

# Current Indoor Radon Studies In New York State

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## ABSTRACT

Three indoor radon studies to raise awareness among New York State residents have targeted *real-estate transactions*, school administrators, and the Internet. A survey of 1004 real-estate offices and 2220 recent home buyers established that most indoor radon information is provided by home inspectors. Overall, 29% and 13% of home buyers and real-estate agents, respectively, returned surveys. Results indicated that radon disclosure during real-estate transactions varies widely across the State. In another study over 4000 school principals and superintendents were sent information detailing school locations and indoor radon risk. Less than 2% of schools returned a questionnaire and took advantage of an offer for a free CD-ROM of radon educational material. A third project has formatted state and county radon risk maps and tables for display on the Internet ([www.health.state.ny.us](http://www.health.state.ny.us)). Users are able to view State-, county- and town-level indoor radon risk estimate maps and tables.

## INTRODUCTION

Inhalation of the radioactive decay products of radon ( $^{222}\text{Rn}$ ), a naturally occurring gaseous decay product of radium present in all soil, has been linked to an increased risk of lung cancer (1). To lessen exposure, the New York State Department of Health (DOH) has focused primarily on educational outreach, measurements, mapping, remediation, and identification of high-risk towns. The DOH has distributed indoor radon detectors for 15 years, thereby providing data for the spatial mapping of nearly 45,000 basement short-term (2-5 day) measurements. From these data and computer digitizing of surficial geologies, the geometric mean and percent of homes with greater than 4 pCi/L of indoor radon were estimated for each town and city in the State (Fig. 1). The methodology for estimating radon potential from a combination of measurements and surficial geology has been presented elsewhere (2,3). In addition to the Statewide maps, indoor radon risk maps were prepared for each county showing the estimated percentage of homes with greater than 4 pCi/L of radon for each town and city in the county (example shown in Fig. 2). One set of maps provides living area, long-term estimates of percentage of homes with greater than 4 pCi/L and the second set provides basement short-term estimates. The radon-risk information was distributed as part of three separate studies to recent home buyers, practicing realtors, and school administrators, and it was made available on the Internet.

A substantial fraction of all radon testing occurs during real-estate sales of single-family homes. While an unknown number of radon measurements and remediations may occur as a stipulation of these home sales, little information exists on a) who conducts the measurements, b) the occurrence of radon disclosure during the sales, or c) the reduction strategies implemented at

these newly purchased homes, often as a stipulation of the sale. A study was conducted to survey homeowners and real-estate agents involved in recent home sales. An objective of the study was to obtain information from four regions of the State regarding the occurrence of radon disclosure, measurements, and remediations during the recent sales transactions, as well as the role that radon plays in the purchase of a home from two perspectives.

As indoor radon has been shown to attain elevated concentrations in some schools, the DOH encourages measurement and remediation of radon in schools through various outreach programs. To educate school administrators and to encourage measurement (and remediation) of the buildings, a study was conducted to provide radon risk maps and materials to public and private schools in the State. While schools are reluctant to measure for radon, as funding for remediation can be costly and difficult to obtain, the State Education Department dictates that districts are responsible for testing and mitigation of radon in their schools. Currently a small percentage of schools in the State have been measured for radon.

Due to the quantity of information that is easily accessible on the Internet, a third distribution method provided maps and tables of the radon risk estimates through this medium. The objective of the study was to provide radon measurement results and risk estimates to homeowners, home-related professionals, and community developers without the need for them to call or write for the information. This is especially useful to professionals who have business spanning several counties.

