecting an effect (people consider contamination a "bad" thing and either avoid the property or offer a discounted bid). The second is a pretemporal relationship between the contamination and the property value effects (the contamination predates the loss in value). The third factor is that other alternative explanations of property value reduction are controlled for (e.g., ideally in a statistical model). This third factor is generally the hardest to attain. Hedonic regression does this better than other techniques because other variables can be statistically controlled for in the model, as opposed to being assumed to have no effect.

However, data collection for hedonic regression analysis is demanding. In general, the analyst needs about 10 observations per independent variable. If, for example, 30 independent variables were used, at least 300 sales observations with complete data in the data set would be needed. If a model were constructed with fewer independent variables, then fewer sales might be needed. Although the actual number of impacted sales and overall sales is a function of the quality of the data and particulars of the case, it has been the author's experience that the analyst would need a minimum of several hundred unaffected sales of the same land use type in the county or market area where the event occurred. Further, a minimum of 15 or more sales affected by the contamination is also desirable. In cases where the environmental effect is strong and pronounced, the analyst can sometimes use fewer contaminated sales, but findings of statistical significance are then typically hard to obtain. The irony is that often knowledge of a contamination event can reduce sales, making it harder to get enough sales to use this technique.

However, not all market areas have enough sales data of sufficiently good quality to conduct regres-

4. Richard Roddewig, "Classifying the Level of Risk and Stigma Affecting Contaminated Property," *The Appraisal Journal* (January 1999): 98-102.

5. Paul Syms, "Perceptions of Risk in the Valuation of Contaminate Land," *Journal of Property, Valuation and Investment* (UK, 15: 1): 27-39. See table on page 32.

6. Simons. July 1999, *Ibid.*

sion analysis. The information needed generally includes sale amount and date; building square footage; lot size; number of bedrooms, bathrooms, and fireplaces; garage capacity; building quality and age; etc. Usually this data is available from the county property tax assessor, or through a data vendor that bases the information on the county assessor data. To these property attributes can be added neighborhood variables such as median income in the census tract, or other factors typically from U.S. Census sources. Missing data can be problematic, as these observations must be discarded or missing fields must be filled with estimated values. Most urban areas have enough good quality data for regression analysis; some urban areas and many rural areas do not. Holding aside the issue of a sufficient number of sales, missing fields can often render the data unusable for regression analysis.

### **Next-Best Options**

#### **Best Available Data (BAD data)**

Given insufficient and incomplete sales data, what can the analyst do? Get the best available data (BAD). BAD data is good. This data might include statistical techniques familiar to REALTORS® and appraisers such as market area trend analysis, considering evidence obtained from market participants, use of list/sale price ratios, sale/resale analysis, and market surveys of potential buyers. These techniques should be used in combination to ensure results are consistent. Not all these techniques are based on revealed preferences (sale price). Some focus on both sides of the market: market trends analysis and sale/resale analysis. Others address only the seller side of the market (sale/list price ratios), or the buyer side of the market (e.g., the market survey technique of contingent valuation analysis, or CVA). Each technique has strengths and weaknesses that are addressed in the following paragraphs.

#### **Market Area Trend Analysis**

Market area trend analysis is a technique that studies the neighborhood where the contamination occurs and compares some measure of average appreciation rates and/or sales volume to a larger market or to another similar, but uncontaminated market area. The positive side of this technique is that there is almost always data available in some form and that sales trends over time may be available. The analysis is based on sale price, which is a revealed preference. Because this technique uses REALTORS® MLS data, it is virtually assured that transactions are fair sales. The main

validity threat from this technique is aggregation bias (the masking of effects by a larger data analysis unit) because the unit of analysis is the affected area or submarket, not the individual sale. Also, defining the area affected by contamination as part of a larger market involves some judgment and is usually limited by some arbitrary submarket area definition. Any average sale figures are also subject to anomalies (outliers, large lots, etc.) and therefore may need to be adjusted. Some markets may also experience a small number of sales, thus making use of averages and other statistics that measure central tendency somewhat tenuous. Under these circumstances it is not typical to test means for statistical significance. However, it may be desirable to do so, especially if this is the most rigorous technique available to the researcher, and if the case is being prepared for litigation. The main problem with this technique is that it does not hold all other potential determinants of sale price constant, so it needs to be used in conjunction with other techniques.

As a practical matter, the analyst's challenge is finding the appropriate measure (e.g., average sale price), and holding constant other factors that may affect property values (e.g., employment trends, other sources of contamination). Adjustments also need to be made for the effects of time, appreciation, and inflation. The correct way to measure loss is to compare the affected area's average property price with the average property price in the control area or larger market area. This should be determined for the before and after dates. The percent difference, if it can be attributed to the contamination source(s), is the loss in value. Results should be compounded over time from the baseline period (the release event or statute of limitations) forward to the current period.

