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RADON IN NEW YORK STATE'S SCHOOLS

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ABSTRACT

For over 10 years, the Department of Health (DOH) has conducted programs to measure and reduce indoor radon concentrations in over 100 public schools located primarily in Zone 1 areas of New York State. Although many schools had few or no rooms containing radon above 4 pCi/L, others had rooms with >20 pCi/L and utilized remediation techniques to reduce exposure. Diagnostic, technical, and monetary assistance was provided during remediations. Short- and long-term radon measurements in the schools were compared to basement and first-floor results from single-family homes in the towns. Maps showing radon potential and school locations were distributed to over 4000 schools in the State, thereby allowing a direct evaluation of the school's potential for containing indoor radon concentrations above 4 pCi/L. Other outreach programs promoted radon testing of schools through regional workshops.

INTRODUCTION

As indoor radon can reach elevated concentrations in some homes and buildings, the New York State (NYS) Department of Health (DOH) conducts programs to encourage measurements and remediations. The programs are frequently directed toward reducing radon exposure of the young in homes and schools. Measurements of >40,000 single-family homes has shown the widespread presence of elevated radon in NYS (Kitto 2001), with over half of the counties designated Zone 1, or high-risk, by the U.S. Environmental Protection Agency (EPA). Over half of the homes in eight Zone 1 counties contain basement-level radon concentrations above the EPA-recommended action level of 4 pCi/L. The potential for high radon levels in schools, and the large amount of time spent in classrooms by children, prompted the DOH to measure over 100 schools during a 6-yr period. Results of these measurements and efforts to reduce indoor radon levels are summarized here.

Although schools are sometime reluctant to measure for radon, as remediation can be costly and funding unavailable, the NYS Education Department in 1999 put forth regulations which dictated that districts have a "responsibility to be aware of the geological potential for high levels of radon and to test and mitigate as appropriate". This regulation resulted in some schools following inappropriate testing protocols, measuring an inadequate number of rooms and locations, and utilizing unqualified radon analysis laboratories. Due to the questionable validity of these data, the DOH was funded, through the

EPA's State Indoor Radon Grants (SIRG), to design and conduct regional training sessions across the State, to educate staff of schools and Board of Cooperative Educational Services (BOCES) on the proper protocols for radon testing in schools and other large buildings. Results of these training sessions are summarized below.

Due to the facts that schools were not previously required to measure for indoor radon, and that children spend a significant amount of time in classrooms, the primary objective of one program was to distribute 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 (NYC) and on Long Island (LI). The latter areas were omitted, due to the low radon risk and the large number of schools. The information was meant to educate school superintendents and to encourage measurement (and remediation) of the buildings. A description of the materials and responses is given.

MATERIALS AND METHODS

There are approximately 7,100 public and private schools in New York State, of which nearly 4,100 are located outside NYC and LI. Many of the latter are located in a high-risk radon area, termed Zone 1 by the EPA. Several DOH programs have been directed at assisting schools in addressing the issue of indoor radon in their facilities. The programs, conducted over a decade and described here, include 1) measurements, 2) remediations, 3) map distribution, and 4) workshops. The measurements were conducted at schools during six separate projects beginning in 1991. A total of 104 schools have been measured in 35 counties through the DOH program. As shown in Figure 1, the number of schools measured in each county varied from one to eight. In general, schools solicited to participate in the studies were 1) located in areas of elevated risk for radon, and 2) distributed so as to provide data covering as many districts and areas as possible. Participation by the schools was voluntary.

Indoor radon measurements were performed according to EPA-recommended protocols for schools buildings. Short-term measurements were completed using electret-type detectors deployed for 2-5 days. These passive radon measurement devices are commercially available (Rad Elec Inc., Frederick, MD) and have been described elsewhere (Kotrappa 1993). The voltage reader was calibrated using electrets exposed at a calibration chamber and were periodically checked with reference electrets. In later studies, charcoal canisters, contracted through a commercial laboratory, were used rather than the electret devices for short-term measurements. At several schools, confirmatory measurements of 30-90 days were conducted using long-term electrets in rooms that had shown short-term screening results >4 pCi/L. These confirmatory data allowed staff to avoid areas with elevated radon levels until long-term results were available, and until remediation could commence. Long-term measurements were conducted using alpha-track detectors, contracted through a commercial laboratory, that were deployed for 9-12 months.