## EXPERIMENTAL

### Buyer/realtor survey

Three counties in each of four regions of the State were targeted to examine differences in real-estate disclosures by region. The regions included the following counties:

- |   |   |
|---|---|
| 1 - West (Allegany, Cattaraugus, Steuben) | 3 - North (Clinton, Essex, Franklin)      |
| 2 - Central (Broome, Chenango, Cortland)  | 4 - East (Columbia, Rensselaer, Dutchess) |

These regions encompass counties of very low population and radon potential (Region 3) to counties of very high radon risk (Regions 1 and 2) and high population (Regions 2 and 4). Addresses of single-family homes sold in these 12 counties from March 1 to May 30, 1999 were extracted from the State Real Property tax database to assure the location of each home in the county. For this three-month period, the number of eligible single-family home buyers for this study ranged from 75 (Franklin) to 619 (Dutchess) with an average of 212 homes per county. This value represents an annual selling rate of about 6% of all single-family homes in these counties. The mailout and measurements were done during the 1999-2000 heating season. Each targeted home received a cover letter explaining the study, a page describing radon and its risks, a dated detector application, and a survey form. Participants returning the applications were sent a 3" charcoal detector which, following exposure, was sent by the home buyer to the contracted laboratory (RTCA, Elmsford, NY) for analysis. Radon concentration results were sent to the participating home buyer. Confirmation measurements were conducted for homes above 4 pCi/L, and all homes with over 10 pCi/L radon were provided with an EPA radon pamphlet and a list of accredited radon contractors.

Information regarding 1,063 realtors in the 12 counties was obtained from the New York State Association of Realtors. Realtors received a cover letter explaining the study, a page describing radon and its risks, and a survey form. Only one letter was sent to each office address, though letters may have been mailed to the same real-estate company located at

different addresses. Realtors were requested to return the completed survey and to provide their standard home-sale contracts to be examined for a radon disclosure clause. Self-addressed stamped envelopes were provided to both home buyers and realtors to encourage return of the survey forms.

### Schools mailout

Due to the facts that schools are not required to measure for indoor radon and that children spend a significant amount of time in classrooms, the primary objective of this study was to distribute the DOH radon risk maps, together with additional indoor radon information, to all of the public and private schools in the State, with the exception of those located in New York City and on Long Island. The latter areas were omitted due to the low radon risk and large number of schools. Of the over 7,000 public and private schools and administrative buildings in the State, 4,027 are located outside New York City and Long Island. Information regarding the number and type of schools targeted in each county is provided in Table 1. Overall 2,421 public schools, 1019 nonpublic schools, and 587 school administrative offices were targeted. A list of schools and district offices was obtained in comma-delimited form from the State Education Department. School addresses and contacts (usually a principal or superintendent) were printed directly onto mailing labels.

Each map package that was sent to a school contained the colored State radon risk maps; county maps showing town names, borders; radon potential and school locations; tabulated data for each town in the county; U.S. EPA and the State Energy and Development Authority (ERDA) radon pamphlets specific for schools; a cover letter; an explanation of the mapping methodology; and a survey form. Both long-term living area and short-term basement radon estimate maps of the State and county were provided with each package. A county map showing town borders and school locations were provided to allow a direct comparison to the radon risk maps. The cover letter provided background information on indoor radon occurrence and health risks, and it contained the toll-free DOH-hotline telephone number. A two-page description provided information on the methodology used in making the maps and on the differences between the long-term living area maps and the short-term basement maps. Each package contained a table listing the towns and cities in the county, the number of homes with basement screening measurements in the DOH database, the living area and basement estimates for percent of homes greater than 4 pCi/L, and the one-sigma uncertainty range for the risk estimates. The package contained two colored pages from ERDA offering technical assistance and indoor air quality services to managers of schools. A check-box on the survey form was also available to request assistance from ERDA. To encourage radon consultation, measurements, and remediations, a three-page list of accredited (NEHA and NRSB) radon contractors located in the State was provided, as well as a listing of reviewed radon sites on the Internet, separated by topic. The survey form was designed to provide useful information regarding radon awareness, measurement and remediation status, and overall concern by school officials about indoor radon. Schools returning the survey form were sent a CD-ROM of radon information developed by DOH. Ten radon detector order forms were included in each map package for use by school staff to obtain short-term charcoal-canister detectors through DOH. As it is recommended that every room of a school in contact with the ground be measured for radon, a school would require many more radon detectors. These materials were assembled into folders containing several school-specific EPA pamphlets.