#### **Sale/Resale Analysis**

Sale/resale analysis (sometimes called paired sale analysis) is another technique that requires one property to be sold twice, with the environmental event occurring during the period between the sales. The analyst must also control for physical changes to the property (e.g., new square footage) and for inflationary changes over time. As a practical matter, very few properties meet this technique's criteria. For example, it might not be possible to obtain information on sales for environmental releases over a long period of time that took place before the contamination was initiated. Further, statistical significance is usually hard to establish due to small sample size.<sup>7</sup>

7. Simons, Bowen and Sementelli, April 1999, *Ibid.*

### Transaction Rates Analysis

It is not unusual for environmental contamination to reduce or delay the number of property sales in an affected area. This phenomenon makes it more difficult to gather sales for hedonic regression analysis. Reduced transaction activity may apply to long-term, sustained contamination situations and also to short-term events following an abrupt release of contaminants. In these cases, the environmental situation may cause a reduction in the number of sales in a given period. This delay in sales is a form of property value loss because of the present value of money. There is also an associated loss of liquidity whereby the owner is unable to access capital tied up in real property. A good measure of reduced sales activity is to compare transaction rates between affected (case) and unaffected (control group) properties, either from MLS data or county tax records. Difference of means tests or a similar technique can be applied in many cases to generate a statement concerning the statistical significance of the results.

Another measure of delayed transaction rates is to examine the average number of days on the market from MLS records for both environmentally compromised properties and a control group of properties unaffected by contamination. This data is often complex to use correctly because listing contracts expire and then are reinstated later, sometimes with other companies. Even harder to obtain is data concerning sales that fell through during the negotiation phase or mortgage defaults. Thus, the potential for error is moderate. Nevertheless, in the absence of other information, the average number of days on the market can be another tool in estimating the property-related effects of contamination.

### Sale/List Price Analysis

When availability of data is sparse, sale/list price analysis may be a helpful tool. This technique uses only MLS data and cannot be applied to for-sale-by-owner properties. Also, there is very little about this technique that has been published in peer-reviewed journals, especially in the context of environmental contamination cases. The analyst should look at the final sale price of a property and also at its original listing price. The ratio of these two figures reflects the discount from the original price, in percent. This discount might vary by market area

and might also experience annual fluctuation cycles. A typical example would be a sale price of \$93,000 on an original list price of \$100,000, for a sale/list price ratio of 0.93. In theory, sellers of property perceived to be contaminated may often not know or not acknowledge this fact or how it would affect sale price. Contaminated sites should have a deeper discount, a reality check on how sellers behave when confronted with reluctant buyers. The uncontaminated properties should have a smaller discount. The difference between prices paid for properties in contaminated areas and those paid for properties in uncontaminated areas is the additional discount. This is a seller-based data point. The concern regarding statistical significance mentioned above also pertains to this technique.

### Market Surveys of Potential Buyers Using Contingent Valuation Analysis (CVA)

The techniques discussed so far are either revealed preferences (arm's-length, market clearing sales) or measures of seller-side issues, such as the sale/list price ratio. Purely buyer-side data on preferences regarding property attributes and characteristics has not yet been addressed. This type of information is usually easy to obtain, but it does require primary data collection because it is not found in the public records. It also reflects stated preferences (e.g., prospective buyers state what they would do, not what they have actually done). Thus, using common statistics like averages may be systematically different from revealed outcomes, and the difference may not be random.

Contingent valuation analysis (CVA) is a form of market buyer survey. It asks what buyers would do under certain specific circumstances and asks them to price features or characteristics of housing (or other) land use types. A brief overview of CVA in the context of formal research methods in appraisal is available.<sup>8</sup> Two articles pertaining to CVA and its use in real estate contamination cases have been published recently in *The Appraisal Journal* and *Journal of Real Estate Practice and Education*.<sup>9</sup> These articles describe key pitfalls to be avoided in implementing CVA and several alternative forms of the survey. In general, CVA surveys should be as explicit as possible and non-biased with respect to steering the respondent toward one outcome or another. More traditional and recent

8. Marcus T. Allen and Grant Austin, "The Role of Formal Survey Research Methods in the Appraisal Body of Knowledge," *The Appraisal Journal* (October 2001): 394-399.

9. David G. McLean and Bill Mundy, "Addition of Contingent Valuation and Conjoint Analysis to the Required Body of Knowledge for the Estimation of Environmental Damages to Real Property," *Journal of Real Estate Practice and Education* (1: 1): 1-19; and Bill Mundy and David McLean, "Using the Contingent Value Approach for Natural Resource and Environmental Damage Applications," *The Appraisal Journal* (July, 1998): 290-297.

applications of CVA pertain to willingness to pay for goods that cannot easily be priced such as the value of forgone benefits derived from being unable to visit polluted recreational sites.

Market surveys of buyer intentions with complete information with a random or stratified random sample should be intended to replicate buyer intentions in the market area. Telephone calls are often the way data is collected, although focus groups have also been used. The approach is to ask general questions about homeownership decisions, and the price respondents might pay for an uncontaminated house. The interviewer then goes into several detailed scenarios of contamination and asks for bid prices. The survey concludes with a demographic section. If the survey is done properly the respondent will not know the focus of the survey. Because not all respondents will bid, the CVA gives an estimate of decrease in market demand. Also, the ratio of bid prices to the prices the respondents indicated they would pay for uncontaminated houses provides the discount for the contamination.

