THE ELECTRET RADON SNIFFER AS A DIAGNOSTIC TOOL FOR OPTIMIZING THE EFFICIENCY OF SUB-SLAB VENTILATION SYSTEMS AND/OR SEALING

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ABSTRACT

A method for the measurement and interpetation of radon levels beneath a poured concrete slab floor is presented, along with application strategies intended to guide the mitigator in his efforts to effect an optimally efficient sealing or sub-slab mitigation system installation in the structure so measured. Case studies are presented for illustrative purposes, and cautions and uncertainties in this method are detailed, along with related areas of inquiry. The presumed greatest utility of this method is in attacking radon in structures evidencing poor sub-slab communication.

INTRODUCTION

In the eastern panhandle of West Virginia, experience suggests that there are two predominant types of SSC (sub-slab communication) communication): poor and none. In some cases, older homes with slabs retrofitted directly over dirt basement floors have been seen to evidence better SSC than "floating slabs" of more recent vintage, provided with a lift of gravel beneath the slab for support and drainage. The former opportunity is often not realized due to the predominant use of so called "crusher run", gravel which has not been separated by size and contains a high percentage of fines and "rock flour". This material has been found packed so tightly under a slab that, in extreme cases, SSC could not be measured between two test holes spaced a foot apart! Even less extreme cases represented a substantial obstacle.

In the course of studying patterns of radon concentration stratification obtained in the course of measuring radon in a cavern lying beneath Charles Town, West Virginia, a hint of a possible plan of attack was implied by the data. The main thrust of inquiry for that exercise was to determine the potential for an underground void, in this case a cavern, to concentrate and then to vent radon into structural foundations in communication with the void; in this case, wastewater systems antedating public sewer that were said to deliver into the cavern through the foundations of some older homes were thought to be providing such communication. At the suggestion of Doctor Robert Anderson, Ph. D. Environmental Biology, WVU, stratification measurements were added to the exercise. Three pairs of Electret Ion Chambers (S chambers manufactured by Rad-

Elec, 5330 J Spectrum Drive, I-270 Technology Park, Frederick, MD 21701) were deployed at floor and ceiling elevations along the longitudinal axis of the cavern. At the midpoint, an electronic scintillation system was programmed to measure hourly counts of alpha decay, to track the subterranean diurnal cycle, along with a QA EIC (which measured within 7%, average concentration for the 5 day sample period). Fig. 1 displays the results. A fifteen inch tunnel seen entering the cavern on the west wall was adjacent to the center pair of monitors. These monitors measured both the highest floor and ceiling measurements for the cavern and also the greatest difference found between floor and ceiling concentrations. This was interpeted as due to dilution, moving away from the apparent point of main entry, and diffusion between upper and lower elevations within the volume of the cavern. This method may provide a means of determining the vicinity of a main entry into a volume, assuming the volume is not subject to air movement from thermal or mechanical influences, and that the main entry is at a relatively lower elevation. From a sense of respect and appreciation for the guidance and support to radon professionals he has taught and inspired, I propose this pattern be recognized as the "Anderson Effect," after Doctor Robert Anderson.

The apparent highly focussed radon entry into Charles Town Cavern provoked the question of how focussed radon's arrival under a structure's foundation may be. The implications of high focus to the mitigator were perceived as being a clue to attacking structures with poor SSC. The first problem was to devise a means of measuring the radon concentration under the slab. Boring a matrix of holes through the slab would enable radon to move up from under the slab into a container placed above the hole. As a dense gas and probably at a lower temperature than ambient basement air, it was reasoned that a hole in the top of the containment vessel would enable the displacement of ambient air trapped inside the vessel when it was placed over the hole. The result would be a volume of soil gasses, including radon, in approximately the same concentration as was under the slab at that point, certainly enough for qualitative comparisons from one area to another. The first rough method employed a plastic ASTM concrete 6" cylinder mold, used to form concrete cylinders for strength tests. This was a mass-produced, easily available commodity that conformed to tight specifications, in respect to the volume and dimensions. The mold was large enough to place over a hole through the slab and an adjacent EIC. Matching a .5" hole in the slab with a .5" hole in the top of the mold provided for displacement of ambient air trapped when placing the mold by soil gasses moving up from under the slab, as shown in Fig. 2. The measurements were regarded as qualitative and comparable, from one area to the next.

There are two reasons why the lower measurement, in adjacent tests, would be lower. First, the concentration of radon may be lower due to decay and dilution as it diffuses furthur from the area in which it comes up under the slab, the "window". Second, the higher concentration may indicate the radon is trapped, and the lower concentration is lower because it is venting into indoor air. Standard SSC tests, performed by putting one hole under vaccuum and reading negative draw with a micromanometer or magnahelic gauge on the other hole, is a way of verifying, in advance, that a proposed ventilation point will draw soil gasses from under remote areas of the slab. The lower the SSC, the more difficult it is for radon to diffuse through the gravel layer laterally. Considering the overall pattern of radon concentration against a plan view of the foundation area and then considering the observable aspects of potential main entry routes and the quality of SSC yielded a pattern enabling identification of the apparent best area to locate the main vent, subject to acceptance by the client.

Fig. 3 illustates an ideal case. A partial basement with ambient readings in the upper teen to lower twenty range of picoCuries per Liter was measured out and length and width divided by four to yield measurements to lay out a nine-point grid. Using cylinder molds and S-chambers with short term electrets, a four hour sniffer test yielded the results. SSC was moderate between adjacent holes, poor once removed, and apparently zero from opposite corners. The structure was two story and electric baseboard zone heat with a woodstove in a family room over an adjacent crawlspace that had ambient levels of about 5pC/L. The four-digit concentration in the center of the slab was interpeted as a static pool. The three triple-digit measurements at one end were interpeted as the center and edges of the window. The vent point selected was between the high center and the high end test holes. The plan was to draw what we could from here in a phased approach, and then seal the end, if required, to prevent recirculating basement air and improve the radius of fan draw. Nothing in the basement presented a backdrafting problem.

a 150 CFM fan provided post-mitigation concentrations below 1.0 pC/L. No sealing was required! Without data about the location of concentrations of radon under the slab and without information about the quality of SSC, an alternate location may have been selected for the vent which may have yielded less desirable results.

A third type of measurement can also be added to the sniffer and SSC data, grab samples from various areas or rooms in the foundation area. Fig. 4 illustrates a particularly difficult structure in which 72 hour integrated measurements were taken prior to mitigation attempts. Simultaneous tests in several parts of a foundation provide information about the apparent location of radon entry into the foundation area, or may pin point a single source, such as a sump or drain. Adding the sniffer and SSC data to ambient data provides optimal diagnostic opportunities--something should "add up".

After performing about four mitigations targeted by sniffer tests, P. Kotrappa kindly consented to review existing data and enter the field to furthur study and confirm the process. Certain refinements were developed to produce more quantitative data in a shorter period of time. A method of performing qualitative "grab" measurements with a bare electret eliminated 72 hour area measurements or a box full of Lucas cells requiring four hours to be readable. By combining the electret monitor shell with the containment vessel, the four hour sub slab measurement was reduced to a 30 minute process offering more quantitative data. It was now possible to enter a structure, perform ambient grabs, sniffer measurements and SSC results and sit down with a full set of diagnostic data inside of two hours! The precise method for grab samples ("instant radon") and sniffer measurements are given in Appendices one and two, respectively. See also fig. 13.

PROCEDURE FOR MEASUREMENT

1. Determine the size and matrix to employ, usually a nine point matrix for a small, squarish basement or a twelve point matrix for a larger, more rectilinear shape. Lay out the measurements to locate the holes.
2. While this is being done, perform 10 minute grab tests of ambient levels by area, e.g. quadrant or room, and by suspect potential point of entry, e.g. cleanouts, sumps, floor drains, major cracks.
3. Drill each hole almost through for the sniffer tests; when all holes are almost through, go back and finish each hole as quickly as possible and immediately set the pails, as in Appendix Two.
4. Perform the tests and calculate the results.
5. Perform SSC measurements.
6. Seal the holes by an approved method.

Other records it may be wise to keep include the size, configuration, and HVAC system notes, soil conditions, atmospheric conditions and temperature, inside and out, orientation of the structure, and exterior grade, the number of floors, exterior dimensions, and height of the basement ceiling, if disparate from 7-8'. Sketch a plan view with location of relevant features, including possible main entry sources.

RESULTS

In most cases, radon concentrations have been seen to be highly focussed into one end, corner, or area of the slab. Given the uniqueness of each structure, very little can be said about any summary of data that can be expressed with a mathematical statement, such as "in X% of two story homes..." It appears to be the case, however, that radon does not penetrate modern floating slab construction as easily as it does older, retrofitted slabs. It seems that it takes less under the slab at the highest concentration measured, to produce a higher ambient measurement. For example, an ambient measurement in an older basement is multiplied by 30 to estimate, in general, the highest radon measurement found under the slab. In a floating slab home, the factor to multiply by is 100. These are extremely tentative and untrustworthy numbers which will also vary widely with the quality of the entry routes, but they serve to give someone a place to begin and compare to until more data and experience gives something more reliable.

