6 Collecting and Managing Data on Lead in Soil

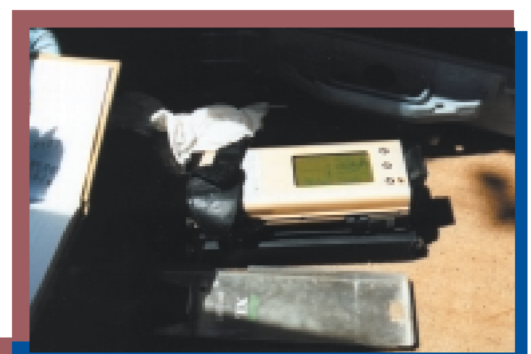
This chapter describes a state-of-the-art technique, using field-portable x-ray fluorescence technology, for collecting and managing data on lead in soil. This technique allows inspectors to discern patterns of contamination at a property quickly and accurately. This technology is suitable for use by trained, certified inspectors who meet federal, state, and local requirements for collection of environmental samples, as described in Section 6.4. This chapter is not intended to provide guidance for inspectors, but to give you, as a program organizer or decision-maker, an overview of the data collection and management process.

Section 6.1 is an overview of data collection and management techniques used by the EMPACT Lead-Safe Yard Project. Section 6.2 provides information on how to find the necessary equipment and laboratories for testing and how to cut costs. Section 6.3 is a step-by-step description of testing, quality control, and data management procedures that are used by professional inspectors; Section 6.4 discusses health and safety precautions for inspectors; and Section 6.5 is devoted to equipment maintenance.

If you mainly want a general idea of what data collection and management entails, you can focus on Section 6.1 alone. Sections 6.2 through 6.5 present more detailed material for those who are responsible for implementing a lead-safe yard program. Such readers may also be interested in the reproducible site worksheets at the end of this chapter.

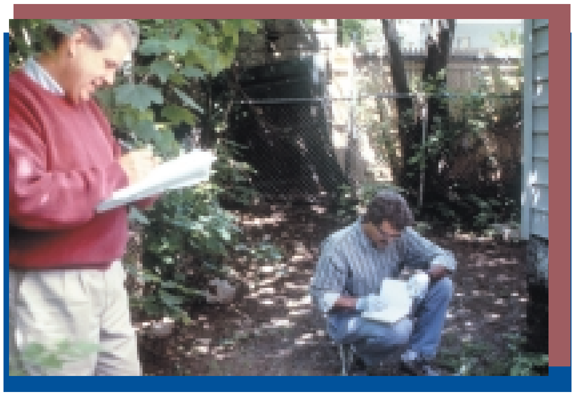
6.1 Collecting and Managing Data: An Overview

A key component of the EMPACT Lead-Safe Yard Project is the use of field-portable XRF technology. This technology allows inspectors to provide residents with onsite, real-time data about lead contamination in yards, without having to wait for the results of laboratory analysis. Field-portable XRF requires a substantial capital investment, as noted in Sections 6.2 and 6.5. On the other hand, programs committed to soil inspection for the long haul may find that the investment more than pays for itself. The EMPACT LSYP has conducted XRF analysis on roughly 2,000 soil samples over the past three years, which makes the cost per sample far less than it would have been for laboratory work. After all, sending samples to a lab involves not only charges for the analysis itself but also the expense of sample collection, shipping, and handling.



The XRF is a hand-held field-portable device that allows inspectors to get a lead-level reading within seconds.

Studies have affirmed the accuracy of XRF, and it has received EPA verification as well. (For example, EPA's Environmental Technology Verification Program has conducted field demonstrations to test several XRF technologies. Verification Reports and Statements from these tests are available online at http://www.epa.gov/etv/verifrpt.htm#monitoring.) What makes XRF technology especially valuable for a lead-safe yard program is that it offers real-time results with a hand-held, battery-powered device. This means that inspectors, while on site, can get parts per million (ppm) lead levels for individual soil samples within seconds, and, if necessary, adjust their testing strategy for the property as a whole accordingly. Experience has shown that lead concentrations in properties often vary significantly and unpredictably. With XRF, inspectors can learn about any unusually high lead levels right away and then take more closely spaced readings in the area from which the high reading came. The result is a clearer delineation of how soil contamination differs from one part of the property to another.



Inspectors mark the location of each XRF reading on a plot plan and record lead levels on a site worksheet.

One concern that has been raised about field-portable XRF is that it tests for lead only at the surface level. Many experts, however, are convinced that this is usually where the lead level in soil actually is highest. Also, the top layer of soil clearly poses the greatest potential health risk because of its accessibility.

When the EMPACT LSYP conducts XRF testing, the first step is to determine some rough guidelines by interviewing the homeowner and observing current conditions in the yard. Several high-risk or high-use areas may be identified. As the sample interview form in Chapter 5 suggests, these could include gardens, picnic areas, and children's play areas, in addition to areas of bare soil and heavy foot traffic. Such parts of the property are singled out for careful inspection. Another target is the drip line, generally a 3-foot-wide strip around the foundation of a house where lead tends to accumulate in soil due to flaking and peeling paint from exterior surfaces.

The EMPACT LSYP's procedure for taking XRF readings is straightforward. The XRF and test guard are placed on the exposed soil surface and depressed to open the shutter. A 30- to 60-second measurement should yield reliable results. As inspectors take these readings, they mark the location of each on a plot plan of the property and record the lead levels on a site worksheet. Any other relevant descriptive information, such as the weather and the general condition of the yard, is noted on the worksheet as well.

The lead levels from different locations within a particular area—say, the east drip line—are averaged to yield a mean value. Depending on this value, the EMPACT LSYP assigns each area to one of its four categories (see Section 3.4.3.1 for a comparison with proposed categories under TSCA Section 403):

- Very high (5000 ppm or more)
- High (2000 to 5000 ppm).
- Moderately high (400 to 2000 ppm).
- Low (400 ppm or less)

Detailed guidance about mitigation strategies for each of these categories is provided in Chapter 7 of this handbook.