Because some bids are of the “bottomfisher” variety, they would be of little value to a seller of a contaminated property. Bids near the top of the market (nearing full value), on the other hand, would get the attention of the seller. In other words, the marginal buyer at the top of the market would win the bid. Looking at the percentage who bid at all and also at the discounted percentages gives a buyer-side estimate of the market with complete information. Usually, this discount would be larger than for a revealed preference (regression-type) study because the bids are prenegotiation and have complete information, which is not always the case in housing market transactions. In other words, CVA has value to the analyst, but property value discount outcomes typically need to be adjusted downward from the average figures. Benchmarking CVA to regression or other revealed outcome studies is one approach that would be a fruitful area for future research.

### **Reconciliation of Loss Estimates**

Finally, there is the reconciliation aspect of the study with the determination of diminution of value. Unlike the appraiser with the three approaches to value, a real estate economist need not choose one dominant approach and has more flexibility. Also, a real estate economist may not necessarily talk directly to market participants (although in some cases using this information might also be a corroborative technique) but may glean results from secondary data and mar-

ket outcomes. In fact, in some cases, direct communication with market participants can be upsetting to the respondents, or the respondents' best interests may be served by obfuscating factually accurate details.

Regression analysis generates a high level of support for the three pillars of causality (theory, pretemporal occurrence, and holding alternative reasons constant), because it holds many important variables in the analysis constant. However, most other techniques cannot individually satisfy all three conditions. This is primarily because they compare mean values (i.e., average sale prices for both impacted and nonimpacted groups), which do not necessarily hold constant other factors that may contribute to value loss and result in a lower sale price. The validity of the results of these techniques can be strengthened if the different means are compared statistically (i.e., with a difference of means test or another technique), if appropriate. Still, the opinion is best supported if several different techniques generate similar findings. It is not expected that all techniques give the same result. In fact they would not be expected to produce similar results if different parts of the market (e.g., buyer's side, seller's side, market clearing sale) are being evaluated. If this occurs, the analyst can compare the techniques and take a reasonable measure of centrality among the property loss estimates.

### **Case Study of Anniston, Alabama**

The example provided below shows how this multi-technique approach was used in a PCB contamination case in Alabama.

#### **Background Information**

Anniston, Alabama, is the seat of Calhoun County (population about 125,000), and is located roughly halfway between Birmingham, Alabama, and Atlanta, Georgia. It is one of very few places in the U.S. where PCBs were manufactured and where the Monsanto plant had been making them for decades. The site currently occupies about 50 acres, plus an above-ground landfill storage of PCBs. The Monsanto plant has stopped producing PCBs but is still open and now produces precursors to pesticides.

Information about the PCB contamination in Anniston has been widely publicized in the local press and in Environmental Protection Agency (EPA) reports for about 10 years. Extensive contamination testing data is also available. These studies show that PCBs have traveled off site in the air and by surface water. The neighborhood just east of the plant, the subject neighborhood, used to contain

about 80 homes and was largely acquired by a company related to the Monsanto plant over the past five years. The baseline period for analysis is 1994–1995, when publicity about the PCB releases from the plant became most intense and just before the firm's property purchase program was initiated.

The assignment was to evaluate the effect of continued releases from the plant on both a single subject property at the edge of the buyout area and also on its surrounding neighborhood just east of the plant. The street the subject property is located on overlooks a small park and has the potential to be quite pleasant. Fenced-off areas extend up to the block of the subject property, including up to the backyard of the subject. Several commercial businesses in the neighborhood were also fenced off and abandoned. The house adjacent to the subject prop-

erty was abandoned and other signs of blight were evident on the subject's street. The area appeared to be suffering from substantial lack of updating and investment. The subject property is one of about 35 PCB soil sampling sites. The subject property showed 13.7 mg/kg of PCBs, the highest category and over the EPA action limit of 10.0mg/kg.<sup>10</sup> Other sites in the area were also sampled, and many showed the presence of PCBs. Public documents containing these facts would be available to potential real estate market participants.

### Real Estate Market Trends Analysis

MLS data from Calhoun County from 1991–2000, inclusive, were used in this analysis and are presented in Table 1 and Figure 1. The focus is on the West Anniston submarket, which contains the Monsanto