In a more general sense, the results support the notion that the sniffer test, along with other data to be considered, provides useful information in optimizing mitigations, as in Fig 3., eliminating sealing when it is unneeded and when there are no potential problems with backdrafting. In cases of poor SSC, sniffer tests have been useful. A third utility is in targeting the area most requiring sealing when attacking borderline radon levels. The fourth task for the method is to investigate mechanical pipes or chases cast into slabs as possible radon transporters. These will be shown in a narrative case study format.

Also, some cases of typical problems, such as finished and unfinished sections of basement, will be shown, as well as an example of the everpresent capacity of the universe to blindside one with the unexpected (Fig. 6)

POOR SSC --

Fig. 4 and fig. 5 illustrate two cases where mitigation efforts were successful solely due to the use of sniffer data. Fig. 4 illustrates a large, finished basement with drywall ceilings and walls, with vinyl, ceramic, and carpeting on the floor. In order to test at all, carpet was slipped off the tack-track near the walls and pulled back far enough for the drill to clear the footer, if it were an exterior wall. Ambient ranges in rooms indicated that the two bedroom areas appeared to be receiving most infiltrating radon. A diagonal plane of high measurements was identified on this end of the structure. SSC was below the limits measurable with equipment we use. An initial 4" vent was located in a bedroom closet and extended through the attic. This was about 50% successful. Tapping into the line at two ends with 2" vents hidden in wall frames, between joists, and down a mechanical chase brought it down to single digit from the 35 pC/L range. Putting airtight doors on the 48" hearth to eliminate the thermal stack from that structure was required to get radon down to the 4-5 pC/L range in February. That satisfied the client, so we could not proceed.

Fig. 5 represents an L-shaped basement, a partial excavation within the foundation walls, which left the balance of the included area unexcavated and retained. This structure was retrofitted both with a basement and a slab over earth and stone. The indoor measurement was in the mid to upper teens range, pico

Curies per Liter. There was no measurable SSC. Only one point measurement evidenced significant radon concentrations. The vent was installed right on top of this point. Post-mitigation concentrations were measured at 1.5 pC/L. It is believed that locating the vent more than three feet in any direction would have resulted in no measurable effect on ambient radon, and certainly in less favorable results.

BORDERLINE LEVEL ATTACKS--

The transferee in a relocation context was informed of a 4.6 pC/L basement measurement by a third-party contractor. In a time-driven situation, it was perceived as important to effectively seal out enough radon to provide more acceptable concentrations. The results of failure would neccessitate installing a mechanical system to remove a borderline amount of radon! That would mean an energy consuming appliance for the next owner, surely an inefficient remedy. A nine point grid was established, after confirming levels between 4.0 and 5.0 did, in fact, exist. No radon was measured in excess of 200 pC/L, Concentrations below 200 pC/L are not thought to contribute to ambient air without a very strong stack or a very facile entry route, and neither case appeared present. The transferee looked over the data, listened to the problem, and then recalled that there was a double footer, resulting from an initial incorrect stakeout for the foundation! A second range of tests were performed between the two footers as shown in Fig. 6. The radon was found, and intensive sealing was performed with a post-mitigation measurement just under 3.0 pC/L, satisfying the relocation company.

Fig. 7 shows another borderline attack of a 4.1 pC/L measurement. Sniffer tests demonstrated that there appeared to be insufficient radon under the slab to be of concern and diagnostic grabs over floor drains indicated they were the source of radon gas. Gas proof drains were installed, and post-mitigation measurements were below the LLD; radon was practically gone!

MECHANICAL SYSTEMS IN COMMERCIAL BUILDINGS--

Fig. 8 represents a section of the United States Federal Building in Martinsburg, WV. SSC was erratic and levels were variable and would not line up. Something different was operating. A set of mechanical plans for this section of the building was requested. Wastewater lines below the slab were scaled onto the measurement plan view and it was quickly seen that radon levels were higher the nearer the test point to the wastewater line. A few additional holes and measurements confirmed that radon was moving along the pipe route, possibly in a "shadow" where material was not consolidated under the pipe when concrete was poured. The communication from holes bored nearest the pipe evidenced marginal but workable communication, and a 180 CFM fan provided post-mitigation levels below 1.0 pC/L in areas measuring in upper single and lower double digit ranges in picoCuries per Liter. The building slab was poured on solid rock, without a lift of gravel.

TYPICAL PROBLEMS--

Many homes with basements, especially "walkout" style homes built into grades, have large finished areas the client is reluctant to damage to enable sealing the slab/wall interface

and the top of the hollow block foundation walls typical of this area. As Fig. 4 illustrated, it is sometimes possible to pull back carpet over tack-track to do testing. In the case of Fig. 9, the carpet was glued down. Ambient levels were seen to be about 22-24 pC/L. Visible portions of the slab looked good, and there were no floor drains or sumps, hollow columns below the slab, or slab penetrations. It was decided that a radon concentration between 2200-2400 pC/L would be accepted as the likely area of arrival. Test holes were drilled in the unfinished portion of the basement and in a wood bin with a slab floor adjacent to a wood stove. Ambient grab tests indicated main entry was apparently in the unfinished area, and SSC tests were about the best seen in about 50 homes measured by this method to date, except for one corner which measured zero communication and had a sniffer test measurement below 200 pC/L in spite of four-digit measurements adjacent to it and at the opposite corner of that end. The vent point selected was as far back from the foundation wall as it could be set along a partition wall and still clear the doorway. A 150 CFM fan easily removed measurable radon; post-mitigation measured below 1.0 pC/L. Given two doors and a partition wall and then an open stairwell to the upper level between the system and the wood stove, no backdrafting problem was perceived and no negative pressure was measured in the foundation wall near the system, and the clothes dryer venting to the outside had been operated when the stove was in use without a problem.
It is not always the case that the unfinished portion of the

basement contains the problem. A home being worked on at this time, in Mineral County, WV is built on solid shale, leveled with "the bulldozer blade smoking", no lift of stone provided under the slab. Ambient measurements range in the upper 30 to lower 40 picoCuries per Liter, and implicate the finished end of the basement as the apparent area of main entry. Sniffer measurements found no consequential radon under the slab in the unfinished part of the basement. The carpet is, of course, glued down. There is a drop ceiling, and the finished interior wall is framed with a four inch gap between the interior and exterior wall. Also, the upstairs measurements are about 75% of the downstairs level, indicating strong transport between floors in the wall and ceiling frames. The main entry route was suspected to be the hollow wall blocks until the client responded that these had been filled with concrete. A series of ambient grabs is planned for the next visit, to be taken above the drop ceiling along the finished end and the side fitted into grade. The interior panel will be removed adjacent to the highest value measured, and sniffer tests taken, after cutting out the wall frame plate between wall studs. If this works, we may yet find the radon. When it is found, it can be attacked.

When a matrix measurement is not possible, available points are measured and compared with ambient levels. If the apparent area of entry is not found, it is neccessary to be creative, intrusive or both. More often than not, but not always, the area of arrival in a structure built into a grade appears to be in the end of the structure into the grade, that is, the area which is more below grade than the other end or side.

CONCLUSIONS

Clearly, the flexibility, economy, and tolerance to humid and low temperature conditions of the electret method of measurement are of great benefit in diagnostic work. The methods outlined here hold promise to solving tough mitigation problems. However, there are some cautions to note.

First of all, reading a cold electret with a warm reader is likely to cause an overread, a false high. The electret contracts just enough to appear to have lost more voltage than it has. In most cases, this will not be a problem, but be alert for this in extremely cold weather in unheated basements. Also, the uniqueness of any structure, in terms of construction, communication, mechanical systems, topography, interior partitioning, floor cover, and floors above grade combine to make comparative data slow to come by. All notions must be held very tentatively, for example, predicting the highest likely concentration under the slab from ambient levels, which is subject to range due to unquantifiable aspects, such as stack variations and varying quality of main entry routes. Also, variations in geology outside the Uraniferous shale/piedmont soils may require adjustments and present new obstacles or opportunities.

It is hoped that furthur contributions by others may result in a furthur enhanced methodology that will make mitigation almost an exact science, lowering the overall cost of mitigation, and making it more easily affordable to more families. Even relatively low levels of radon have been seen to be very difficult to seal out, in many cases. Something the size of an atom does not require much room to maneuver through a very tiny means of access, especially if drawn in by low pressure. An intensive sealing effort guided by two hours of relatively inexpensive diagnostic work will probably produce better results, in most cases, and result in good reductions without resorting to energy consuming mechanical systems. When those are required, however, good diagnostics will provide more efficient results, by eliminating unneccessary sealing, when possible, or, by getting on target in homes with poor SSC. It is the philosophy of this firm not to let equipment sit idle. When equipment is not working for a living, it can be used to increase knowledge and your experience. We are still in the infancy of this industry, and there is much to be learned.