In an outreach program conducted in 2000, radon information was mailed directly to schools located outside NYC and LI. The map package contained colored State radon risk maps, tabulated data for each town in the county, EPA radon pamphlets specific for schools, and an explanation of the mapping methodology. In addition, the package included county maps showing city and town names, boundaries, and percentage of homes with >4 pCi/L of radon. A map showing school locations within each town was provided, to allow a direct comparison to the radon risk maps. The package included an offer of free technical assistance and indoor air-quality services to school officials from the NYS Energy Research and Development Authority (ERDA), lists of accredited radon measurement companies and remediation contractors, a review of radon Web sites, and a one-page questionnaire. School officials

returning the questionnaire were sent a compact disk of radon instructional information developed by DOH entitled "Radon and Your Home".

The regional training sessions were designed to provide school and BOCES officials with the knowledge to conduct testing within their own school districts, and to oversee testing (and remediation) conducted by a radon contractor. The training included information on radon occurrence, health effects, measurement protocols, remediation techniques, and an introduction to EPA's Indoor Air Quality Tools for Schools. School officials were notified in advance of forthcoming sessions in their area, and were eligible to attend the all-day session at no charge. Short-term measurements were conducted using charcoal canisters provided, with grant assistance, at a reduced cost ($3-3.50) through the program to the schools.

RESULTS AND DISCUSSION

Over the past 10 years, the DOH has conducted six projects that measured the radon concentrations in schools. As shown in Table 1, about half of the schools solicited agreed to participate. The number of schools measured averaged about 18 annually, but it varied from 37 during the second year (Y2) to only four in the third year (Y3). Completion of the Y2 projects required more than the allotted time, resulting in a much less aggressive effort in Y3. The measured schools are dispersed across two-thirds of the counties of the State, but they constitute only 2-3% of the schools located outside of NYC and LI. In the six projects combined, radon concentrations were measured using short-term detectors in 4,269 school rooms. While the majority of the measurements were conducted in rooms over crawlspaces or in physical contact with the soil, a significant number of results were determined for the first and second floors of the schools. Inclusion of measurements from the latter locations, which are known to contain lower radon levels than do basement rooms, increased the percentage of rooms, given in Table 1, that contained radon below the 4 pCi/L action level. Several schools had all of their measured rooms below 4 pCi/L, while other schools had >50% their rooms above that value. About 700 school rooms, or ~16% of those measured, contained from 4 to 20 pCi/L of radon. While a small percentage of the rooms had concentrations above 20 pCi/L, 31 rooms, located in 20 schools, contained up to 75 pCi/L of radon. Nearly 2,000 rooms housed both short- and long-term detectors, allowing a direct comparison of values obtained for the short- and long-term time frames. For example, Figure 2 shows a comparison of results from short- and long-term detectors deployed in 37 schools during Y2. It is readily apparent that the measurements conducted with the short-term detectors give close agreement (r^2=0.96) with the long-term results. The short-term results are nearly always slightly higher than their long-term counterparts, due to the fact that the short-term detectors were deployed during the winter heating season, when indoor radon levels are typically elevated relative to the spring, summer, and fall months that are also included in the long-term measurements.

Remediation of indoor radon levels in the school rooms was accomplished by several means. Following a diagnostic air-quality test of the building by ERDA staff, indoor radon levels could occasionally be reduced sufficiently through simple adjustment of the heat/ventilation (HVAC) system. As shown in Figure 3, this adjustment appeared to have raised radon levels in a few rooms, although the increase was likely due to meteorologically controlled parameters rather than a true increase in soil-gas infiltration. A second method to reduce exposure of staff and students to rooms containing high radon levels was to restrict or deny access to the rooms. A third method to reduce radon exposure, especially in schools with a high percentage of rooms with >4 pCi/L of radon, was through the installation of an

active mitigation system. The result (Fig. 3) of radon reduction at one school, after HVAC adjustments and installation of a mitigation system, was representative.

A total of 2,421 public schools, 1,019 non-public schools, and 587 school administrative offices were sent packets of radon information. The relatively small number of questionnaires that were filled out and returned (<2%) indicates that school officials were not highly concerned about radon issues at the time. However, as noted above, school officials are currently responsible for being aware of the geologic potential for radon in the schools. Results of the returned questionnaires indicate that few schools have been measured for radon, and most have no plans to conduct radon measurements. An unknown number of schools sought radon measurement and remediation through non-DOH programs as a result of the mailing of the radon information.

A project composed of radon training workshops for schools' staff was conducted in 2001 at five locations in high-risk areas of NYS. There were a total of 125 attendees from 87 schools. The workshops discussed the occurrence and health effects of radon, measurement procedures and protocols, and remediation techniques and contractors, and it introduced attendees to the EPA's "Tools for Schools" package. Radon detectors were offered at a discount price to schools that chose to measure through the program. Some schools were, and continue to be, measured by their staff or BOCES personnel. The short-term results conducted as part of the training workshops have been included in the measurements section above, while long-term measurements are being conducted by BOCES personnel. Indoor air-quality services have been provided to interested and eligible schools by ERDA without charge.