The EMPACT LSYP takes several quality control measures to back up XRF readings on every property. Accuracy and reproducibility are checked periodically using continuing calibrations (verification against a known standard) and replicate measurements, respectively. Inspectors also collect a small number of soil samples for confirmatory lab analysis. Since XRF is still a new technology, its results need to be judged against the gold standard of accepted practice, in this case inductively coupled plasma (ICP) or atomic absorption (AA) methods, both of which are conducted in a laboratory and take about 2 to 4 weeks.

Nevertheless, inspectors often have enough confidence in their XRF findings to give homeowners and landscapers a provisional color-coded map of a property's lead levels well before the results of confirmatory lab tests are available. The map on page 81 is an example. Inspectors may prepare such a drawing before they even leave the site, using markers or colored pencils and a copy of the plot plan. This hand-drawn method is simple, immediately interpretable, and readily accessible to the homeowner. Alternatively, the XRF readings may be taken to an office and used to produce a computer-generated map, as shown on page 82. Either way, homeowners and landscapers can gain a general understanding of what areas of a yard need remediation and start making plans.

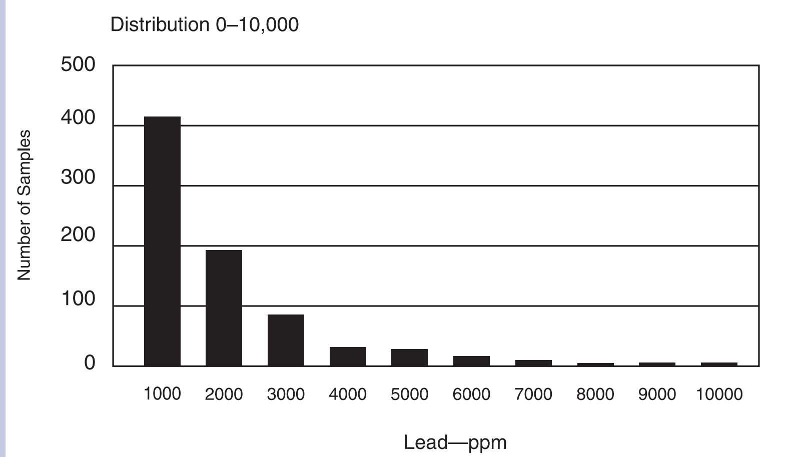
Once a lead-safe yard program has tested a sizable cross-section of properties in a city, it might be useful to record the results on a map to see if a geographical pattern emerges. If such a pattern does emerge, the information could be made available to the public, perhaps on a Web site, to promote awareness of the lead-in-soil problem and help homeowners and communities make more informed decisions.

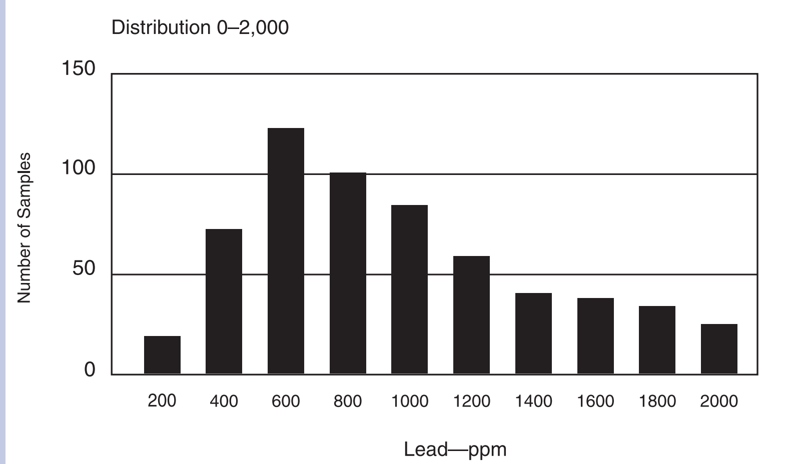
As an example, maps showing the lead content of soil in various parts of New Orleans, Louisiana, are available online at http://www.tmc.tulane.edu/ecme/leadhome/soil.html. Environmental

EMPACT LSYP 1998
ANALYTICAL PROGRAM FINDINGS

In Phase I of the EMPACT Lead-Safe Yard Project, lead in surface soil concentrations measured in the Bowdoin Street neighborhood ranged from 103 to 21,000 ppm.

The mean value for these data was 1,632 ppm (n=781). Twenty-two percent of the measurements were above 2,000 ppm, and 87 percent were above 400 ppm.





Lead Concentration Distribution for Phase 1 Field Work toxicologist Howard Mielke of Xavier University in New Orleans analyzed 3,074 surface soil samples representing 283 census tracts. The data indicate that the most contaminated areas usually lie in the central part of the city, where traffic is heaviest.

6.2 Getting Started

Individual homeowners or groups planning a very limited lead-safe yard program will probably just want to hire a risk assessor certified for use of XRF for soil analysis. In any case, local authorities regulating lead abatement activities should be consulted.Those seeking to implement an extensive program will probably want to buy their own field-portable XRF to be used by trained/certified inspectors working with the program. The EMPACT LSYP uses an instrument manufactured by Niton Corporation[17], which also provides training. For information, call 1-800-875-1578 or visit http://www.niton.com. See Section 6.4.2 for information about XRF use licenses and certification.

An XRF similar to the one used in the EMPACT LSYP, a field portable Niton Model 702, costs about $26,500, making it the most substantial expense a program will face. Day-to-day maintenance of the XRF is generally not costly, though programs will face the additional expense (around $2,600) for replacement of the instrument's radioactive source at least once every two years, if not more frequently (see Section 6.5). Some savings are possible, however. The box below provides some suggestions; for example, it describes a less costly XRF instrument that was not available when the EMPACT LSYP purchased its instrument.