RECOMMENDATIONS

In each county seat is a soil conservation district office at which you may obtain, free of charge, a soil survey book for your county. There will be a county map showing the major soil associations for your county. You may try comparing your testing results to those soil associations. In West Virginia, we have found a strong correlation between the highest radon levels measured and the and Berks association soils. These soils also appear to deliver radon to structures with greater frequency than adjacent soils. I will not repeat the pitfalls of trying to predict radon in an individual structure by relying on a map, but as a research and marketing tool, the USDA Soil Survey guide for your county may give you something to report to your State radon officials and your local planning and zoning officials, and the media. Just be sure you have statistically significant data or that you qualify your remarks. A little homework into the parent material of the surface soils may also be beneficial.

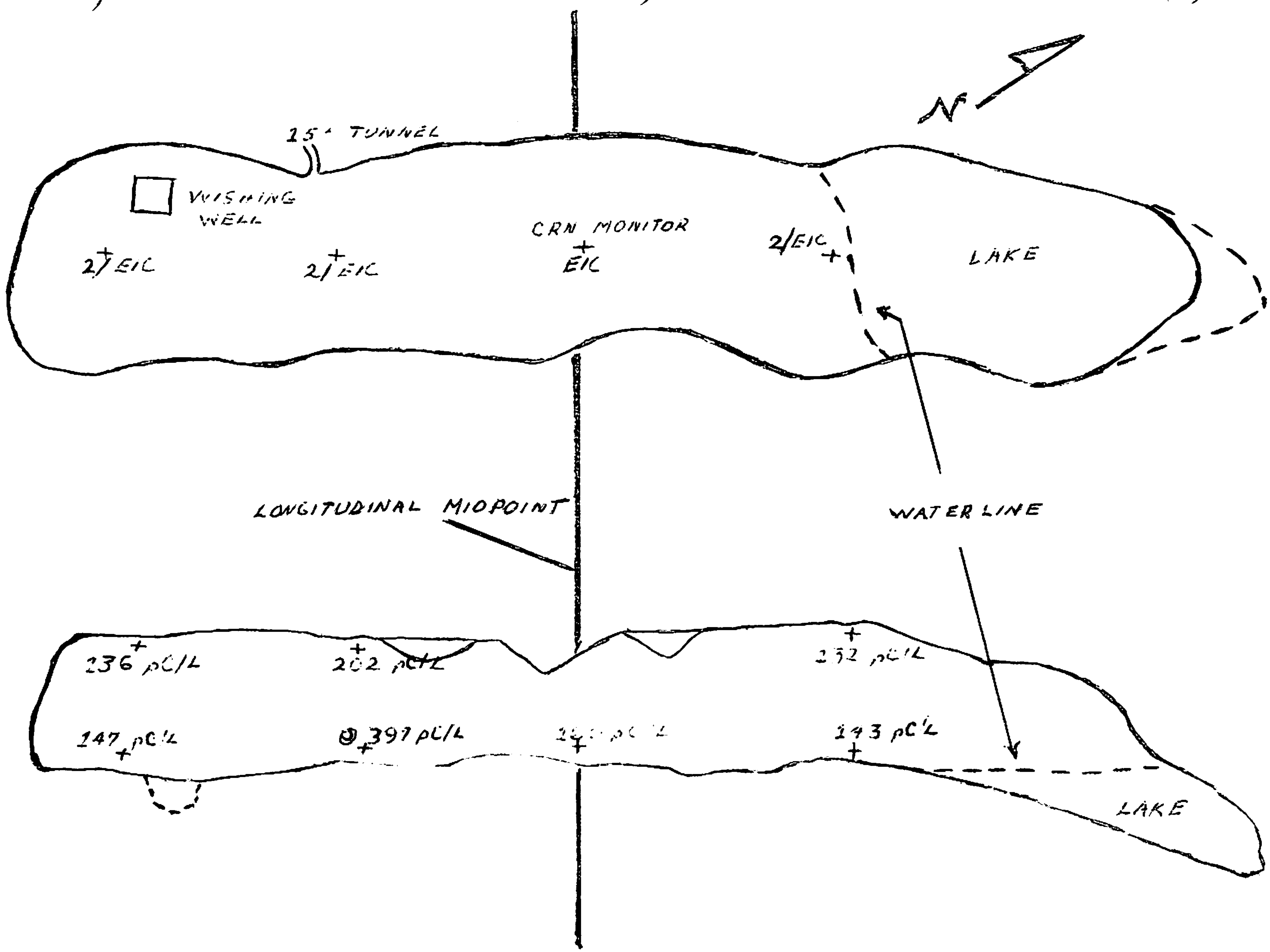
If you have underground voids, such as mines, tunnels, quarries, storm sewers, caverns, stormwater management vaults, and the like in your area, you may check into the possibility that these are concentrating radon and the potential for those to vent that radon into structures.

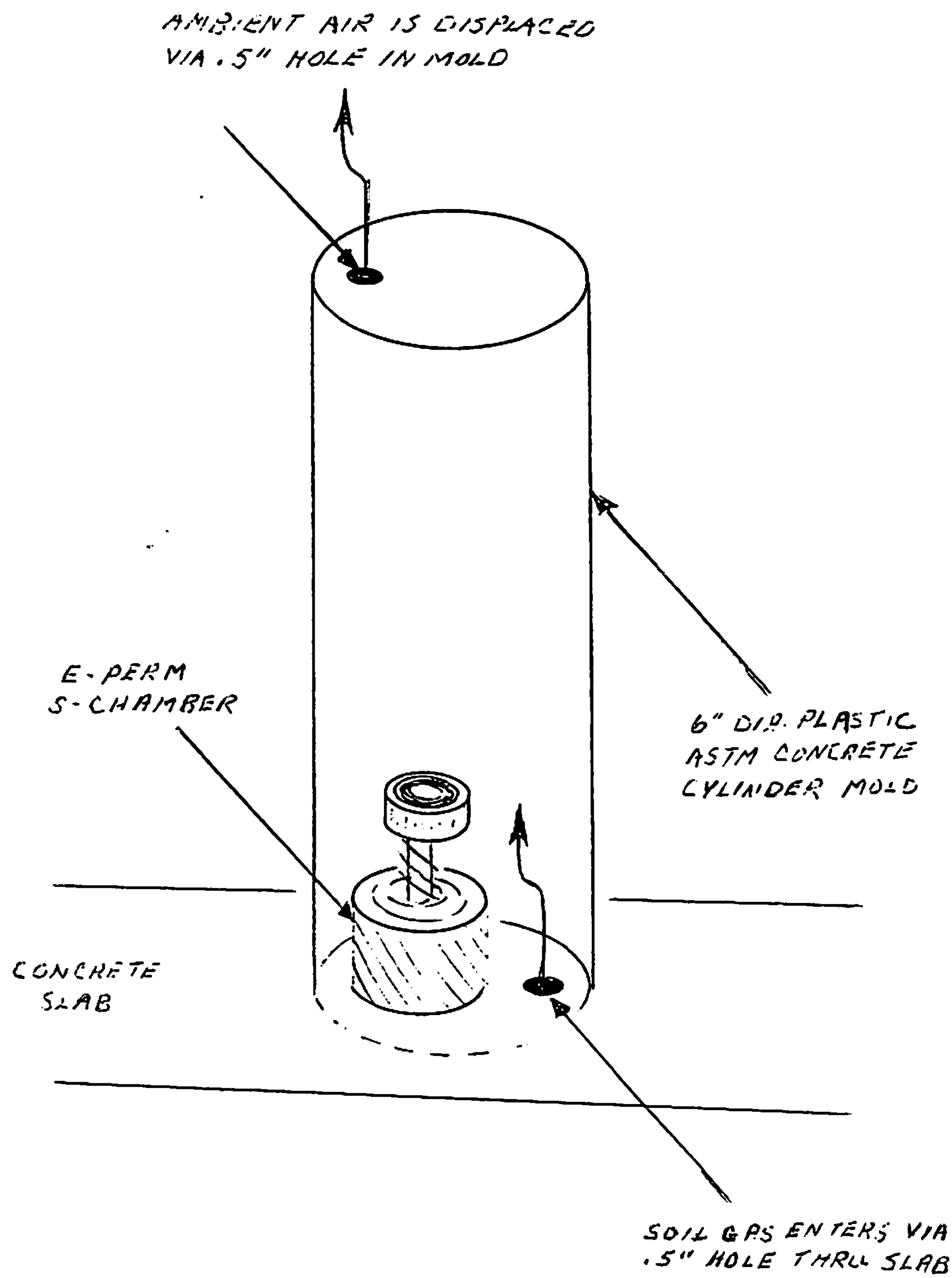
Other individuals or firms working with the methods presented here may wish to bear these two points in mind as they proceed. In addition to the other data it was suggested be recorded, add the soils type, and always be alert for the potential of receiving concentrated radon from an underground void, as was seen in Fig. 7.