### Internet

A colored State map and 62 county radon risk maps of both long-term living-area and short-term basement estimates were saved as jpeg files, a format useable for web pages. Tables of each county were processed into web pages (html). The addition of several pages of methodology description and study summary created nearly 200 pages of radon information relevant to New York State.

## RESULTS AND DISCUSSION

### Buyer/realtor survey

*Home buyer survey* - Of the 2,551 detector applications mailed to single-family homes located in the 12 counties, 331 letters were returned due to addressing errors or delivery problems, and 647 completed surveys and 588 detector applications were returned. The results of the mailing are summarized in Table 2 and briefly discussed below. The number of surveys returned for Regions 1 through 4 are 118, 186, 80, and 263, respectively.

Radon information was provided to home buyers about 40% of the time. This conflicts with the results of the realtor survey (below), which indicate that they provided radon information during 75% of sales. Home buyers in Regions 2 and 4 were provided radon information during 50% of sales, while radon disclosure was nearly nonexistent (5%) in low-risk Region 1. Of the home buyers who did receive radon information during the sale, the information was provided by home inspectors about half of the time and by realtors only about one-third of the time. The most knowledgeable group, radon contractors, are rarely involved in the initial discussion of radon with the prospective home buyers, and they provided the radon information only 5% of the time.

As most home buyers are not familiar with the topic of radon, the information provided by the home-related professional must be accurate and reliable. According to the survey, home buyers were told that a) the home should be tested (34%), b) radon is a health problem (19%), and c) a radon contingency clause should be added to the contract (15%). These are all valid issues. However, 67 home buyers were told that radon is not a problem or not to worry about it, with most of these located in high-risk counties. No buyers in low-risk Region 3 were advised to test. Half of the respondents were told that radon is not a problem in Region 3, which is generally a correct - but not acceptable - statement, considering past measurement of homes containing over 4 pCi/L in these counties.

Of the 647 respondents, 191 reported that the home had a radon measurement, primarily during the sale. None of the 80 respondents in Region 3 conducted a radon test during the sale. Nearly all of the buyers who reported receiving any radon information also reported that a radon measurement was done during or prior to the sale. This implies that buyers receiving radon information are more likely to conduct a measurement as a stipulation of the sale. The majority (80%) of radon tests were done during the sale of the home, accentuating both the need to provide radon information to buyers early in the sale process, and the role that real-estate transactions play in promoting radon measurements. In Dutchess county, a significant number (17%) of tests were conducted before the sale (previous ownership), suggesting a history of past radon measurements during real-estate transactions in this populous area.

In addition to providing radon information, home inspectors conducted two-thirds of the radon measurements of these homes. This illustrates the importance of radon training and certification of home inspectors. The most knowledgeable group, radon contractors, provided only 20% of the measurements, and home buyers conducted about 7% of the tests themselves. Surprisingly, realtors conducted few (3%) of the measurements in the 12 counties. The majority (66%) of follow-up measurements were conducted by radon contractors. This is likely due to the

contractors' involvement in home remediations following an initial result above 4 pCi/L. Home inspectors conducted 25% of the follow-up measurements and realtors conducted very few. Most (72%) of the follow-up measurements were below 4 pCi/L.

About three-quarters of the measurements were conducted in the basements of homes, with most of the remaining measurements conducted on the first floor. One-third of the home buyers stated that the initial radon measurement was >4 pCi/L. While home buyers in Cortland, the highest radon-risk county in the State, reported 60% of basement measurements above 4 pCi/L, past measurements (2) show the value to be near 74%.

Nearly half of the respondents purchased the home with radon levels >4 pCi/L without negotiating a change in the price, indicating that indoor radon plays a minor role in selection of a home. This attitude may indicate ignorance of, or apathy toward, indoor radon, but it likely reflects a desire not to complicate the home sale. Nearly 22% of home buyers *required the seller* to install a remediation system as part of the sale, while about 14% required a reduction in the home's price, presumably to pay for installation of a remediation system.