HOW TO CUT COSTS

Recently, Niton has developed a field portable XRF that tests for lead alone, not the wide range of other metals detectable with a 700-series Niton. This instrument, the XL309, costs just $17,000, and a version exclusively for lead in soil is available for $15,000. The main reason the XL309 is so much less expensive is that it lacks a high-resolution silicon pin detector. But this feature is useful largely for measuring levels of elements such as arsenic, which require a great deal of precision. Lead levels, by contrast, are fairly broad measurements. A high-resolution silicon pin detector is not necessary.

A lead-safe yard program may also save money if it can align itself with a university, which is much more likely if the work has a research component. In this case, the school might pick up some or all of the cost of the XRF, and interns paid by the school might conduct inspections under the supervision of a faculty member trained and certified to use the XRF. This type of approach is described in more detail in Appendix B, which presents less-resource-intensive approaches to implementing lead-safe yard programs.

6.3 Testing Step by Step

This section describes the procedures used by professional inspectors in the EMPACT LSYP for soil testing, quality control, and data management. In developing these procedures, the EMPACT LSYP relied on two primary sources: 1) Method 6200 from EPA publication SW-846 (entitled *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*), EPA's compendium of methods on evaluating hazardous waste; and 2) the Quality Assurance Project Plan (QAPP) that was developed for the EMPACT program. What follows is mainly a summary of the directives from these two sources, along with recommendations and insights from the program's inspectors themselves. You can go to http://www.epa.gov/epaoswer/hazwaste/test/sw846.htm to learn more about SW-846 and obtain a copy online. The EMPACT LSYP's QAPP is provided in Appendix D.

6.3.1 Before Beginning

The inspectors should plan to allot about two hours for testing a typical residence. Homeowners need not be present, but they do have to have signed a permission form (see Chapter 5). Ideally, all

[17] Mention of trade names or commercial products in this publication does not constitute endorsement or recommendation for use.

the information about yard use gained from observations and homeowner interviews will have been incorporated into the plot plan prepared during outreach and education. This plot plan will be used as a guide for testing. See Section 5.3 for guidance on conducting homeowner interviews and developing a plot plan. A sample interview form and plot plan can be found on pages 63 to 65.

Favorable weather conditions are necessary for testing. Experience shows that XRF testing does not work well when the ground is frozen or when the air temperature falls below 40 degrees Fahrenheit. And while high temperatures usually pose no problem, direct sunlight can cause the instrument to overheat. Inspectors should take care to shade it on sunny days, even in relatively cool weather.

der on each side of the house.

Soil moisture can not only interfere with readings but also damage the XRF, so soil that is saturated with water should not be tested. This condition is most likely to occur in early spring, when the ground absorbs water inefficiently because it hasn't yet thawed and dried out from the winter months. Inspection should be delayed in the event of rain as well; even after the rain has stopped, testing may still be inadvisable for several hours, because of standing water on the grass. The XRF can generally tolerate humidity, however.

If conditions are favorable, and all the necessary paperwork is in place, inspectors may prepare the property for testing. Debris such as rocks, pebbles, leaves, and roots should be removed, and the ground should be made flat enough to allow uniform contact with the XRF. In some cases grass or plant material may need to be moved aside to expose the soil surface. As they do this, inspectors must remember that lead in soil is mostly a surface phenomenon, and that readings may not be accurate if the ground is disturbed too much.