A final note on topography. Fig. 10 and Fig. 11 show a very hypothetical model that attempts to explain why datapoints often "connect" and appear to have some width related to this "line", and why high concentrations are often found in the curve of a hillside the home is built into, rather than on the side of the more gentle grade. Asynclines, dome shaped folds in strata, may concentrate radon moving upwards by conducting it parallel to the fold in the strata, focussing it toward the area of greatest bend, which is most likely to contain fissures. Emerging into soil very focussed along the crack through the fold, which will often be nearly perpendicular to the strike of the bedrock, it may begin to diffuse out from above the crack as it works up through soil, giving the window an elliptical or oval shape. This is very hypothetical, but by tracking orientation of apparent "lines" of radon and learning more about local geology, radon professionals may be able to learn more about this question.

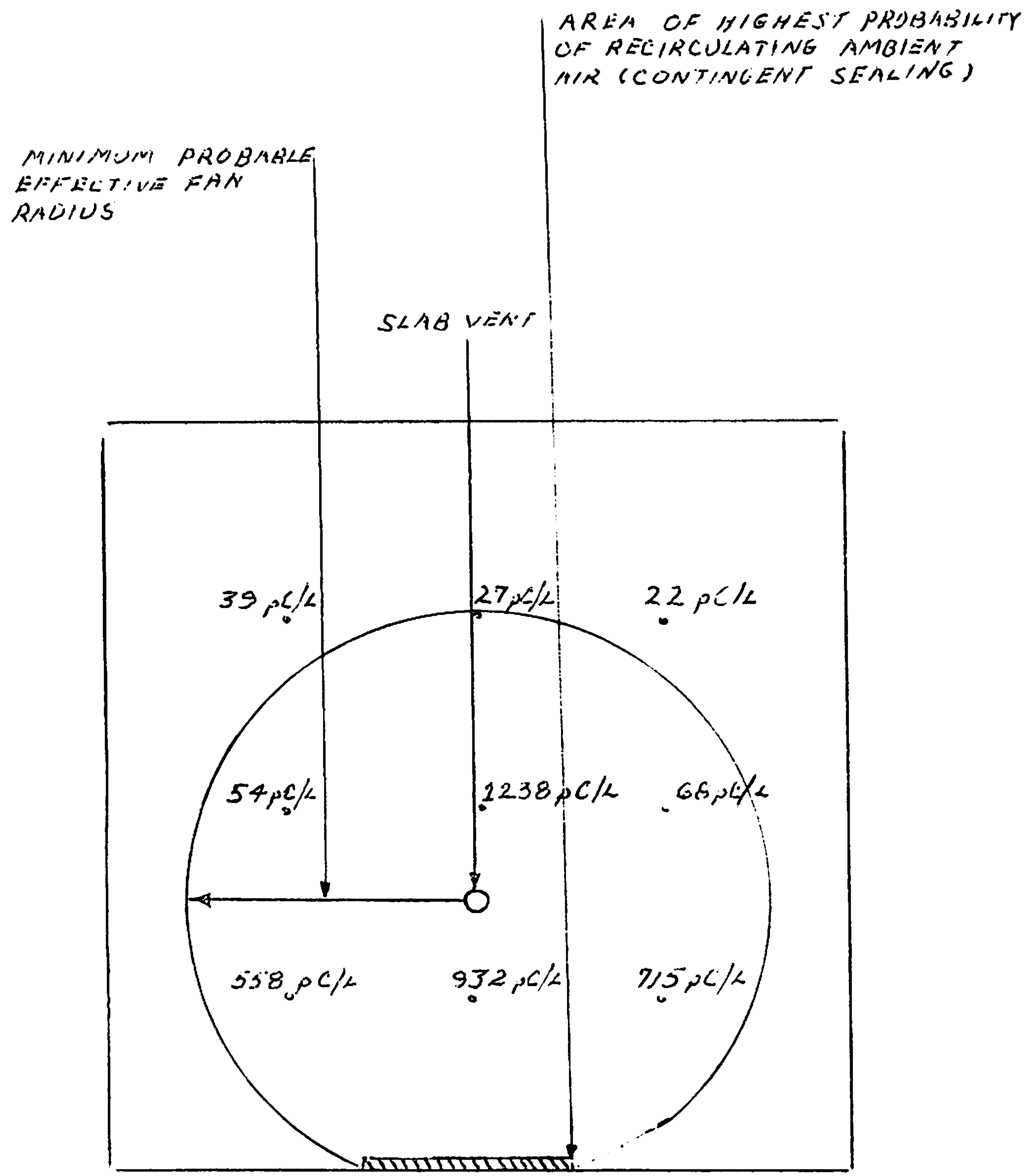
LIST OF FIGURES AND CAPTIONS:

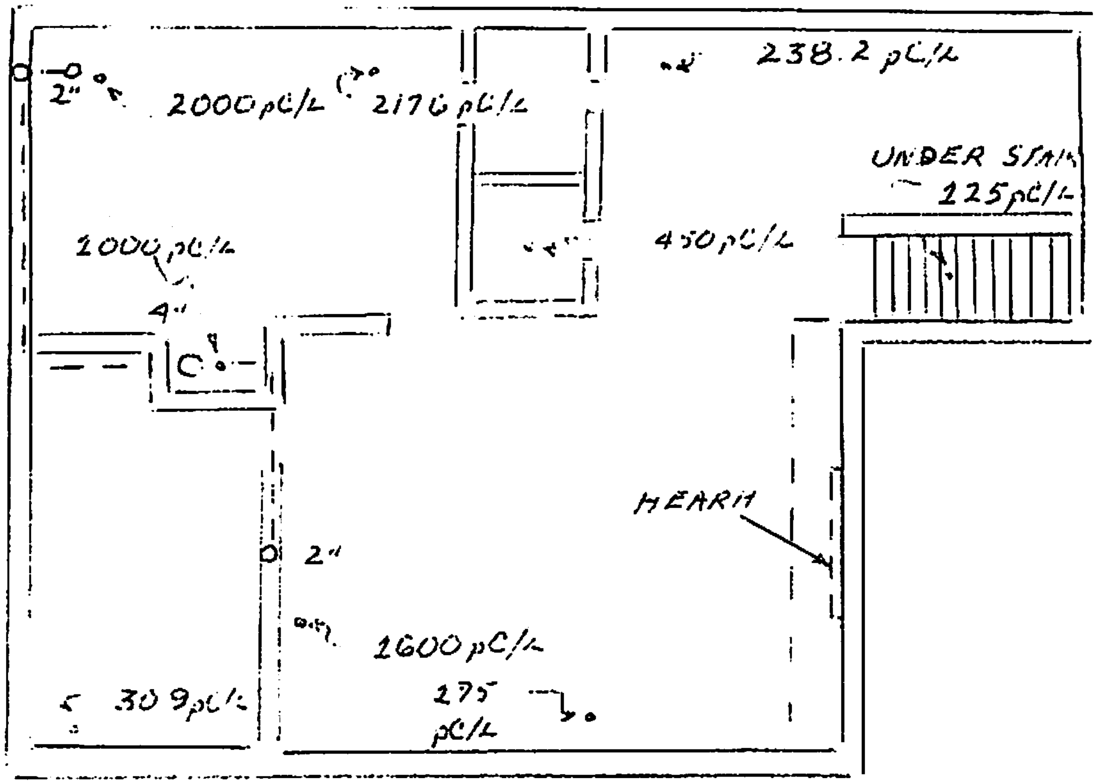
APPENDICES


N
15' TUNNEL
WISHING WELL
2/EIC
2/EIC
CRN MONITOR
EIC
2/EIC
LAKE
WATER LINE
LONGITUDINAL MIDPOINT
236 pC/L
202 pC/L
232 pC/L
147 pC/L
397 pC/L
143 pC/L
LAKE