The most prevalent (44%) action to reduce indoor radon levels was to install a mitigation system. Of the 62 reports of homes with >4 pCi/L of radon, 21 had mitigation systems installed to reduce elevated concentrations. This approach was followed by the less effective methods of sealing cracks (23%), opening windows (13%), and increasing ventilation (10%).

An overwhelming 94% of home buyers requested the radon detector that was offered through the program, regardless of the home's previous measurement history. It is interesting to note that while very few homes in low-risk Region 3 were measured during the sale, 99% of the respondents from this region requested a radon measurement as part of this program.

*Home buyer measurements* - Although radon detectors were mailed to responding participants, only 218 detectors were properly exposed and returned for measurement to the contracted laboratory. The primary reasons for excluding deployed detectors were overexposure of the canister by the homeowner (>7 days) and delay in returning the canister to the laboratory, even though instructions are included with the detectors. Overall, the return rates for the applications and surveys were greater than 26%. Of the detectors mailed, radon measurements were completed 37% of the time, with 76% of these conducted in basements.

Basement measurement results were log-normally distributed, with a geometric mean of 3.4 pCi/L and a maximum of 72 pCi/L. Overall, nearly half (48%) the basements had radon concentrations exceeding 4 pCi/L. About 17% of the basements had concentrations above 10 pCi/L. Living-area radon concentrations for the participating homes had an overall geometric mean of 2.1 pCi/L, and a maximum of 17 pCi/L. About 33% of the first-floor (and higher levels) measurements were above 4 pCi/L, and 9% of the concentrations exceeded 10 pCi/L. None of the 13 measurements in the low-risk Region 3 exceeded 2 pCi/L.

*Realtors* - Of the total of 1,063 realtors targeted, 59 letters were returned due to addressing errors or delivery problems. A summary of results of the 135 surveys returned by the realtors is given in Table 2. The numbers of surveys returned for Regions 1 through 4 are 13, 24, 22, and 76, respectively, and represent an overall 7% return rate.

To provide insight into their knowledge of radon risks, realtors were asked to describe radon levels in their counties. Realtors in the low-risk counties (Clinton, Essex, Franklin) correctly identified them as such. The remaining nine moderate-to-high risk counties were described as low risk as often as moderate- and high-risk combined. The two highest-risk counties (Cortland and Steuben) were correctly identified as such in only 20% of the responses.

All responding realtors conduct sales of single-family homes, and a third also deal with multifamily or mobile homes. This ensures that the surveys were completed by realtors of single-family homes and are likely representative of real-estate practices in their areas. As over 90% of the buyers' surveys were completed by owners of single-family homes, this means that a direct comparison can be made between the responses of the two types of questionnaire.

In the nine high-risk counties, realtors reportedly discussed radon during 75% of the sales. This conflicts with the information given by the home buyers, who reported receiving radon information during only 40% of sales in these same counties, and then primarily from home inspectors (47%), rather than realtors (34%). For example, realtors in Columbia and Chenango counties overwhelmingly (96%) reported discussing radon during the sale, but only 36% of home buyers in these counties reported receiving the information. Though home buyers in the low-risk counties reported not receiving radon information, a third of realtors claimed to provide radon disclosure in this region. Nearly half of the realtors stated that radon disclosure is not discussed during sales of mobile homes.

While home buyers most often (64%) made the decision whether or not a radon measurement was conducted, realtors recommended testing a home (29%), suggested a radon contingency clause in the contract (24%), noted that radon is a health concern (16%), and advised that concentrations can be reduced at a modest cost (15%). These latter two items (health and cost) should be relayed to every buyer and are often selling points for installation of mitigation systems. The least-conveyed information is that the home buyer should call the State Radon Hotline (5%). However, this conflicts with the results of a later question in the survey in which 59% of realtors stated that the Radon Hotline number is known in their office.