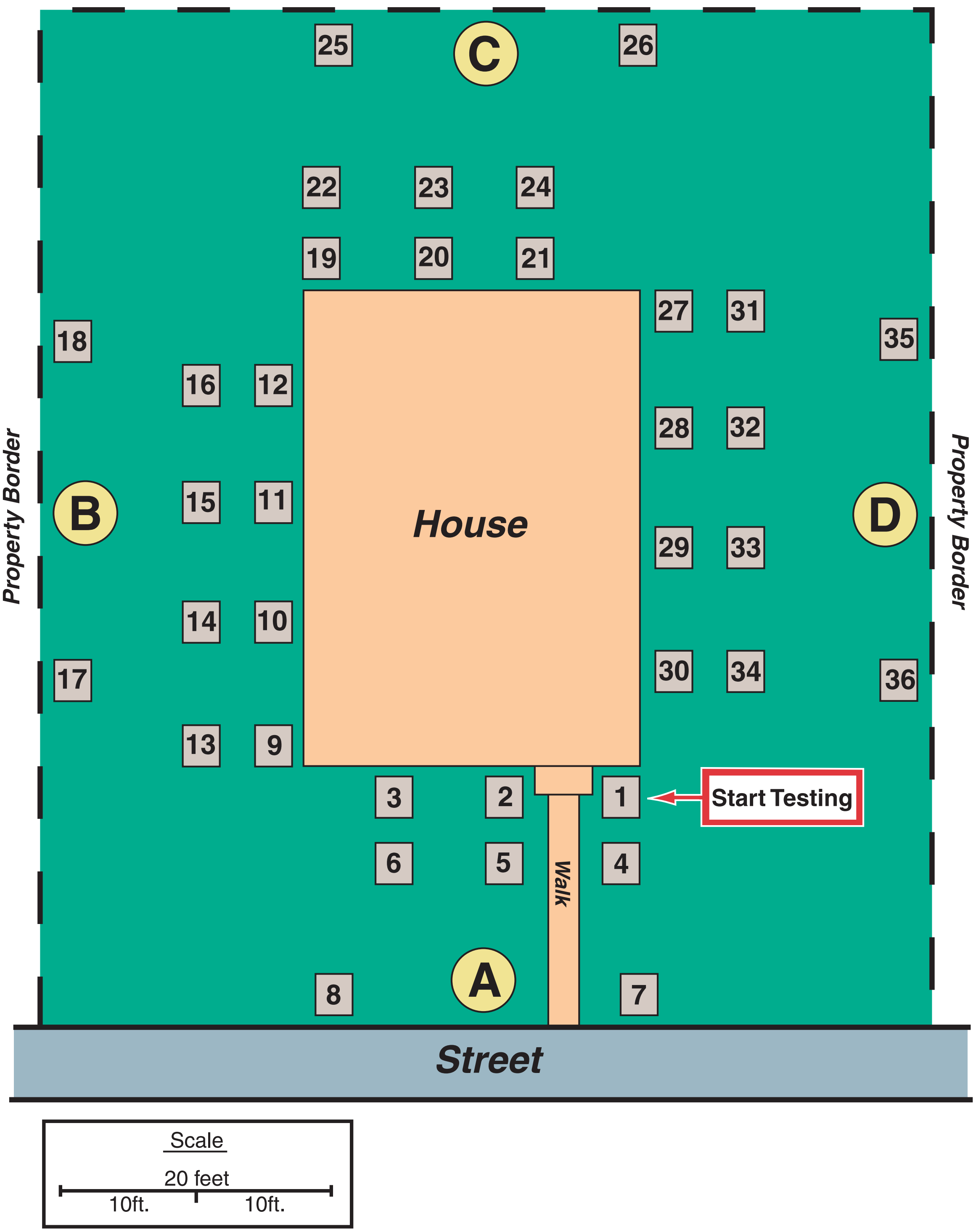
6.3.2 Testing Strategy

Although each property is different and must be approached with its unique characteristics in mind, testing typically focuses on four main concerns: the drip line, play areas, areas of exposed soil, and areas that may be contaminated with lead from sources other than the house, such as structures on abutting properties. In the EMPACT LSYP, if play areas are found to have lead levels greater than 400 ppm, they are tested further to determine the extent of contamination. Other areas are subjected to extra testing if they are found to have levels greater than 2000 ppm.

A variety of formats for testing are possible, but data collection is generally more systematic and efficient if inspectors decide on one format and use it consistently. In the EMPACT LSYP, the sides of the house on a property are labeled A, B, C, and D (see "Generic Testing Pattern" on page 72). The A side is that which bears the house's address, and the B, C, and D sides follow in a clockwise fashion. Inspectors start at the corner where the A and D sides meet, then cover the whole A portion of the yard, and after that the whole B, C, and D portions, until finally they arrive at the A-D corner again.

The pattern for testing a particular area on any of the sides of the house depends on the size and shape of that area. In long, narrow areas such as drip lines, initial XRF readings are generally taken at 10-foot intervals along an imaginary line that extends from one end of the area to the other. If an area is not long enough to yield at least three readings with this method, inspectors mentally divide the imaginary line into thirds and take a reading from each third.

Generic Testing Pattern



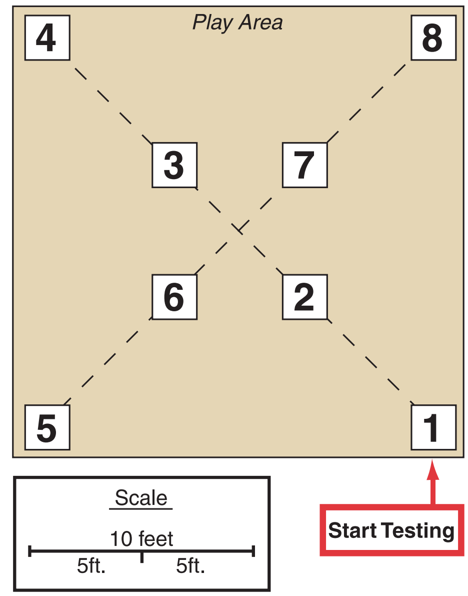
Inspectors then take a second series of XRF readings along an imaginary line that is parallel to the first one but 2 to 5 feet away from it. If the area is in fact a drip line, this second imaginary line usually falls outside it, so lead levels are expected to drop off. If they don't, further testing is conducted to ascertain whether and where they do.

Before completing testing on any one side of the house, inspectors take at least two readings along the property border. These readings are generally evenly spaced. If either reading shows elevated lead levels, additional reading are taken along the border.

For other areas of concern, including play areas, an imaginary X is usually superimposed on the ground. Readings are taken at 5- to 10-foot intervals along each line of the X. If the area is too small to yield at least five readings with this method, inspectors mentally divide the lines of the X into thirds and take a reading from each third.

When sufficient readings have been obtained from a given area, the lead levels are averaged to produce a mean value, and on the basis of this value, the area is assigned to a specific lead-level category, as explained in Section 6.1.

Testing Pattern for Play Areas, Gardens, and Other Areas of Concern



> **NOTE!**
>
> **Borderline mean values for an area are judged to fall into the more toxic category rather than the less toxic one. For example, a mean value of 1,980 ppm would earn an area a "high" rating (2,000 to 5,000 ppm). The idea is to avoid the risk of undertreating a contaminated area. Measurements of lead levels are broad, and a difference of just 20 ppm is insignificant.**

6.3.3 Quality Control

Niton XRFs are factory calibrated, so site-specific calibration is not necessary. Regular checks of the instrument's calibration are an essential aspect of quality control, however. Before inspectors from the EMPACT Lead-Safe Yard Project begin to test a property, they take readings on standard reference materials (SRMs) whose lead levels are known to be 400 ppm, 1,000 ppm, and 5,000 ppm, the anticipated range for lead in urban soil. They also take a reading on a blank—a soil sample whose lead level is less than 100 ppm, which is the detection limit for the XRF instrument they use. If any of these readings fails the quality control criteria (± 30% for SRMs; < 50 ppm for field blank), possible problems are investigated and the check is re-run until the instrument passes. If it never passes, it is sent back to Niton to be recalibrated. These same calibration checks are conducted at the end of testing on a property, to ensure that the instrument's calibration has remained intact throughout.