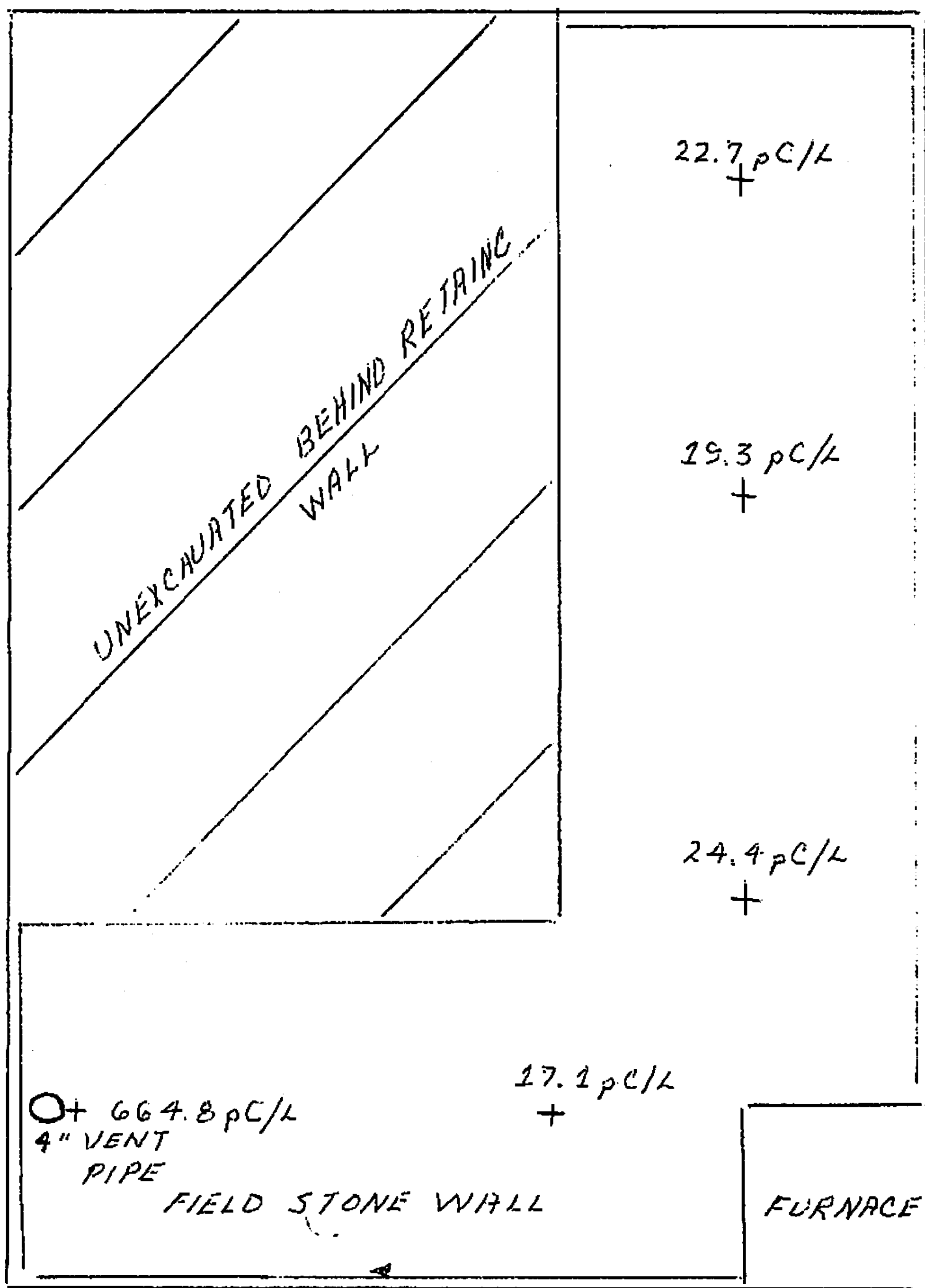


AMBIENT AIR IS DISPLACED
VIA .5" HOLE IN MOLD
E-PERM
S-CHAMBER
6" DIA. PLASTIC
ASTM CONCRETE
CYLINDER MOLD
CONCRETE
SLAB
SOIL GAS ENTERS VIA
.5" HOLE THRU SLAB

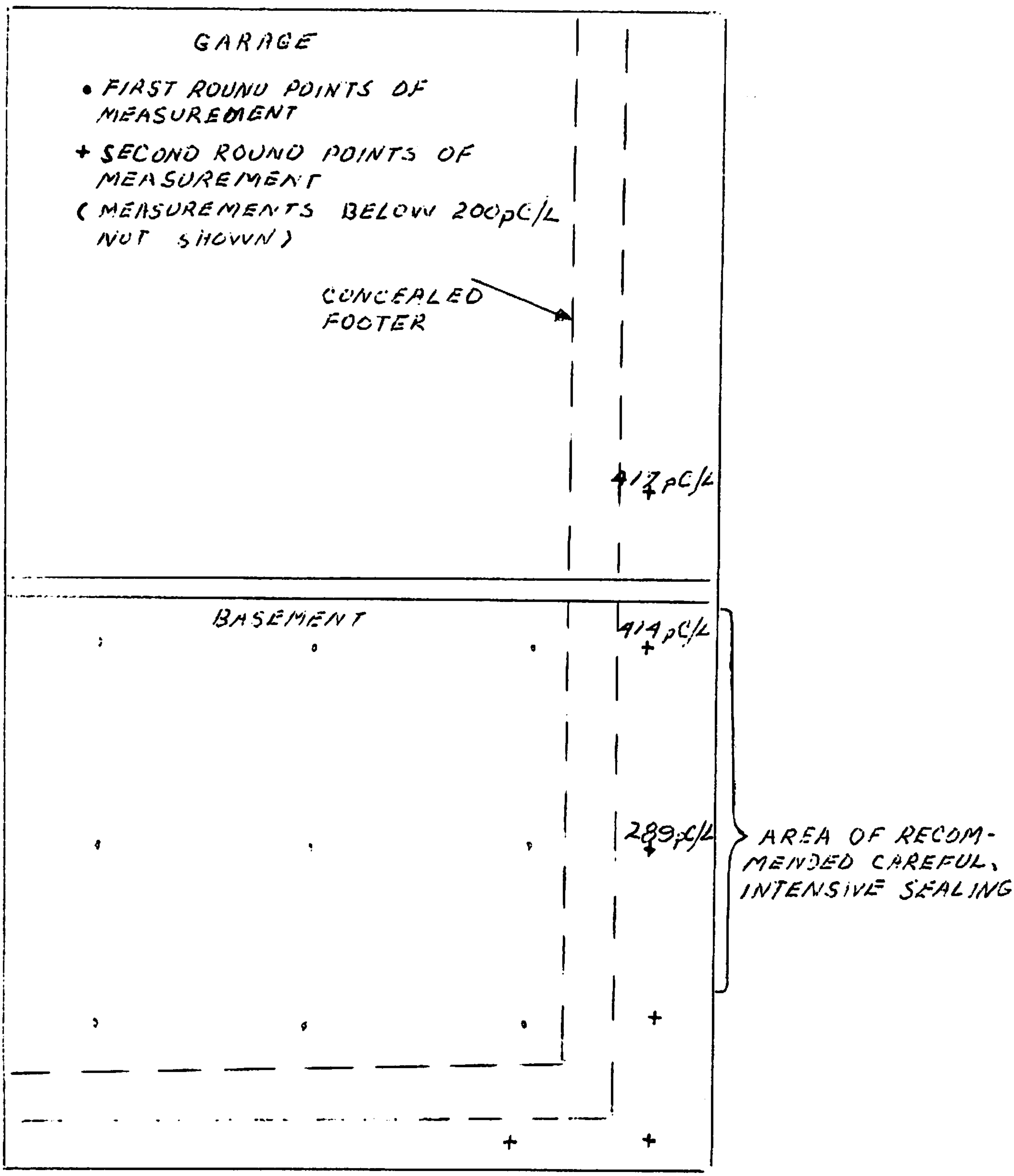

AREA OF HIGHEST PROBABILITY OF RECIRCULATING AMBIENT AIR (CONTINGENT SEALING)
MINIMUM PROBABLE EFFECTIVE FAN RADIUS
SLAB VENT
39 pC/L
27 pC/L
22 pC/L
54 pC/L
1238 pC/L
66 pC/L
558 pC/L
932 pC/L
715 pC/L