Two-thirds of realtors reported that radon measurements are made in basements. This result is supported by the home buyers (72%). Short-term charcoal canisters are utilized 70% of the time for radon measurements, while electronic (real-time) devices are used for 27% of measurements. Only one use of electrets was reported. Similar to the results of the home buyer's questionnaire, realtors reported that the majority (74%) of measurements are conducted by home inspectors. This again illustrates the importance of training and certification of home inspectors with respect to radon. Realtors reported that radon testing is conducted in 57% of home sales in these counties, while home buyers stated that measurements were done only 29% of the time.

The primary action (35%) taken following a radon measurement above the EPA action guideline is to install a radon reduction system. This prevalence of installing mitigation systems agrees with the results (44%) of the home buyers' survey. Other actions recommended by realtors include re-testing of the home (19%), sealing of cracks in the basement (15%), and purchasing at a reduced price (13%).

About a third of responding realtors learned about radon from seminars or meetings, though the source of this training is unknown. Slightly fewer (29% and 24%, respectively) gained radon information from the media and EPA.

Overall, 66% of realtors believe that the presence of radon has no effect on property values. Nearly all realtors in low-risk Region 3 noted that radon had no effect on property values. This is not true elsewhere as property values in the highest risk counties are reported (>60% in Broome, Cortland, and Steuben) to be affected by radon concentrations.

### Schools mailout

Overall, radon-risk map packages were assembled and mailed to 4027 schools in late 2000. To date, 51 completed surveys have been received from schools located in 24 counties. The most replies were from Monroe and Westchester counties, both with a large number of schools. Based on the responses, 29% of the schools had been measured previously for indoor

radon, though this is much higher than the State average. The radon measurements were often conducted by building inspectors (35%) or school staff (41%). Of those schools that had not been tested for radon, most (69%) had no plans to measure, but 26% of respondents planned to measure the schools' radon levels within the next five years. Most of the respondents (72%) noted that their school was using a municipal water supply, a source likely to be low in dissolved radon. However, most of the 13 schools using private water supplies are located in southeastern New York State, an area known to contain elevated levels of dissolved radon and other radionuclides, nonetheless, none of the school supplies have been measured for radon. In this region, a waterborne contribution to indoor radon concentrations is possible. Very few schools reported having classrooms below ground level, but of those that did about 20% of the rooms were below surface level. Seven schools checked the box requesting technical assistance from NYSERDA for improving the indoor air quality.

### Internet

Currently, the final disposition of the radon maps and tables on the Internet has not been approved, but they are expected to be displayed at [www.health.state.ny.us/radon](http://www.health.state.ny.us/radon). The presentation will provide a colored State risk map with selections of counties by graphic and text means. Tables and figures are provided for all areas of the State, as well as links to other radon web sites.

## CONCLUSIONS

A package containing an extensive collection of risk maps, radon information, and offers of technical assistance, as well as a questionnaire, was sent to over 4000 public and private schools, and to their administrative offices, in the State, in an effort to raise radon awareness levels among school managers and increase the number of schools measured (and mitigated) for radon. Sufficient information was provided in each map package for an evaluation of the school's potential for radon. The relatively low number of surveys returned (<2%) indicates that school managers are unmoved by radon issues. Results of the returned surveys indicate that while some schools have been measured for radon, most have no plans to conduct radon measurements.

Home buyers returned many more surveys than did realtors. Responses from the two groups both agreed (inspectors do the majority of measurements) and conflicted (identity of provider of radon information). Nearly a third of responding home buyers had radon measurements done in the home. Of the actions taken to reduce indoor radon concentrations, approximately half reported installing a mitigation system, corresponding to an eighth of all respondents. While interest in receiving the radon detectors is evident from the high response rate, the improper exposure and return of these detectors to the analytical laboratory resulted in fewer measurements. Radon measurements and disclosure were nearly nonexistent in the low-risk counties.