**Table 1 Housing Trends in Metropolitan Anniston, Alabama**

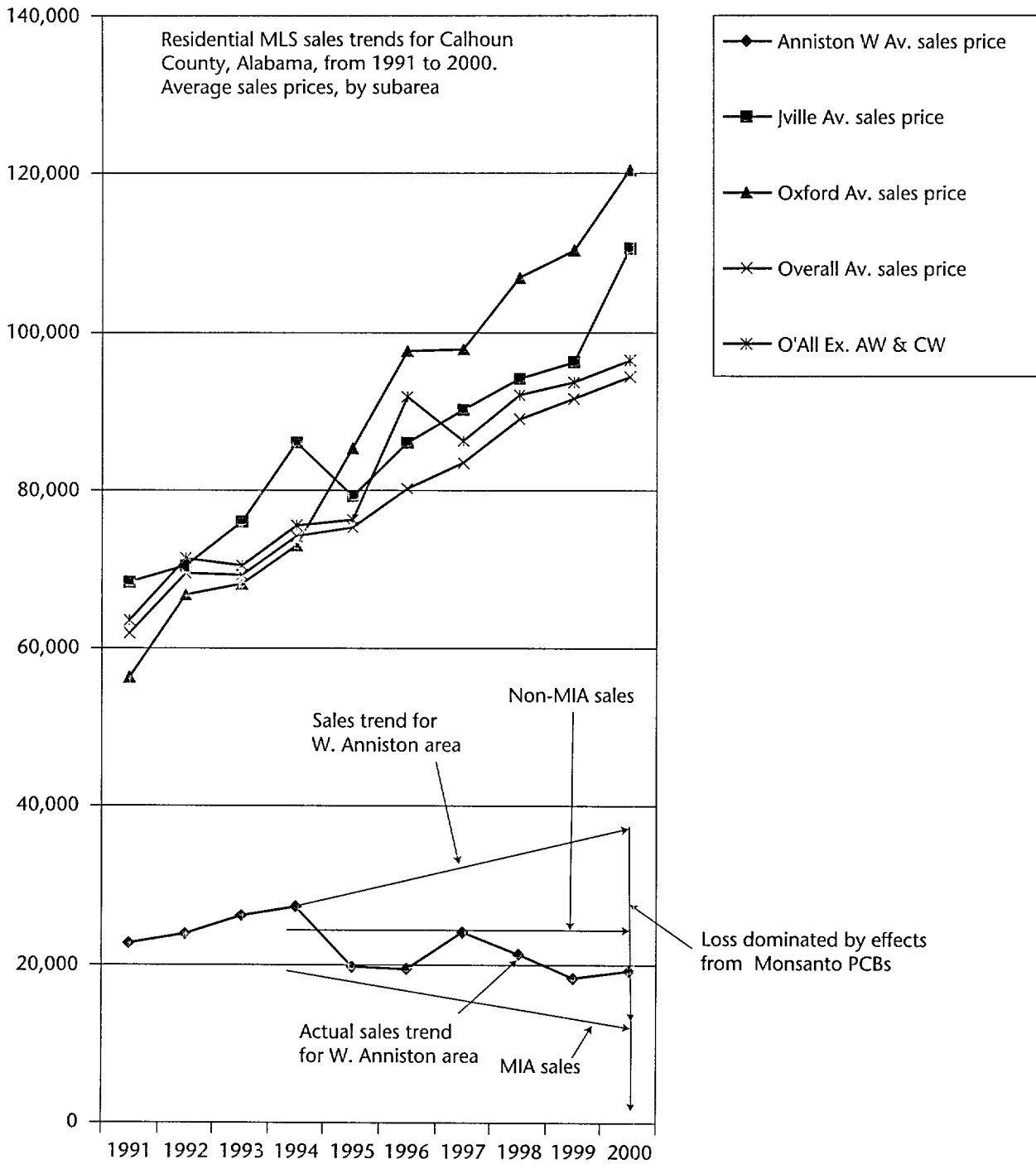
#### Housing Market Analysis Metro Anniston, Alabama

Year	Total # Sold	Sold Volume	% Change	Av. Sale Price	% Change	Med. Sold Price	% Change	Average Days on Market
1991	556	\$34,411,170		\$61,891		\$55,650		140
1992	765	\$53,172,064	54.52%	\$69,506	12.30%	\$63,500	14.11%	147
1993	801	\$55,560,599	4.49%	\$69,364	-0.20%	\$65,000	2.36%	149
1994	869	\$64,436,490	15.98%	\$74,150	6.90%	\$67,000	3.08%	162
1995	792	\$59,593,703	-7.52%	\$75,245	1.48%	\$65,500	-2.24%	183
1996	814	\$71,277,207	19.61%	\$80,087	6.43%	\$70,800	8.09%	147
1997	827	\$69,098,614	-3.06%	\$83,553	4.33%	\$73,500	3.81%	135
1998	940	\$83,656,562	21.07%	\$88,996	6.51%	\$78,000	6.12%	140
1999	1032	\$94,420,471	12.87%	\$91,493	2.81%	\$78,950	1.22%	140
2000	1059	\$99,933,640	5.84%	\$94,360	3.13%	NA	NA	145
<b>West Anniston</b>								
1991	17	\$386,501		\$22,735		\$20,000		150
1992	23	\$550,058	42.32%	\$23,916	5.19%	\$22,000	10.00%	128
1993	17	\$443,695	-19.34%	\$26,100	9.13%	\$24,000	9.09%	200
1994	16	\$437,169	-1.47%	\$27,323	4.69%	\$22,750	-5.21%	187
1995	15	\$296,019	-32.29%	\$19,735	-27.77%	\$19,900	-12.53%	220
1996	29	\$565,900	91.17%	\$19,514	-1.12%	\$17,900	-10.05%	173
1997	16	\$385,092	-31.95%	\$24,068	23.34%	\$24,400	36.31%	177
1998	19	\$406,761	5.63%	\$21,408	-11.05%	\$25,000	2.46%	140
1999	24	\$439,272	7.99%	\$18,303	-14.50%	\$17,873	-28.51%	162
2000	33	\$636,585	44.92%	\$19,290	5.39%	NA	NA	145
<b>Averages</b>		<b>1994</b>	<b>2000</b>	<b>Change</b>	<b>Loss/Gain/1994 Base</b>	<b>Loss/Gain/2000 Base</b>		
Overall		\$74,150	\$94,360	\$20,210	27%	21%		
WA actual		\$27,323	\$19,290	-\$8,033	-29%	-42%		
WA trend		\$27,323	\$34,770	-\$15,480	-57%	-45%		
<b>Averages</b>		<b>1994</b>	<b>1999/2000</b>	<b>Change</b>	<b>Loss/Gain/1994/1995</b>	<b>Loss/Gain/2000 Base</b>		
Within MIA		\$19,540	\$9,468	-\$10,072	-52%	-106%		
Outside MIA		\$23,804	\$23,078	-\$726	-3%	-3%		
Ratio: in MIA/outside		82%		41%	-50%			