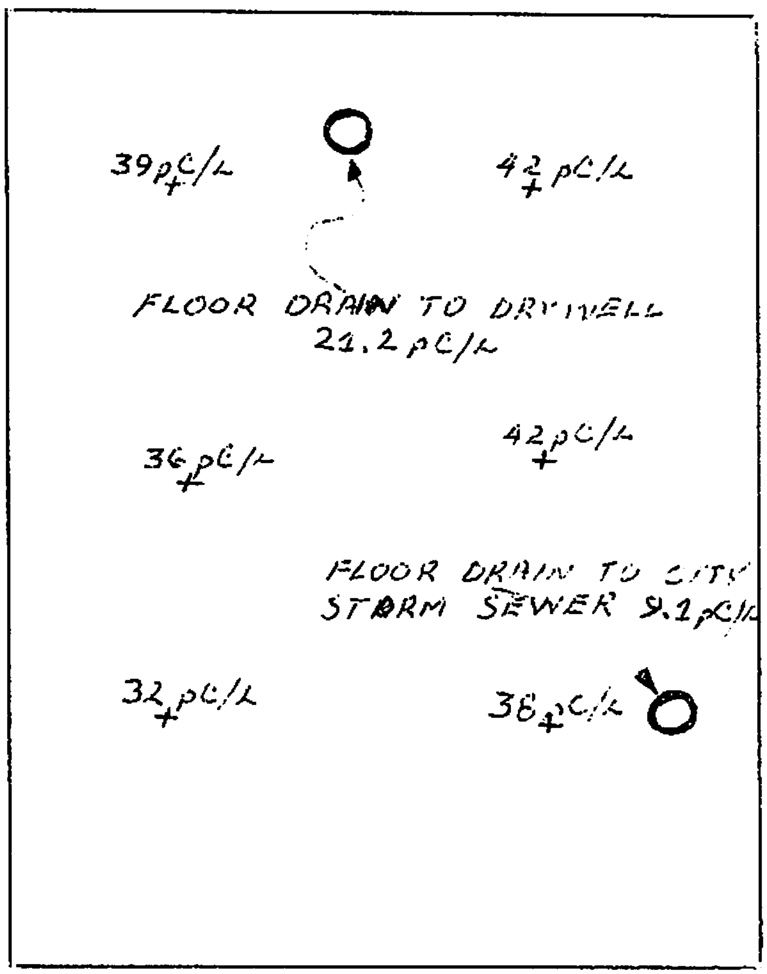


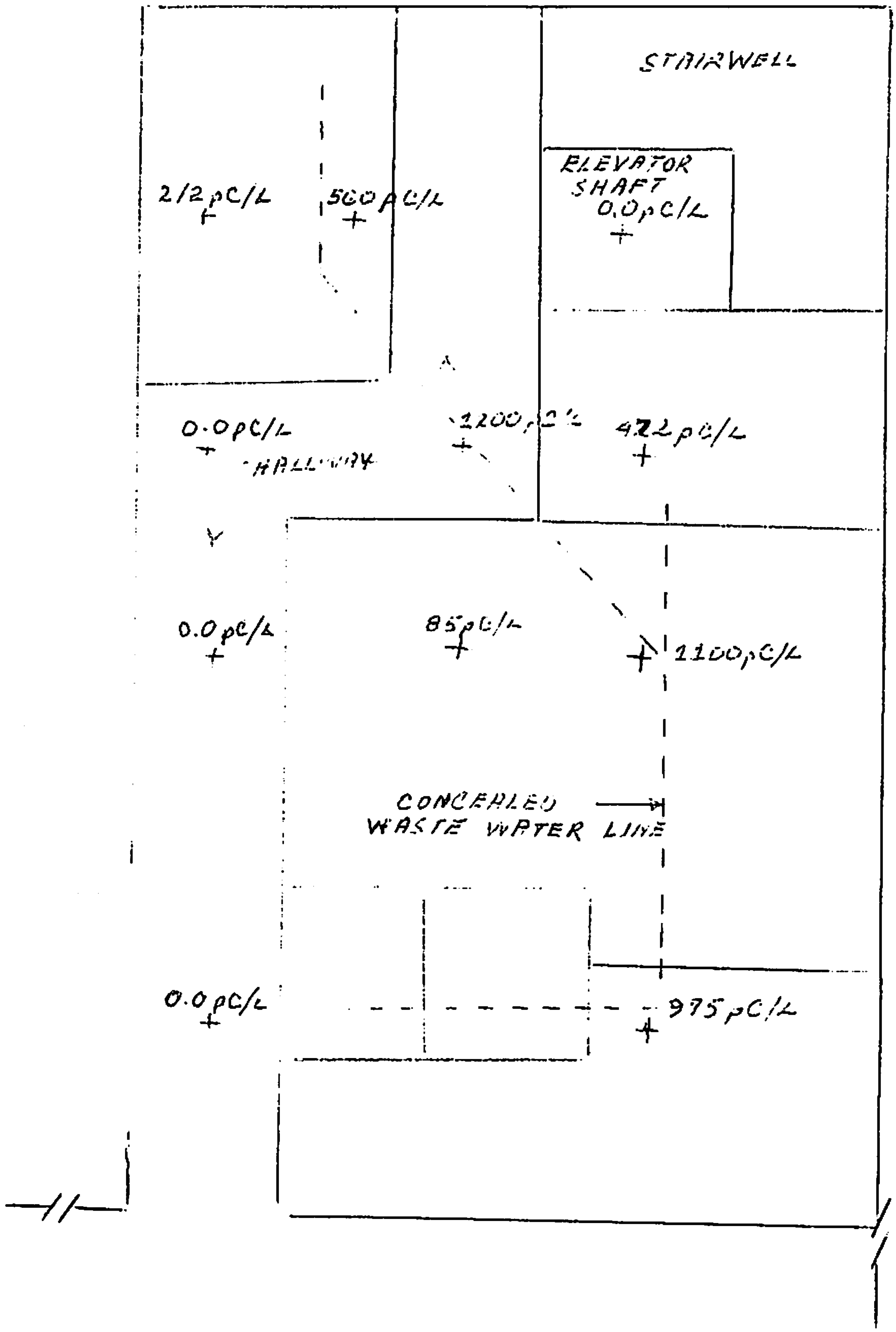
238.2 pC/L
2"
2000 pC/L
2176 pC/L
UNDER STAIR
225 pC/L
1000 pC/L
450 pC/L
4"
HEARTH
2"
1600 pC/L
309 pC/L
275 pC/L

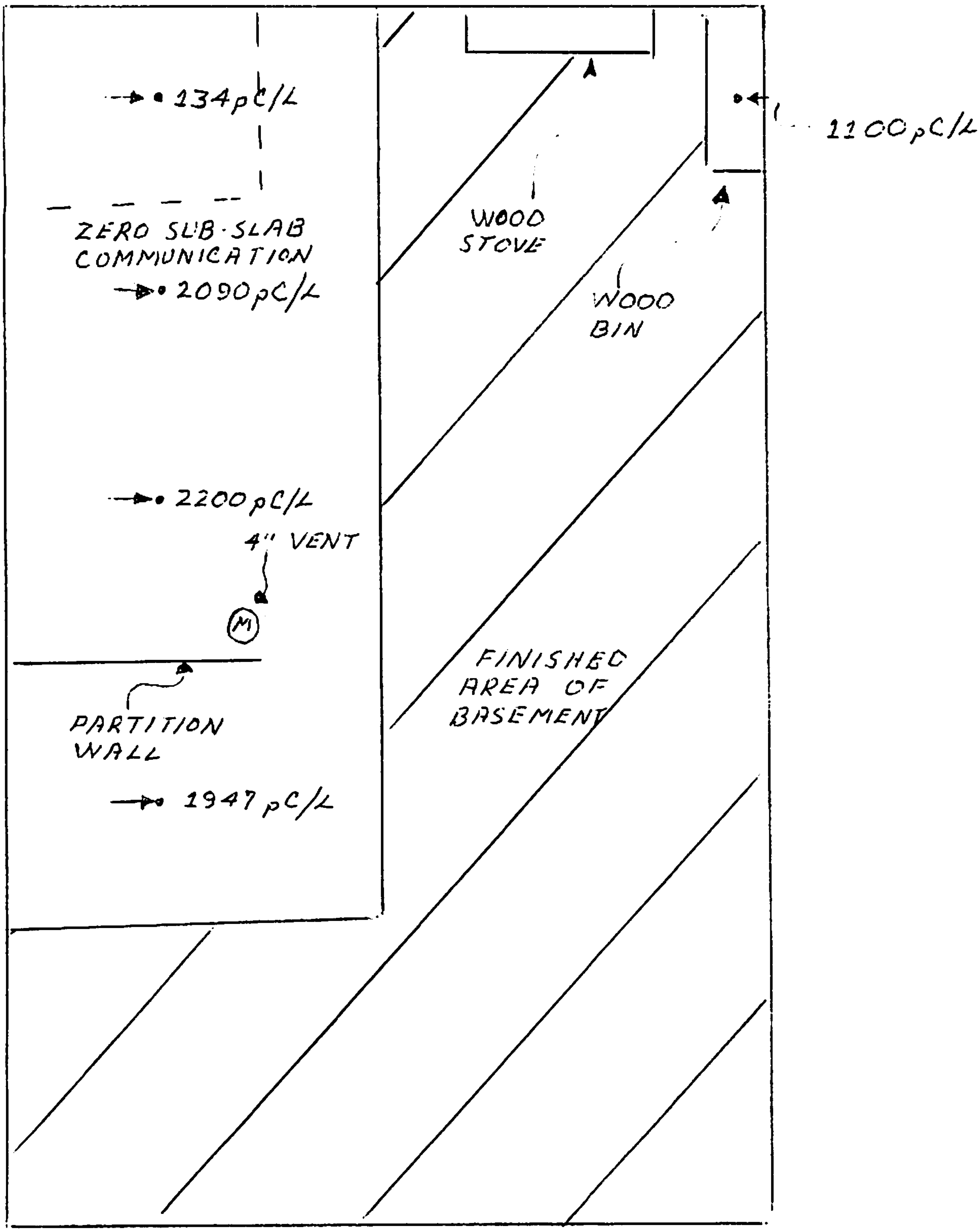


22.7 pC/L
19.3 pC/L
24.4 pC/L
17.1 pC/L
664.8 pC/L
4" VENT
PIPE
UNEXCAVATED BEHIND RETAINING
WALL
FIELD STONE WALL
FURNACE