CONCLUSIONS

Results of programs to reduce radon exposure of students and staff at public and private schools in NYS have been described. Measurements at >100 schools, located primarily in high-risk Zone 1 areas, showed that a majority of the rooms contained radon levels <4 pCi/L, and <20% of all measured rooms exceeded this level. Remediation of the schools, achieved by adjustment of HVAC systems and/or active mitigation systems, was a successful strategy to reduce radon concentrations. A package containing a collection of radon information and offers of technical assistance was sent to over 4,000 public and private schools in the State in a largely unsuccessful effort to raise radon awareness among school officials, and to increase the number of schools measured and mitigated for radon. Lastly, school representatives were educated in proper measurement and remediation techniques, so as to be able to conduct their own measurements and/or oversee implementation of a mitigation system.

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Figure 1. Rooms in over 100 schools were measured in 35 EPA-designated Zone 1 counties.

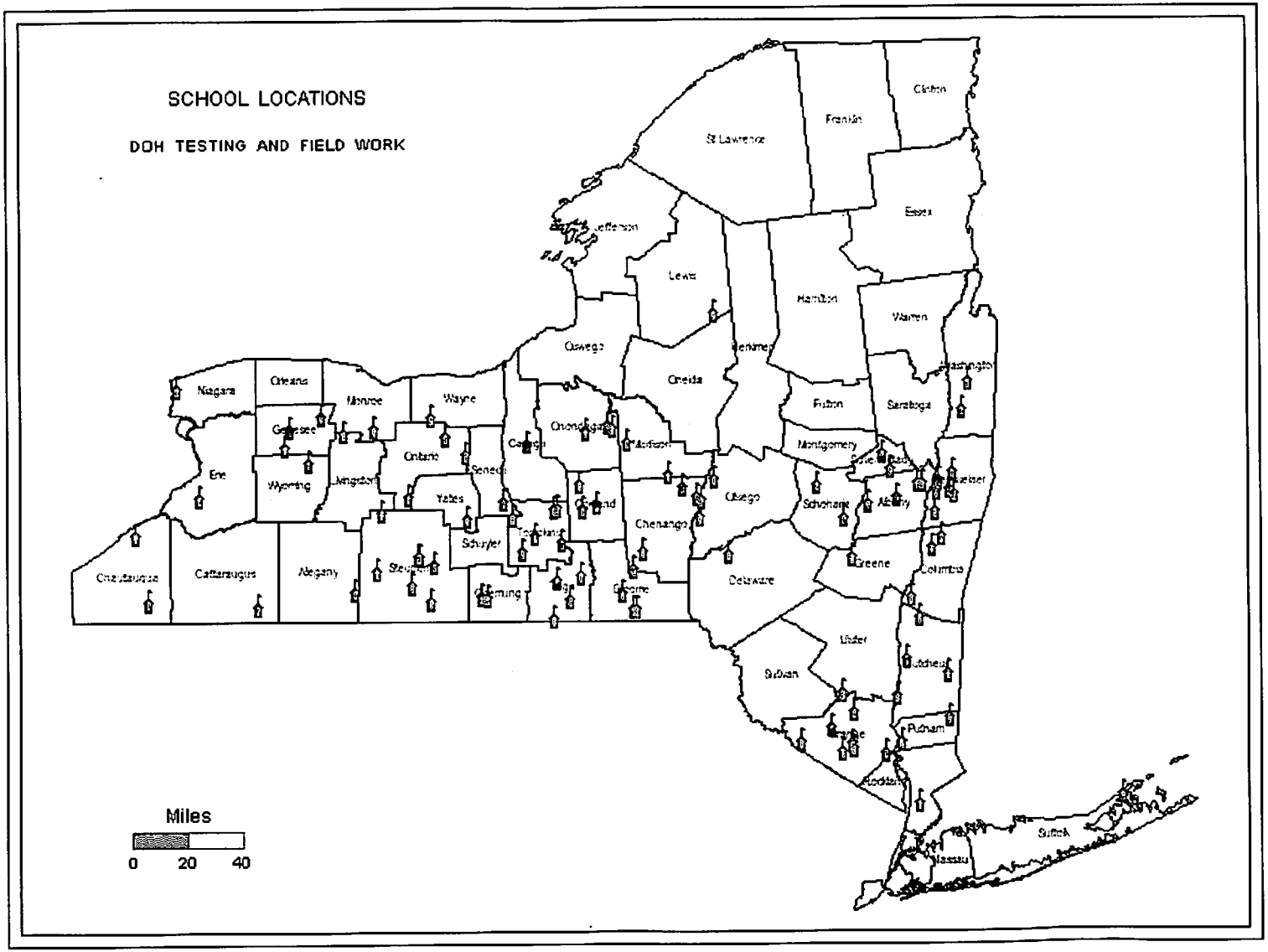

Figure 2. Close agreement of short- and long-term radon results from 37 schools, measured over one year.