Source: MLS, RS&A, Inc.

10. United States Environmental Protection Agency. *SESD Surface Soil Sampling* (1998). Project number 99-0547. Solutia, Inc., Anniston, Alabama, Figure 1: Map of Sample Locations and Test Results.

**Figure 1 Residential Trends for the West Anniston Market**





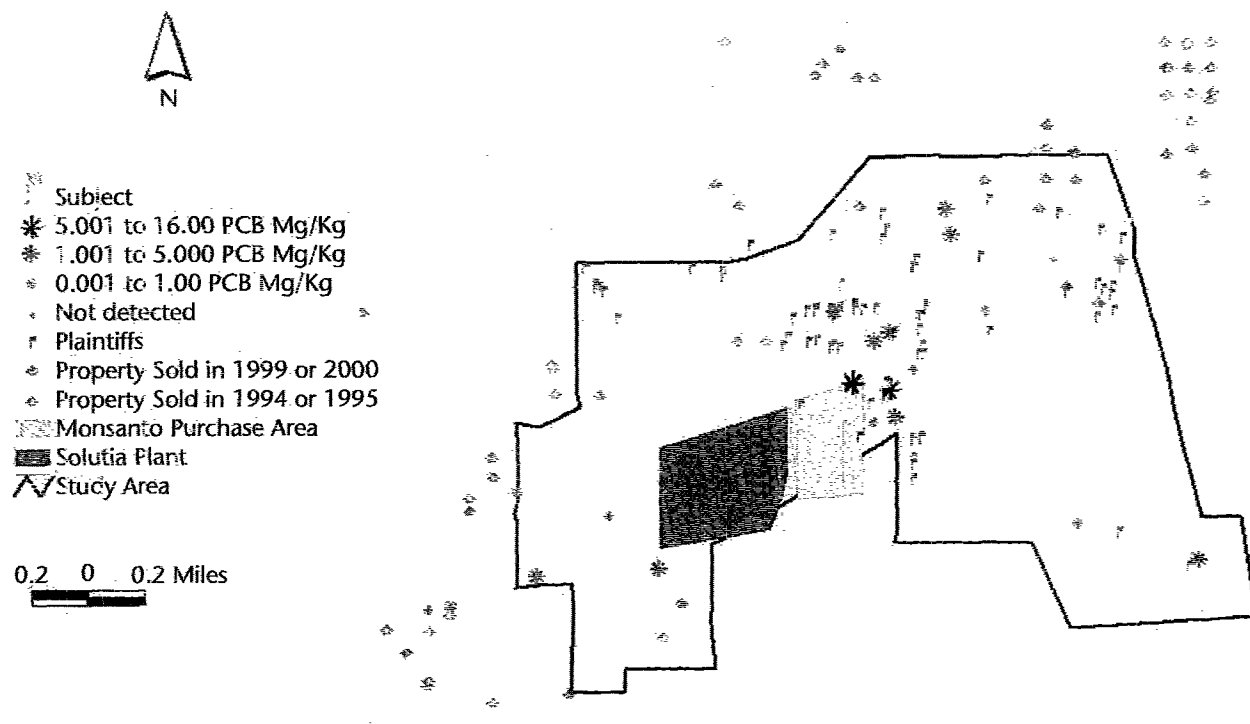
plant and the subject property. This area is compared to the overall county market. The Monsanto plant is the polluting site closest to the subject property. With the publicity and purchase program, it exerts most of the downward price pressure on sales in the West Anniston submarket. Between 1994 (a baseline year) and 2000, the overall Calhoun County average residential sale price went up from \$74,150 to \$94,360, an increase of slightly more than \$20,200, or 27%. Over the same period, the West Anniston submarket's average residential sale price went down, from \$27,300 to \$19,300, a decrease of \$8,000, or 29%. If the West Anniston submarket had appreciated in the same trend as the overall Calhoun County market since 1994, the average West Anniston property would have been worth \$34,800 in 2000. This is equivalent to using the market appreciation rate to take the 1994 base year to current (Year 2000) dollars. The total decrease since 1994, considering appreciation in the overall Calhoun County market, less the average sale price in 2000, was \$15,500, a loss of 45% in the West Anniston submarket. Figure 1 shows this same information as well as how the loss figures were calculated.