GARAGE
• FIRST ROUND POINTS OF MEASUREMENT
+ SECOND ROUND POINTS OF MEASUREMENT
(MEASUREMENTS BELOW 200pC/L NOT SHOWN)
CONCEALED FOOTER
417pC/L
BASEMENT
414pC/L
289pC/L
AREA OF RECOMMENDED CAREFUL, INTENSIVE SEALING


39pC/L
42 pC/L
FLOOR DRAIN TO DRYWELL
21.2 pC/L
36 pC/L
42 pC/L
FLOOR DRAIN TO CITY
STORM SEWER 9.1 pC/L
32 pC/L
38 pC/L


STAIRWELL
ELEVATOR SHAFT
0.0 pC/L
212 pC/L
500 pC/L
0.0 pC/L
HALLWAY
1200
422 pC/L
0.0 pC/L
85 pC/L
1100 pC/L
CONCEALED WASTE WATER LINE
0.0 pC/L
975 pC/L



134 pC/L
1100 pC/L
ZERO SUB-SLAB COMMUNICATION
2090 pC/L
WOOD STOVE
WOOD BIN
2200 pC/L
4" VENT
M
FINISHED AREA OF BASEMENT
PARTITION WALL
1947 pC/L

1 SHALE

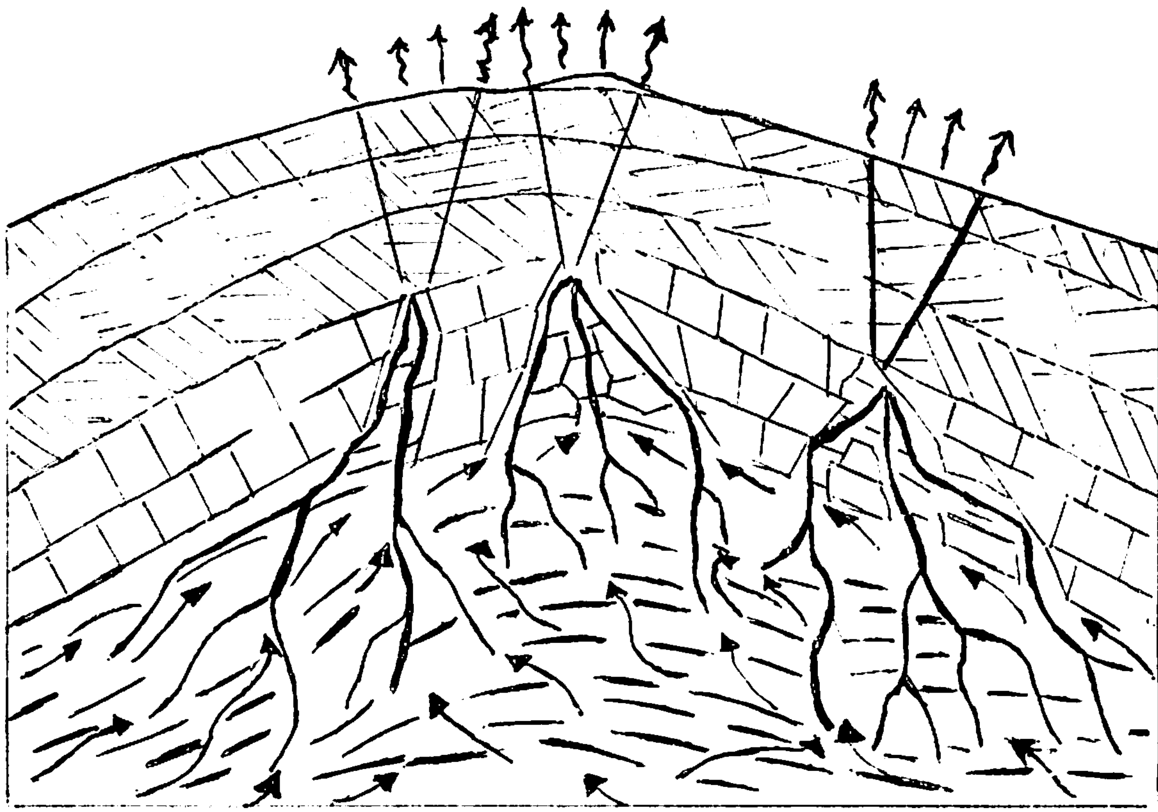
RADON GAS CONCENTRATING IN SHALE STRATA, RISING THROUGH UPPER END OF FISSURES.

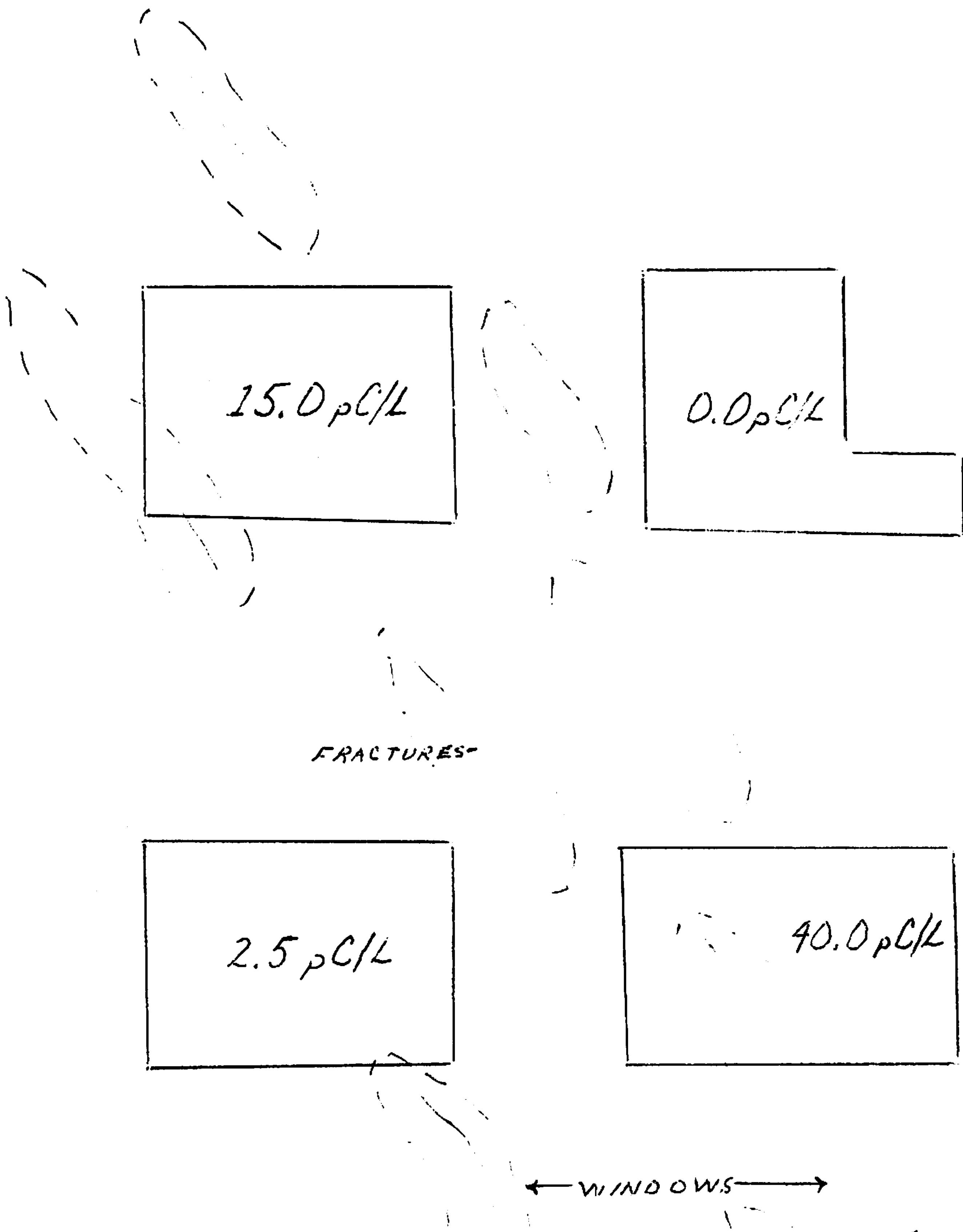
2 FRAGIPAN

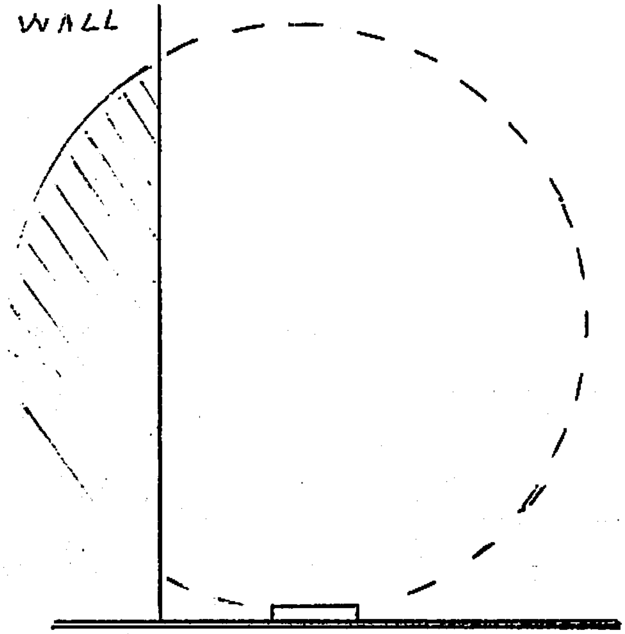
CONCENTRATIONS MERGE AT FISSURES THROUGH LIMESTONE OR FRAGIPAN OF DETERIORATED SHALE; POINT OF TIGHTEST FOCUS.