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## REFERENCES

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Figure 1. Indoor radon risk map of the State constructed from short-term basement estimates and correlations to surficial geology. Long-term living area estimate maps were also provided.

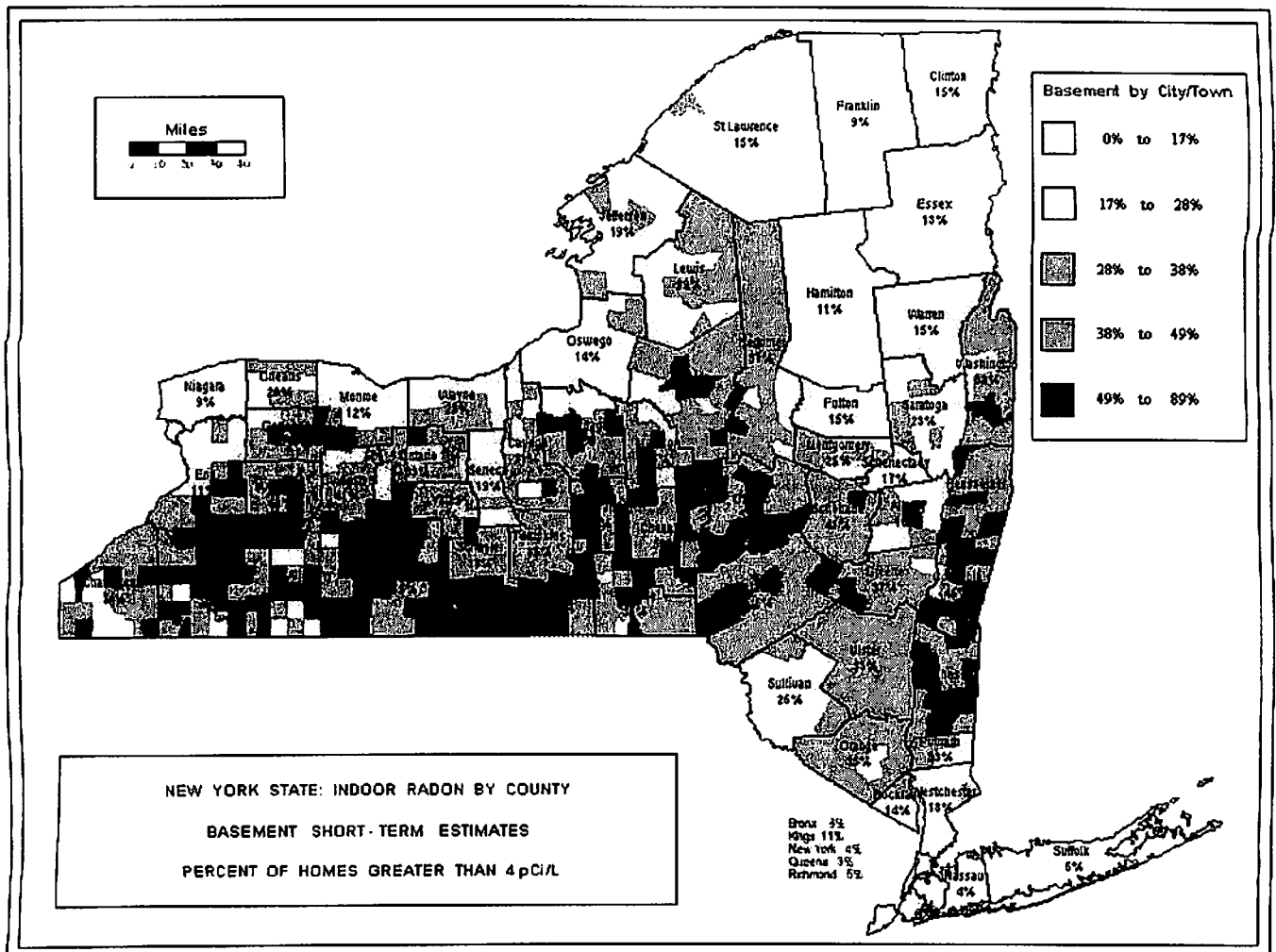




Figure 2. Typical county indoor radon risk map of short-term basement radon estimates. Long-term living area estimate maps were also provided.