The next step was to define an area of influence within the West Anniston submarket, which was directly related to the polluting entity. This is referred to as the Monsanto Impact Area (MIA). To gauge change over time, sales in a baseline period were compared to sales in a recent period, and the change in value was then further compared to West Anniston submarket trends. Figure 2 shows a map of the study area and key features of the analysis.

In 1994 and 1995, five sales took place in the areas surrounding the residences of the potential plaintiffs' neighborhood and proximate to the Monsanto plant. All of the sales were near the subject property. Their average sale price was \$19,500. During the same two-year period, there were 41 sales in West Anniston outside the impact area, and their average sale price was \$23,800. Thus, in 1994 and 1995, the average sale price within the MIA was 82% of the average sale price of the transactions in West Anniston outside the impact area.

By 1999 and 2000, 11 sales took place inside the MIA proximate to the plant, generally near the perimeter of the plaintiffs' area. The average sale price of these sales was about \$9,400. During the same period there were 54 nonimpacted property sales in

**Figure 2 Comparison of 1994-1995 and 1999-2000 Sales in Monsanto Impact Area, Anniston, Alabama**



West Anniston, and their average price was \$23,100. Thus, in 1999 and 2000, the average sale price within the MIA had dropped to 41% of the average sale price of the transactions in West Anniston outside the impact area, a drop of 50%.

In other words, the local effects attributable to the Monsanto plant account for a drop in relative sale price that was 50% above and beyond the drop in the West Anniston/Calhoun County price reduction (the reduction from 82%–41%). Therefore, the estimated overall loss to properties in the West Anniston submarket inside the neighborhood populated by affected parties (the plaintiffs) impacted by the Monsanto Plant is 67.5% (a loss of 45%, plus a loss of half of 45% [22.5%] equals an overall loss of 67.5%). Because this figure is based in part on a lower appreciation rate in the overall West Anniston area (not all of which is attributable to the Monsanto plant), adjustments still need to be made for alternative sources of contamination or market factors.

The loss should be calculated from the baseline period of 1994. In order to convert the loss percentage to current dollars, the effect of other polluting entities needs to be accounted for. Examination of the area and environmental records shows that there are two or three other potential sources of pollution that may have had an indirect effect on property values in the MIA. Their effect was indirect because prevailing wind and water patterns indicate that any pollution from these sites would not carry into the impact area itself, but they could have some depressing effect on the West Anniston submarket. In other words, typical of the market trends technique, not all other factors are held constant in this study. To compensate for these alternative factors and be conservative, the loss estimate is reduced from 67.5% to 60%. Using data based on real estate market trends, adjusted for the passage of time from the base year and for local blighting effects, and netting out potentially depressing effects on the West Anniston submarket from other sources, the conclusion is that a property in this neighborhood had sustained a loss of 60% and that this decrease was attributable to the effects of the Monsanto plant.<sup>11</sup>

The subject property is on the edge of the Monsanto plant property buyout zone. Because it is adjacent to the purchase area, the subject property would be even more impacted by the purchase program. Moreover, the subject property had confirmed

PCB contamination at levels in excess of those considered safe for residential use. Therefore, the conclusion about the extent of the loss for the subject property would be a total of 90% of value.

Analysis of transaction rates and marketing time of property sales (Days on Market) was also accomplished using the MLS database. The relative days on market for the West Anniston submarket increased slightly faster than the market as a whole from the 1991–1994 period to the 1995–2000 period. The number of transactions (using the ratio of West Anniston/total Calhoun County market) also decreased slightly. Both results are consistent with theory. Despite the fact that neither of these indicators provided compelling evidence, their results were supportive of the overall conclusions.

### **Sale/List Price Ratio Analysis**

For this sale/list price ratio analysis, for-sale-by-owner transactions that had no list price information could not be used. Large-lot anomalous transactions where the sale/list price ratio was unexplainably large (i.e., well above 1.3) were excluded.

The ratios of sale prices to list prices of MLS transactions within the impact area and their average price compared with the rest of West Anniston were analyzed. In a typical market, this ratio is more than 0.85; in tight markets it is often higher, with just a few points off full value. A relatively low ratio indicates that houses sold for a substantial amount lower than list price. When this happens, sellers do not have an accurate view of what their houses are worth; therefore, they are less likely to accept an offer at the property's discounted market value. This is evident in environmental contamination cases.