3 EARTH

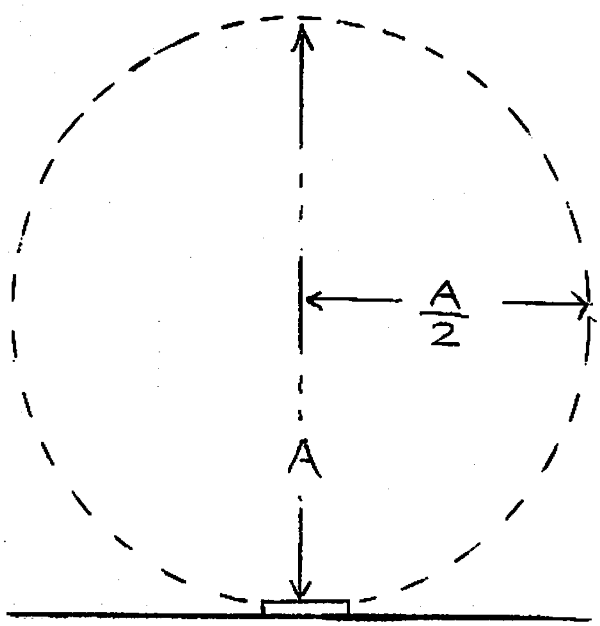
RADON MOVES UP, DIFFUSING OUT AS IT APPROACHES THE SURFACE, DAYLIGHTING IN A RELATIVELY LONG & NARROW ELLIPE.



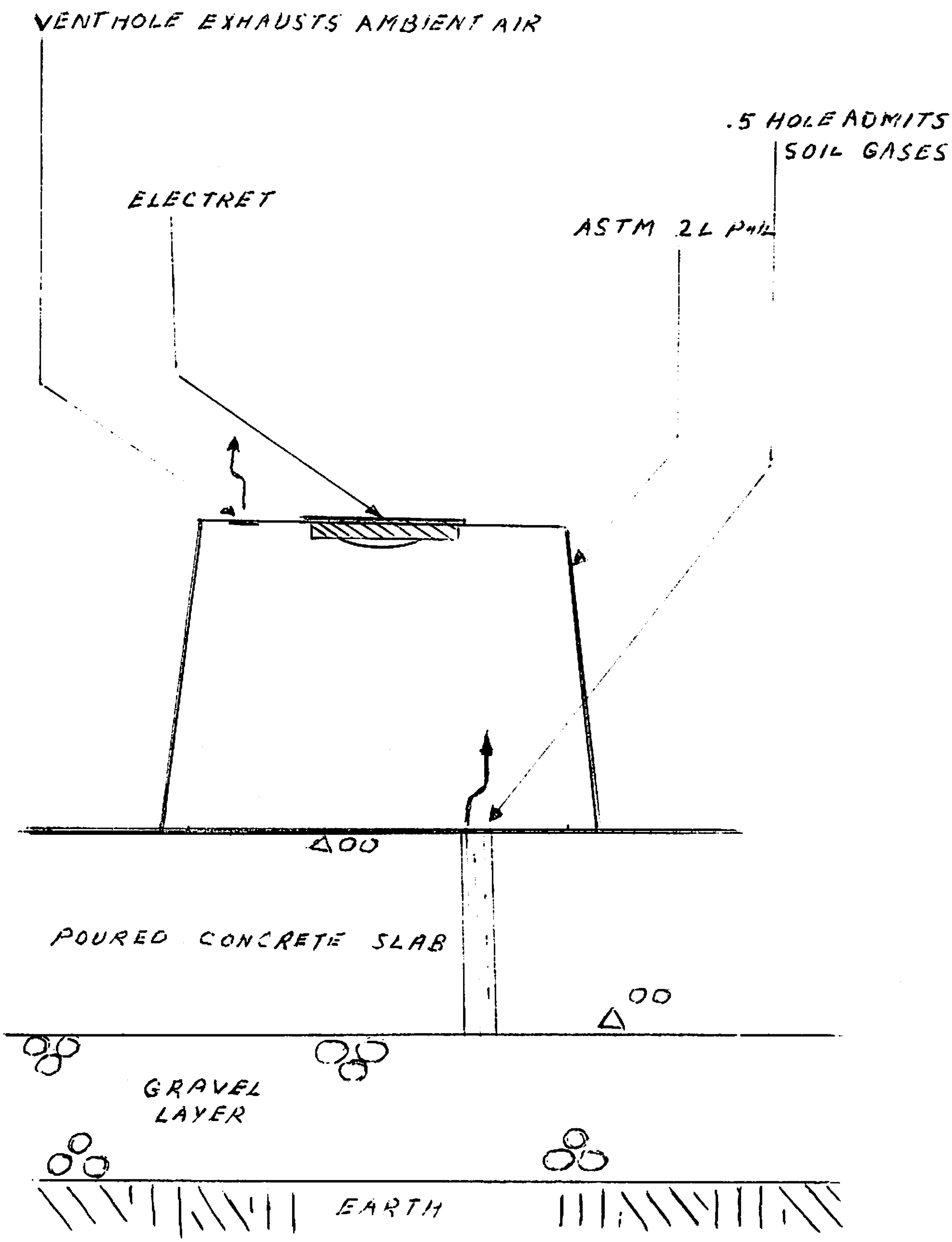

15.0 pC/L
0.0 pC/L
FRACTURES
2.5 pC/L
40.0 pC/L
WINDOWS



IMPAIRED FIELD
A = APPROXIMATELY 36"



CORRECT PLACEMENT



VENTHOLE EXHAUSTS AMBIENT AIR
.5 HOLE ADMITS SOIL GASES
ELECTRET
ASTM 2L PAIL
POURED CONCRETE SLAB
GRAVEL LAYER
EARTH

APPENDIX I

"Instant" Radon Monitoring: It is possible to get an approximate idea of the variation of radon concentrations in an area or between rooms by quickly exposing bare short term electrets to the room/area environment. In this mode the electret will read a spherical field; take care to place the electret in an open area to avoid impairing the reading, as shown in fig. 12.

PROCEDURE

1. Record initial readings, and expose electret for a known period T minutes (recommend 10 minutes). Locations should be in each corner of an open basement plus a pair or two between corners, or in each room of a partitioned basement, plus any potential main entry routes, e.g. a sump.
2. At the end of this exposure, cap and read immediately final voltage (VF). A stopwatch is recommended for timing.
3. Calculate voltage drop per minute ((VI-VF)/T); this is DV.
4. Calculate the midpoint voltage ((VI+VF)/2); this is MPV.
5. Read the calibration factor (CF) from the graph for this MPV.
6. Multiply DV by CF to obtain the approximate concentration of radon in pC/L. DO NOT REPORT THIS AS A RADON MEASUREMENT. This method is sensitive both to radon and progeny. It is a qualitative method of comparing apparent levels from area to area or room to room for diagnostic purposes, or to get a general idea of the "ballpark" concentration of radon gas.

APPENDIX 2

Electret "sniffer" measurement for diagnostic tests: Mapping of the subslab radon concentrations is useful as part of the diagnostic procedure, and can be performed using the same holes bored for the sub-slab communication testing, a matrix of holes located to verify communication from under different areas of the slab. The sniffer consists of an inverted 2 liter metal bucket placed over the hole through the slab. A long term electret fits an aperature at the "top" of the inverted bucket. (The bucket is available from Rad-Elec, Frederick, Maryland.) The sniffer method was calibrated in a radon chamber in a mode identical to the following procedure:

1. Before doing sub-slab communication tests, place buckets over all test holes at the same time.
2. Time fifteen minutes for displacement of ambient air by gasses diffusing in from beneath the slab.
3. Insert premeasured long term electrets into the hole provided. (Measurements below the LLD of the long term electret may be measured with a short term electret, but are not thought to represent sufficient radon to indicate a source of contribution in most cases.)
4. After a timed sample period of 15-60 minutes, read final voltage on the electrets.
5. Calculate subslab radon = 1000 x (I-F)/CF x T. I is initial and F is final voltage, T is time in minutes, and CF is the calibration factor = 1.209 + 0.000778 x ((I+F)/2)

(If a short term electret is used, divide the results by 11.)