In addition, 10 percent of the XRF readings are replicate measures. That is, a particular location is tested a second time, to see if the reading on it falls into the same range. If it doesn't, inspectors try to find out what the problem is and fix it, and calibration checks and further repeat readings are performed until the XRF results are clearly reliable.

The final quality control measure is to collect soil samples for confirmatory ICP or AA analysis. At evenly spaced intervals within a particular area, inspectors scoop up a subsample, which is about a tablespoon of the top half-inch of soil. These subsamples are emptied into a common ziplock bag to create a composite for the area. An XRF reading is then taken on the composite, after which it is ready to be sent to the lab.

Typically, a perimeter composite sample is created by taking twelve subsamples—three from the drip line on each side of the house. Composite samples are also created for every other area designated as high use or high risk, such as gardens and play areas. As in XRF testing, an imaginary X is superimposed on the area. Subsamples—a total of five, if possible—are taken along each line of the X.

6.3.4 Data Management

The two main data management tools, the plot plan and the site worksheet, are versatile and easy to use. As shown on page 81, the plot plan can be converted into a color-coded map of a property's lead levels to help homeowners and landscapers discuss plans for remediation. The plot plan can also be used to formulate a guide for testing, and during the inspection itself, test locations can be recorded on the plot plan, as shown on page 80. Information on developing an initial plot plan can be found in Section 5.3.

The site worksheet offers a simple way to identify the locations marked on the plot plan more closely. It also allows inspectors to keep track of the lead levels found at each location. Finally, it provides convenient spaces to write down any relevant descriptive information: a short form at the top and a "comments" column on the right side. On page 78 is a clean worksheet that groups implementing a lead-safe yard program can reproduce. On page 79 is an example of a site worksheet that has been filled out.

The letters A, B, C, or D in the "sample I.D." column of the filled-out site worksheet tell which side of the house a particular XRF reading came from. The number immediately after each letter corresponds to the testing location noted on the plot plan. The last letter in the "sample I.D." column tells how many feet the testing location was from the foundation of the house.

The number in the "location" column of the worksheet tells how many feet the testing location was from the corner that would be on someone's right when facing the A, B, C, or D side of the house. Thus the right corner on the A side would be the A-D corner; on the B side it would be the A-B corner; on the C side it would be the B-C corner; and on the D side it would be the C-D corner.

The "ppm-lead" column tells the lead levels measured at each testing location. The comment "repeat" in the "comments" column indicates where a second reading was taken on a test location as a quality control measure.

6.4 Health and Safety Precautions

Testing for lead in soil entails two different kinds of risk. The first comes from the soil itself, which frequently does contain high levels of lead. The second comes from the XRF, which employs radioactive material. Inspectors must guard against both these kinds of risks.

6.4.1 Guarding Against Lead Hazards

The important point to keep in mind is that lead can enter the body through ingestion, which occurs as a result of routine hand-to-mouth activities such as eating, drinking, and smoking. Therefore, inspectors should wear gloves and refrain from hand-to-mouth activities on the job. When their work is done, they should wash their hands and faces and clean off their work shoes after leaving the site. On a windy day, inspectors may need to use face masks to avoid breathing airborne lead-contaminated dust when working at dry, dusty sites.

6.4.2 Guarding Against Radiation Hazards[18]

Portable XRF instruments used for lead-based paint inspections contain radioactive isotopes that emit x-rays and gamma radiation. Proper training and handling of these instruments is needed to protect the instrument operator and any other persons in the immediate vicinity during XRF usage. The XRF instrument should be in the operator's possession at all times. The operator should never defeat or override any safety mechanisms of XRF equipment.

For a discussion of required (and recommended) licenses, certifications, and permits for portable XRF instruments, see the box on page 76.

6.5 Maintaining Equipment

Day-to-day maintenance of the XRF is generally not difficult. The instrument's display window should be cleaned with cotton swabs. The case should be cleaned with a soft cloth. Batteries should be recharged as directed in the owner's manual. Beyond that, inspectors usually just need to take care not to drop the instrument, not to get it wet, and not to neglect the calibration checks described under "Quality Control" in Section 6.3.3.

Over the long term, however, XRF owners face the very significant maintenance concern of replacing the instrument's radioactive source, a cadmium-109 isotope. Like all radioactive isotopes, cadmium-109 decays at a fixed rate. Its half-life, or the amount of time needed for the activity of the radioactive source to decrease by one half, is about fifteen months. After that, the XRF can still be used, but the instrument becomes progressively less efficient. Readings that once took 30 to 60 seconds take progressively longer. Eventually the wait becomes burdensome, and a new cadmium-109 isotope must be purchased from Niton, at a cost of about $2,600.

Niton recommends replacing the isotope source every fifteen months, as soon as its half-life is spent, but most inspectors find that they can postpone the job for another three to nine months. After all, readings are no less accurate, just somewhat less prompt. When inspectors do decide to replace the cadmium-109 isotope, they simply send the XRF to Niton. The corporation not only puts in a new isotope but disposes of the old one, upgrades the instrument's software, and provides whatever preventive maintenance is needed.

SAFE OPERATING DISTANCE

XRF instruments used in accordance with manufacturer's instructions will not cause significant exposure to ionizing radiation. But the instrument's shutter should never be pointed at anyone, even if the shutter is closed. Also, the inspector's hand should not be placed on the end plate during a measurement.

The safe operating distance between an XRF instrument and a person during inspections depends on the radiation source type, radiation intensity, quantity of radioactive material, and the density of the materials being surveyed. As the radiation source quantity and intensity increases, the required safe distance also increases. Placing materials, such as a wall, in the direct line of fire reduces the required safe distance. According to NRC rules, a radiation dose to an individual in any unrestricted area must not exceed 2 millirems per hour. One of the most intense sources currently used in XRF instruments is a 40-millicurie 57Co (cobalt-57) radiation source. Other radiation sources in current use for XRF testing of lead-based paint generally produce lower levels of radiation. Generally, an XRF operator conducting inspections according to manufacturer's instructions would be exposed to radiation well below the regulatory level. Typically, XRF instruments with lower gamma radiation intensities can use a shorter safe distance provided that the potential exposure to an individual will not exceed the regulatory limit.