The sale/list price ratio for the balance of West Anniston (excluding the Monsanto impact area) and within the Monsanto impact area for the 1994–1995 period and for 1999–2000 was examined. The years were combined in order to get the number of transactions up so averages could be used more readily. In 1994–1995, there were five sales and the average sale/list price ratio was 0.88. Moreover, 80% of these sales were within 15% of the list price (i.e., the s/l ratio was 0.85 or higher). This is very similar in percent to the rest of West Anniston, where the average sale/list price ratio in the same period was 0.89, and 63% sold within 15% of the list price. Thus, in the baseline period, the sale/list price percentages were quite similar.

11. An alternative way to calculate this directly would be to take the 1999/2000 sale price of \$9,400 for MIA properties and divide it by the MIA projected 2000 value, based on the county appreciation trend of \$24,800. The remaining value is 38.2% of what it should have been absent the Monsanto plant. The resulting loss percentage is 61.8%, which closely approximates the 60% figure.

The next analysis considered the sale/list price ratio for the balance of West Anniston and within the impact area for 1999–2000, after the impacts of the Monsanto situation became fully understood. In 1999 and 2000, there were eight sales with useable ratios, and the average sale/list price ratio in the impact area was markedly lower at 0.70. Moreover, none of these sales were within 15% of the list price. This contrasts strongly with the percentages in the rest of West Anniston where the average sale/list price ratio in 1999 and 2000 was 0.88, and 66% sold within 15% of the list price, nearly unchanged from the baseline period.

This new information underscores the difference between the Monsanto impact area and the balance of the West Anniston submarket. It further demonstrates that sellers within the impact area may have unrealistically high expectations of the market value of their homes. This information ties directly to the potential buyer survey discussed below.

### The Potential Buyer Market Survey (CVA) for This Case

A list of several thousand names of homeowners was bought from a vendor. The list contained names, telephone numbers, income codes, and addresses. Calls were made to residents of Calhoun County and to residents in other counties as control areas. We avoided calling persons in the ZIP code where the plant is located. Names were called at random until a homeowner who would participate in the brief survey was contacted. The total number of respondents in the sample was 143, including 21% African Americans. The characteristics of the sample closely reflect the profile of Calhoun County on key factors such as race and average house price.

The survey instrument contains a baseline case to establish value and four scenarios with potential environmental or nuisance-related disamenities. The fourth scenario relates to PCBs in this case. With respect to the disamenities, the respondents were asked if they would make a bid on the property, and if so how much. The survey instrument is quite detailed and avoids key pitfalls described in Mundy and McLean's contingent valuation articles.<sup>12</sup> The instrument also does not specifically guide the respondent to PCBs, but nests the issue in a broader context.

### CVA Survey Results

Two factors are of key importance in evaluating the results. The first is the portion of respondents that

would bid on a scenario. The ratio of no bid to total reflects the loss of market demand. The second factor pertains to value loss on sale. Of those that bid, the ratio of maximum bid to baseline case reflects the percentage they would pay. One minus this percentage reflects the discount. For example, if the person's baseline price was \$100,000 and the maximum they would bid is \$40,000, a 60% discount is reflected.

The first part of the survey sets the stage and makes the respondent comfortable with the bidding scale. It also determines the average price of a property they are looking for in the context of a job move. The average value in this study is \$93,400, very close to the average for Calhoun County MLS sales of \$94,300. All but one of the 143 respondents provided a value. When asked which scenario they were most likely to bid on, not one respondent said the PCB scenario.

The other scenarios included a business park located a block away from the property, an adjacent leaking underground storage tank with groundwater contamination, and an active railroad track located right behind the home. Between 10% and 66% of respondents bid on these other scenarios, but for the sake of brevity the details are not belabored here.

### The PCB Scenario

The fourth scenario determined the discount related to a PCB scenario:

The house is located about three blocks from a factory that used to manufacture PCBs (polychlorinated biphenyls, an industrial compound that is regulated by the Environmental Protection Agency). The factory is still open and currently manufactures pesticides. For over 30 years, the factory put byproducts from its operations into a landfill. Over time, the chemicals have gotten into the water table and traveled over one mile away. The PCBs have been found in the bodies of local fish. The plant has also emitted PCBs into the air. Testing by the state environmental authority shows that *levels of PCBs and pesticides above those considered safe for residential use* are found at several locations near the plant, *including in the soils on the property you are considering buying*. The company has also been buying up some of the houses in the neighborhood a block or two away. Operators of the plants have attempted to reduce the frequency of new instances of these problems, and evidence suggests that they have probably been successful. Except for this factory, the rest of the neighborhood is like yours, and the house is very similar to your house.<sup>13</sup> [Emphasis added.]

12. Mundy and McLean, 1998, *Ibid.*

13. Robert Simons & Associates, Inc. *Owens v. Monsanto* case, expert report, 2001.

The italicized portion of the preceding paragraph reflects the characterization of contamination found on the subject property. A substantial subset of the sample (just over 60 respondents) had a slightly different characterization of this italicized clause, stating that “the property under consideration had not been tested.” The bidding issue was determined by the question, “Using the scale below, where -3 means you definitely would not bid and +3 means you would, how likely is it that you would make any offer on this house?”