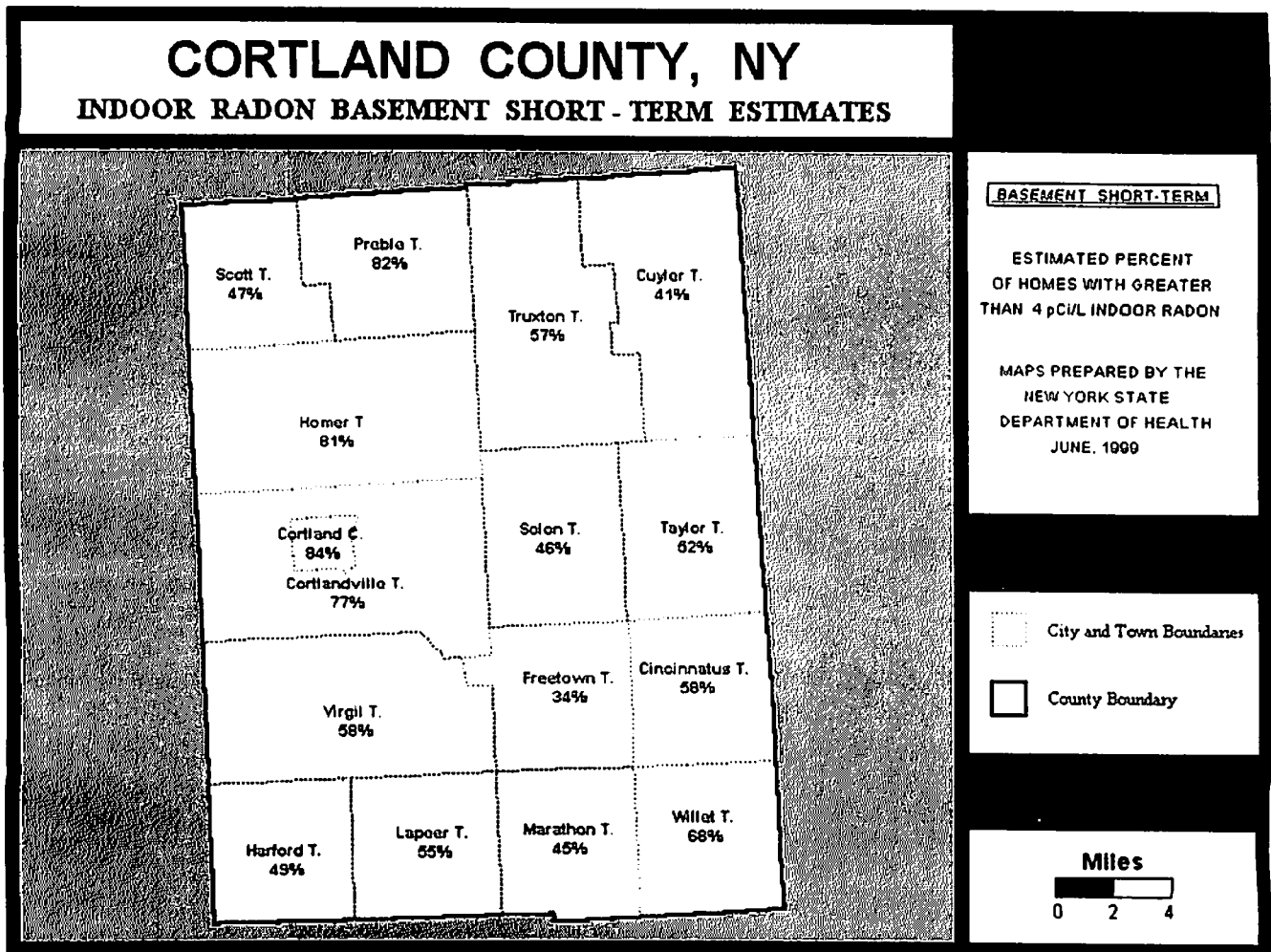


Table 1. Summary of public and private schools and district offices that received a radon map package.