No people should be near the other side of a wall, floor, ceiling or other surface being tested. The inspector should verify that this is indeed the case prior to initiating XRF testing activities, and check on it during testing.

Finally, the effectiveness of the instrument's radiation shielding should be assessed every six months through a leak test. The XRF manufacturer or owner's manual can be consulted to obtain vendors of leak test kits.

If these practices are observed, the risk of excessive exposure to ionizing radiation is extremely low and will not endanger any inspectors or occupants present in the dwelling.

[18]Adapted from *HUD Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing,* Chapter 7: Lead Based Paint Inspections, 1997 Revision. Available at http://www.hud.gov/lea/learules.html

XRF USE LICENSES AND CERTIFICATION

In addition to training and any required accreditation, a person using a portable XRF instrument for inspection must have valid licenses or permits from the appropriate federal, state, and local regulatory bodies to operate XRF instruments. (These are needed because XRF instruments contain radioactive materials.) All portable XRF instrument operators should be trained by the instrument's manufacturer (or equivalent). XRF operators should provide you with information about their training, licensing, permitting, and certification before an inspection begins. Depending on the state, operators may be required to hold three forms of proof of competency: a manufacturer's training certificate (or equivalent), a radiation safety license, and a state lead-based paint inspection certificate or license. To help ensure competency and safety, HUD and EPA recommend hiring only inspectors who hold all three.

The regulatory body responsible for oversight of the radioactive materials contained in portable XRF instruments depends on the type of material being handled. Some radioactive materials are federally regulated by the U.S. Nuclear Regulatory Commission (NRC); others are regulated at the state level. States are generally categorized as "agreement" and "non-agreement" states. An agreement State has an agreement with NRC to regulate radioactive materials that are generally used for medical or industrial applications. (Most radioactive materials found in XRF instruments are regulated by agreement states). For non-agreement states, NRC retains this regulatory responsibility directly. At a minimum, however, most state agencies require prior notification that a specific XRF instrument is to be used within the state. Fees and other details regarding the use of portable XRF instruments vary from state to state. Contractors who provide inspection services must hold current licenses or permits for handling XRF instruments, and must meet any applicable state or local laws or notification requirements.

Requirements for radiation dosimetry by the XRF instrument operator (wearing dosimeter badges to monitor exposure to radiation) are generally specified by state regulations, and vary from state to state. In some cases, for some isotopes, no radiation dosimetry is required. However, it should be conducted even when not required, for the following five reasons:

- The cost of dosimetry is low.
- XRF instrument operators have a right to know the level of radiation to which they are exposed during the performance of the job. In virtually all cases, the exposure will be far below applicable exposure limits.
- Long-term collection of radiation exposure information can aid both the operator (employee) and the employer. The employee benefits by knowing when to avoid a hazardous situation; the employer benefits by having an exposure record that can be used in deciding possible health claims.
- The public benefits by having exposure records available to them.
- The need for equipment repair can be identified more quickly.

6.6 Alternative Approaches

A number of organizations that conduct lead-safe yard activities rely on laboratory analysis rather than field-portable XRF for testing of yard soil. For example, Lead-Safe Cambridge, described in Appendix A of this handbook, sends soil samples to a state laboratory for analysis.

A homeowner in an area where no lead-safe yard program exists may also wish to determine whether there is a lead problem in his or her yard. In this case, the homeowner can collect soil samples in ziplock bags and send them to a laboratory for analysis. To determine sampling locations, a homeowner can follow the guidance in Section 6.3, or refer to HUD Guidelines for the Evaluation and *Control of Lead Hazards in Housing, June 1995 (Title X, Section 1017) Appendix 13.3,* available at http://www.hud.gov/lea/learules.html#download.

Homeowners can contact their state or local childhood lead poisoning prevention program for more information about obtaining soil-lead testing. The following Web sites list state and local lead poisoning prevention contacts:

> The Lead Program of the National Safety Council's Environmental Health Center:
> http://www.nsc.org/ehc/nlic/contacts.htm
>
> The National Conference of State Legislatures' Directory of State Lead Poisoning Prevention Contacts: http://www.ncsl.org/programs/ESNR/pbdir.htm

6.7 For More Information

6.7.1 XRF Accuracy

Verification Reports and Statements on the accuracy of several XRF technologies are available on the Web sites of the EPA Environmental Technology Verification Program and EPA New England:
http://www.epa.gov/etv/verifrpt.htm#monitoring
http://www.epa.gov/region01/topics/restech/xray

Clark, Scott, William Menrath, Mei Chen, Sandy Roda, and Paul Succop. *Use of a Field Portable X-Ray Fluorescence Analyzer to Determine the Concentration of Lead and Other Metals in Soil and Dust Samples*. Call the University of Cincinnati Department of Environmental Health at 1-513-558-1749.

Shefsky, Stephen. *Comparing Field Portable X-Ray Fluorescence (XRF) to Laboratory Analysis of Heavy Metals in Soil.* Call Niton Corp. at 1-800-875-1578.

6.7.2 Test Methods

Methods 6200, 6010B, and 7420 from EPA's SW-846 (entitled Test Methods for Evaluating Solid Waste, Physical/Chemical Methods). For ordering information, or to obtain a copy online, go to http://www.epa.gov/epaoswer/hazwaste/test/sw846.htm.

Sackett, Donald and Kenneth Martin. *EPA Method 6200 and Field Portable X-Ray Fluorescence Analysis for Metals in Soil.* Call Niton Corp. at 1-800-875-1578.