Only 4.9% of respondents (seven total) bid on either PCB scenario. In other words, 95% of the respondents did not bid. Four bids were offered for property with soils testing for PCBs (5.0%), and three bids were for untested soils (4.7%). The bid percentages were almost identical for the two groups. Respondents with below-average house price values had a very similar bid percentage. This implies that the market treats tested and untested properties in this context as essentially the same and reflects an almost complete loss in the market demand for this type of property.

Of those that bid (their score above was generally not -3) the question, “What is the most you would be willing to pay for the house?” was asked. Only seven bids were received out of 143 respondents asked. Of the seven bids, the average base price was \$82,900. The prices offered were discounted by between 20% and 83% of full value. The average loss for the PCB property described above was 53%, whereas the average loss among the “top” half of the market was smaller, at 35%. The discounted bid results for contaminated soils, untested soils, and lower-than-average property values were all about the same, between 52% and 55%. In some other situations with a substantially higher bid percentage, the analyst could look at the top portion of the market to search for typical behavior of the marginal buyer. In this case the market has become so constricted that, due to search costs and the very small number of bidders, the chances are that none of the potential bidders would find the subject property and place a bid. If this unlikely event were to occur, the seller would still have to accept a very deeply discounted bid, which is also very unlikely. Therefore, the resulting conclusion is that the property is almost valueless for residential use, leaving only a token value of 5% (such as for short-term storage).

### Reconciliation of the Analyses

To summarize, the market trends approach showed that properties in the areas directly impacted by the

plant were reduced in value by 60% and that this reduction was attributable to the effects of the plant. Sale/list price ratio analysis showed different results within the impact area: a ratio of 0.7 within the MIA compared with almost 0.9 elsewhere in West Anniston, but outside the MIA. This showed sellers had a somewhat unrealistic idea of what their properties were worth at the time of original listing. Given the context, this can be attributed to the contamination. Not one of the eight sales in 1999 and 2000 in the Monsanto impact area sold for within 15% of its original list price, and the average discount was almost 30% over the seller's original seller list price. Using the CVA, the buyer's side of the market was down 95%, in part due to the high concentration of PCBs on the subject's soils. Overall, conclusion of the subject property's value loss was 90%. This figure is less than the 95% estimate from the CVA, but larger than the 60% reduction indicated by market trends. The market trends data does not show local factors such as proximity to the plant's property purchase program and associated blight, which were considered in raising the total loss to 90%.

### Conclusion and Implications for Appraisers

Ideally, when there is an environmental condition that affects property values, there is sufficient sales data to estimate a hedonic regression model to determine losses to the real estate. In some cases, however, data on sales is not available because of inadequate record keeping and/or thin sales volume. This situation can often be exacerbated by the environmental event. When sufficient sales are not available, as in the Anniston, Alabama, case, a combination of next-best techniques can be used. The findings from these techniques in combination can be used to support an inference of causality linking the polluting entity to property value loss.

Market trends analysis based on MLS data were helpful in providing trend data on sales by submarket, and sale/list price ratio analysis confirmed that sellers in the affected area discounted their properties deeper than those sellers in unaffected areas. Contingent valuation analysis of prospective buyers also provided guidance. Only about 5% of the prospective buyers with full information would bid on a plausible and accurate scenario describing the conditions in this market, and those few bids were heavily discounted.

While individually none of these techniques would provide conclusive evidence, in combination

they guided the analyst to a reasonable and supportable conclusion. In this case, losses were estimated at more than 90%, and the techniques applied provided consistent results.

Appraisers should be diligent in using several techniques, such as hedonic regression analysis, market trends analysis, sale/list price ratio analysis, transaction rates analysis, analysis of evidence presented by market participants, sale/resale analysis, contingent valuation of prospective buyers and possibly other real estate research techniques to generate increased confidence with conclusions about the effects of environmental events on real property values. Data is often readily available from MLS and/or local property records. Use of multiple techniques lends more credence to the results obtained than with the results obtained by using any single technique. The results obtained from the multiple techniques should be consistent, although not always identical. Where applicable, appraisers should conduct statistical analysis to determine the statistical significance of the results, especially the results of the strongest and most heavily relied on techniques.

Future research should address how these techniques can be used together. For example, a comparison of revealed outcomes from regression analy-

sis could be compared with CVA results to determine if they are internally consistent. Also, in order to address the issue of generalizing between markets, comparative research should be conducted to determine the consistency of results across markets, demographic factors, and types of contamination.

**Robert A. Simons, PhD**, is a professor at the Levin College of Urban Affairs at Cleveland State University in Cleveland, Ohio. He directs academic programs in urban planning and environmental studies, and teaches courses in real estate development, market analysis and finance, urban planning, and environmental finance. Dr. Simons has published over 30 articles and book chapters on real estate, urban redevelopment, environmental damages and housing policy. He has written a book on brownfields redevelopment and has written chapters for other books on the subject. He has served as an expert witness on environmental damages to real property. **Contact:**  
[roby@urban.csuohio.edu](mailto:roby@urban.csuohio.edu).