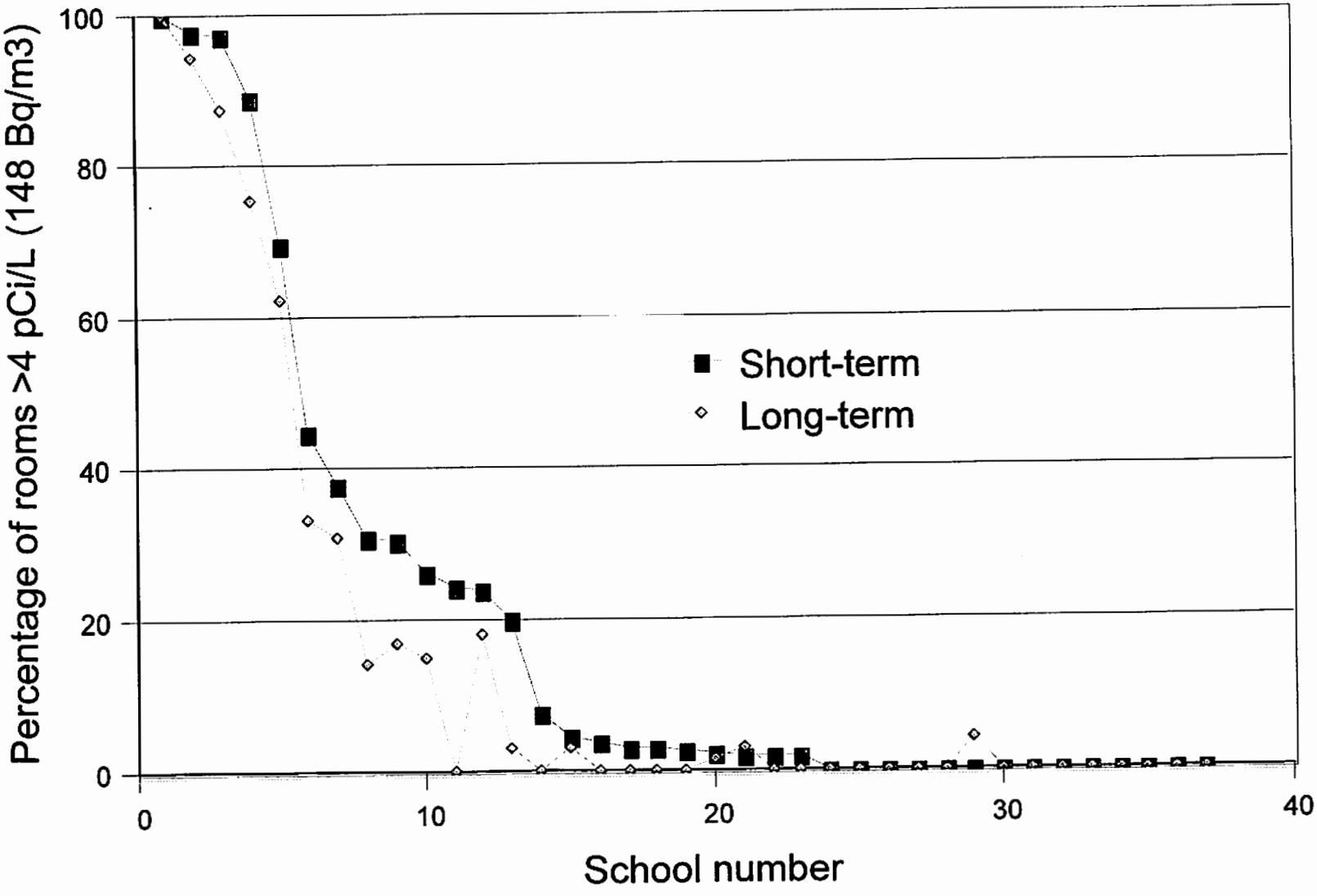

Figure 3. Effects of HVAC adjustments and installation of a mitigation system on radon concentrations at a representative school.