6.7.3 Quality Control

Shefsky, Stephen. *Sample Handling Strategies for Accurate Lead-in-Soil Measurements in the Field and Laboratory*. Call Niton Corp. at 1-800-875-1578.

SITE WORKSHEET

Site Name:______________________________ Date:____________________

Site Address:____________________________ Weather:__________________

Building Type:__________________ Lot Condition:______________________

Yard Uses:____

SAMPLE I.D.	LOCATION	PPM-LEAD	COMMENTS

A = front, B = left, C = rear, D = right
Location = distance from right corner of house

SITE WORKSHEET

Site Name: ______________________ **Date:** 10 - 27 - 98

Site Address: 10 Home Street **Weather:** Clear / Cool 55°

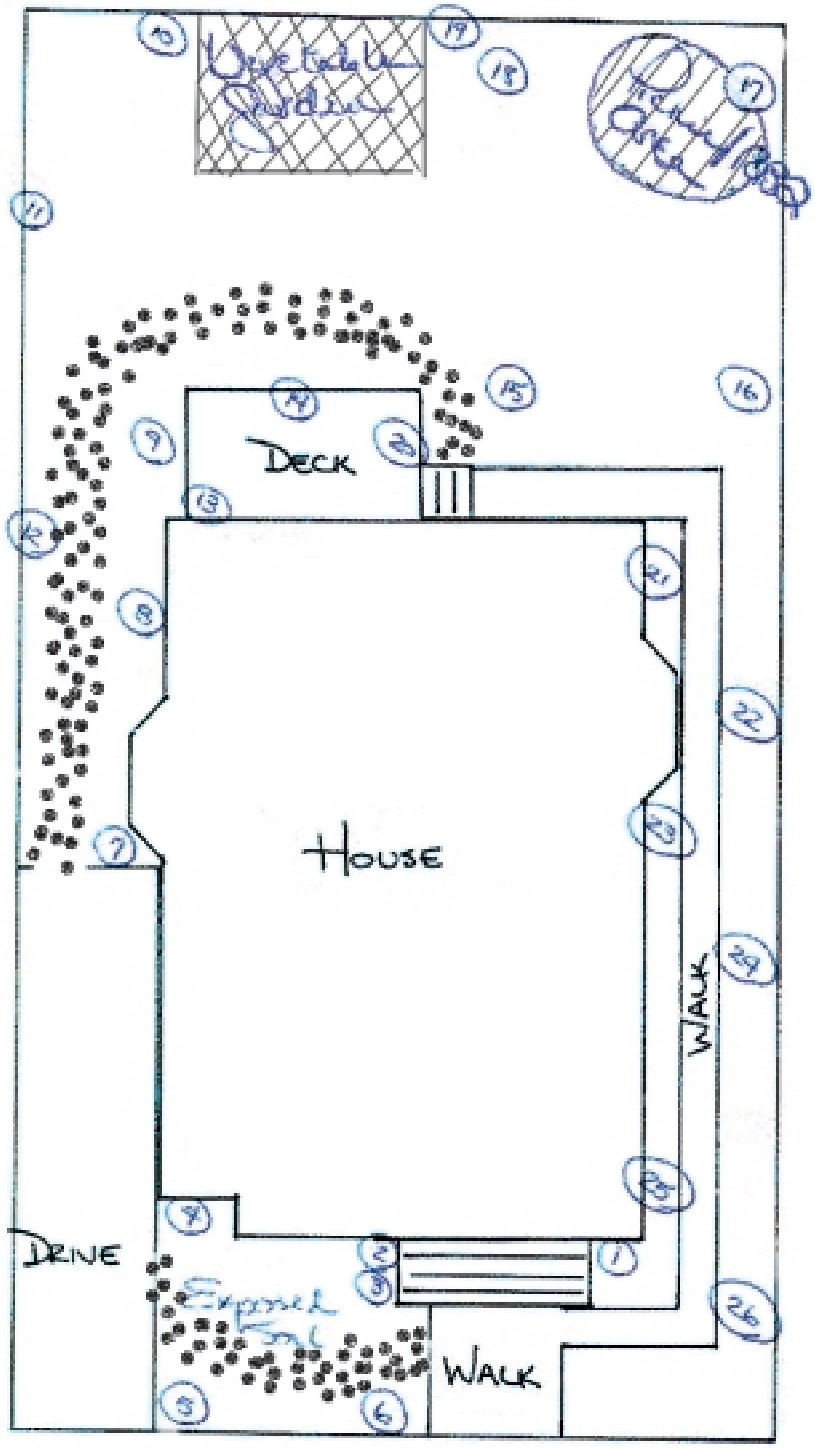
Building Type: 2 Family **Lot Condition:** Very Clean

Yard Uses: Picnic Area / Vegetable Garden

SAMPLE I.D.	LOCATION	PPM-LEAD	COMMENTS
A-1-9	0	1772 ± 303	
A-2-9	11	2510 ± 262	
A-3-9	11	3104 ± 287	Repeat
A-4-1	25	4006 ± 309	
A-5-15	25	435 ± 113	
A-6-15	12	705 ± 129	
A-7-4	21	3987 ± 426	
B-8-1	39	3657 ± 305	
B-9-1	60	1432 ± 175	
B-10-1	34	643 ± 113	
B-11-9	69	550 ± 106	
B-12-9	38	1141 ± 137	
C-13-1	0	2940 ± 267	
C-14-18	10	532 ± 118	
C-15-18	26	518 ± 122	
C-16-18	39	738 ± 130	
C-17-32	26	527 ± 109	
C-18-32	10	466 ± 95	

A = front, B = left, C = rear, D = right
Location = distance from right corner of house

10 HOME STREET



SCALE: 1" = 1'-10"

LEAD LEVELS COLOR KEY

5000 or more ppm (Very High)
Must be treated with a permanent barrier.
Unsafe for all types of gardening.