County DO	School*			County	School*	
	Publ	Priv	DO		Publ	Priv
Albany 15	67	42	13	Oneida	73	22
Allegany 18	21	5	12	Onondaga	127	45
Broome 9	57	21	12	Ontario	29	6
Cattaraugus 18	35	20	14	Orange	87	42
Cayuga 5	25	14	7	Orleans	15	7
Chautauqua 9	54	23	18	Oswego	42	6
Chemung 12	23	13	3	Otsego	23	7
Chenango 6	25	4	8	Putnam	19	6
Clinton 12	30	17	8	Rensselaer	45	18
Columbia 9	20	8	7	Rockland	66	65
Cortland 17	16	7	5	St. Lawrence	41	20
Delaware 12	22	5	12	Saratoga	51	14
Dutchess 6	72	42	14	Schenectady	41	16
Erie 6	222	127	29	Schoharie	13	3
Essex 2	15	10	11	Schuyler	6	1
Franklin 4	22	12	7	Seneca	12	5
Fulton 14	23	4	7	Steuben	41	7
Genesee 10	22	8	8	Sullivan	25	13
Greene 6	17	5	6	Tioga	20	5

Hamilton 7	7	0	7	Tompkins	31	9
Herkimer 10	25	3	11	Ulster	51	24
Jefferson 9	37	12	11	Warren	22	3
Lewis 20	14	5	5	Washingt	22	4
Livingston 11	20	5	8	Wayne	35	5
Madison 46	43	3	10	Westchester	249	124
Monroe 6	206	89	18	Wyoming	12	4
Montgomery 2	18	5	5	Yates	6	4
Niagara	59	25	10			
				Sum	2421	1019
587						

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\*Publ = public schools  
 Priv = private schools  
 DO = district offices

Table 2. Summary of radon surveys sent to home buyers and realtors.

County Name	Recent Home Buyers				Real Estate Offices			
	Total Eligible	Homes Targeted	Surveys Returned	Applications Completed	Measurements Completed	Targeted	Returned	Surveys Returned
<u>Region 1</u>								
Allegany	227	82	10 (12%)	10 (40%)	4 (10%)	40	4 (10%)	
Cattaraugus	445	183	47 (26%)	43 (35%)	15 (1%)	85	1 (1%)	
Steuben	551	238	61 (26%)	51 (47%)	24 (9%)	93	8 (9%)	
<u>Region 2</u>								
Broome	900	465	116 (25%)	104 (35%)	36 (4%)	281	10 (4%)	
Chenango	279	127	26 (20%)	22 (41%)	9 (10%)	71	7 (10%)	
Cortland	210	113	44 (39%)	46 (39%)	18 (12%)	58	7 (12%)	
<u>Region 3</u>								
Clinton	269	127	34 (27%)	30 (27%)	11 (6%)	49	3 (6%)	
Essex	241	97	27 (28%)	4 (15%)	4 (16%)	101	16 (16%)	
Franklin	214	75	19 (25%)	19 (47%)	9 (6%)	51	3 (6%)	
<u>Region 4</u>								
Columbia	396	177	37 (21%)	31 (52%)	16 (12%)	195	24 (12%)	
Dutchess	1079	619	164 (26%)	151 (34%)	51 (6%)	710	42 (6%)	
Rensselaer	610	248	62 (25%)	21 (39%)	21 (5%)	201	10 (5%)	
Totals	5421	2551*	647 (29%)	588 (37%)	218 (7%)	1935	135 (7%)	

\* 331 letters returned due to delivery problems.