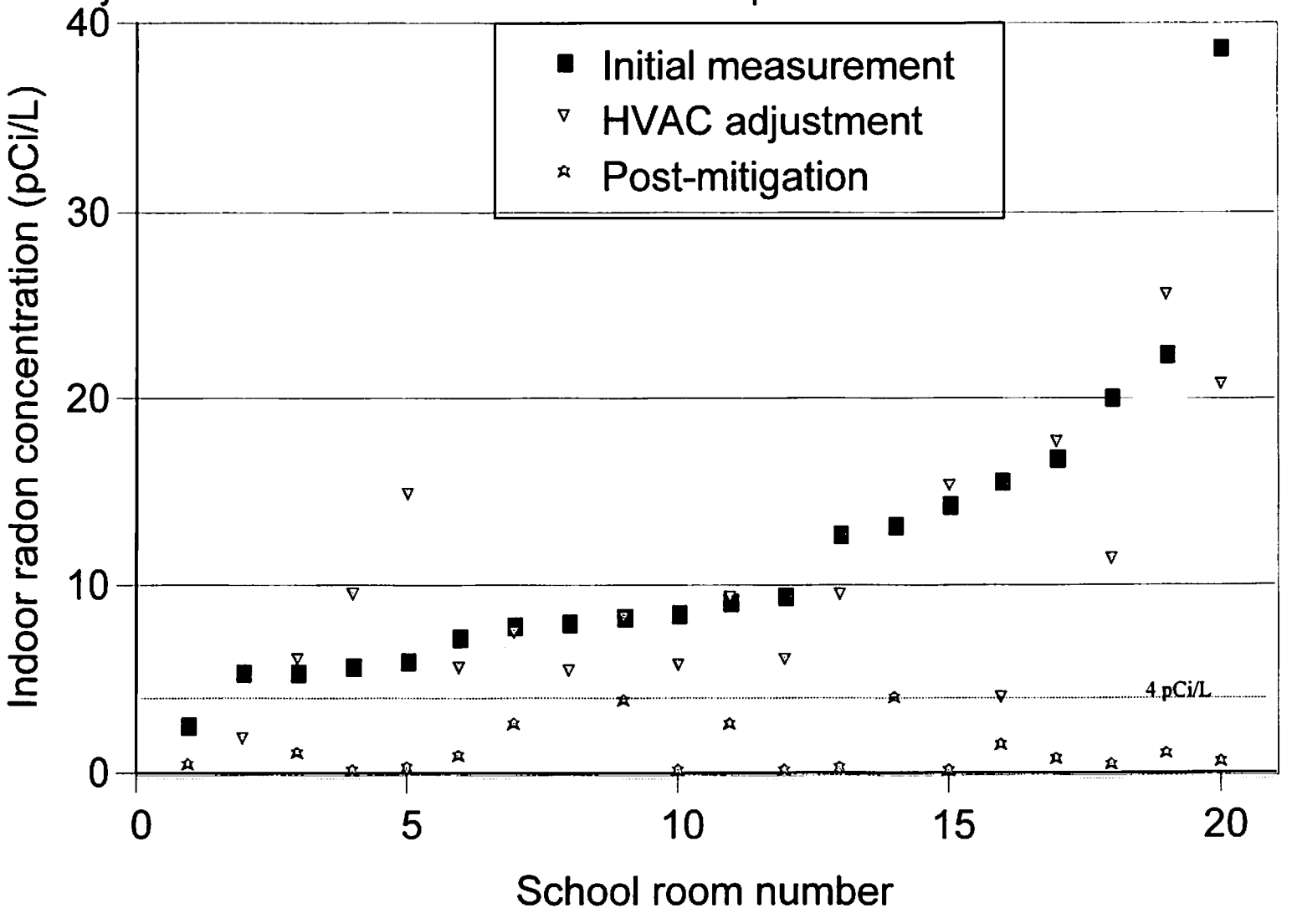

Table 1. Summary of short-term radon measurements at public and private schools in New York State.

Yr	# Schools Solicited	# Schools Measured	Counties	Rooms Meas.	% Rooms <4 pCi/L	% Rooms 4 -20 pCi/L	% Rooms >20 pCi/L (#)	Matched LT and ST	Recv'd Diagns
1	53	22	17	1038	68	31	1 (9)	756	8
2	70	37	24	1789	82	17	1 (19)	1405	8
3	6	4	2	198	67	33	0 (0)	181	2
4	29	17	13	730	88	12	~0 (1)	669	4
5	20	13	2	504	97	3	~0 (2)	NA	
6	18	11	7	>850	97	2	1 (6)	NA	
Totals	196	104	35	>5110	83	16	1 (37)	>3000	>22

NA : Long term measurements were typically completed by BOCES and school staff, and not readily available to DOH.