2000-5000 ppm (High)
Treatment is necessary for any recreational use by children or adults and for pet areas.
Unsafe for all types of gardening.

400-2000 ppm (Moderately High)
Treatment is recommended for use as a children's play area and for gardening, especially vegetable gardening.

400 or less ppm (Low)
No treatment is necessary for most uses by children, adults, and pets.

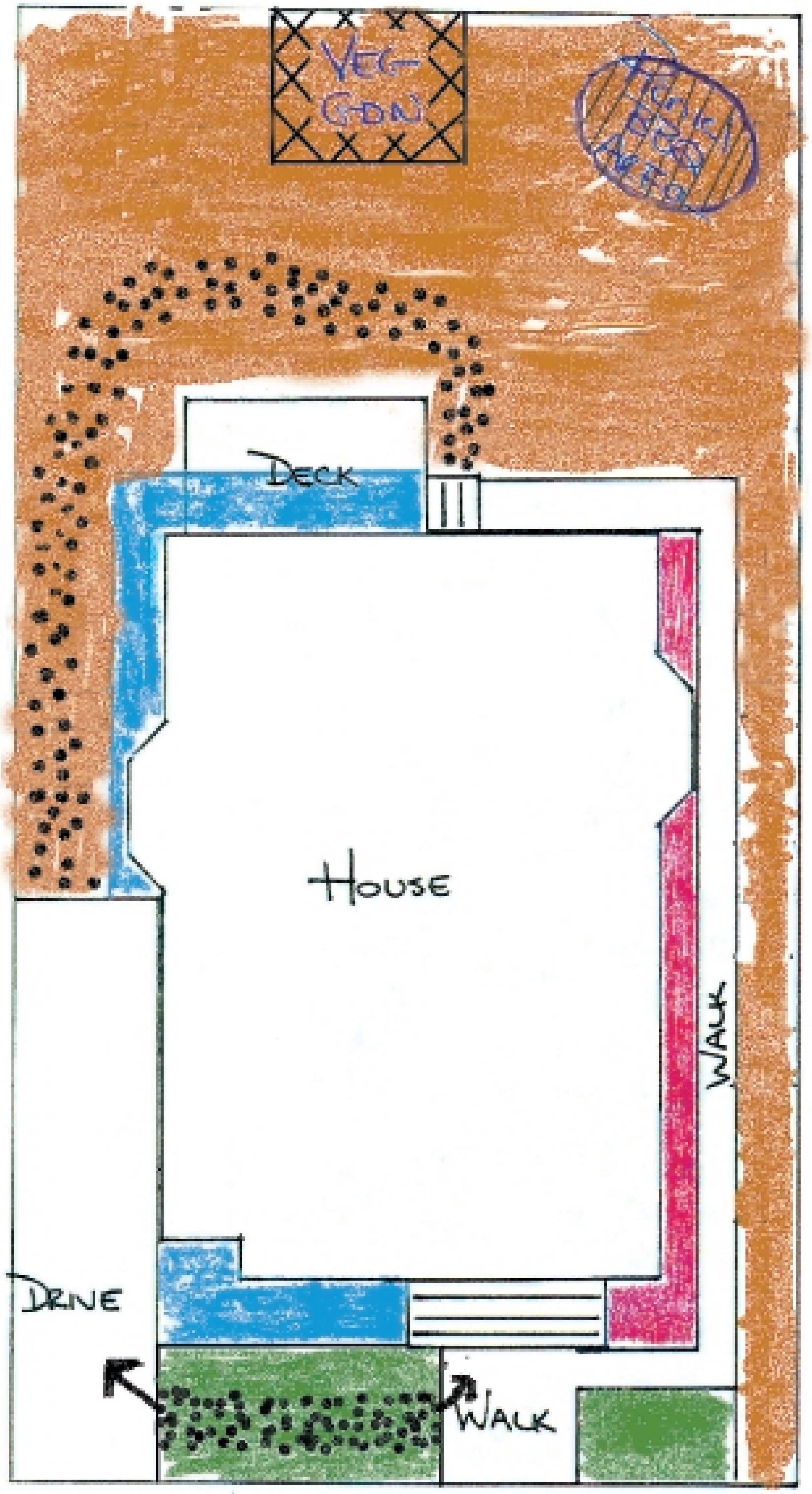
YARD USE PATTERN KEY

DOTS
High Traffic Area (Exposed Soil)

CROSS HATCH
High Risk Use Area
(Play Area or Vegetable Garden)

DIAGONAL LINES
Recreation Area (Picnic or BBQ)

10 HOME STREET



SCALE: 1" = 1'-10"

LEAD LEVELS COLOR KEY

5000 or more ppm (Very High)

Must be treated with a permanent barrier.
Unsafe for all types of gardening.

2000-5000 ppm (High)

Treatment is necessary for any recreational use by children or adults and for pet areas.
Unsafe for all types of gardening.

400-2000 ppm (Moderately High)

Treatment is recommended for use as a children's play area and for gardening, especially vegetable gardening.

400 or less ppm (Low)

No treatment is necessary for most uses by children, adults, and pets.

YARD USE PATTERN KEY

DOTS
High Traffic Area (Exposed Soil)

CROSS HATCH
High Risk Use Area
(Play Area or Vegetable Garden)

DIAGONAL LINES
Recreation Area (Picnic or BBQ)

Less than 400 ppm
No treatment is necessary for most uses by children, adults, and pets. Safe for all types of gardening.

400 to 2,000 ppm
Treatment is recommended for use as a children's play area and for gardening, especially vegetable gardening.

2,000 to 5,000 ppm
Treatment is necessary for any recreational use by children or adults and for pet areas. Unsafe for all types of gardening.

Greater than 5,000 ppm
Must be treated with permanent barrier. Unsafe for all types of gardening.