July 18, 2017

Dear Members of the Historic Resources Commission:

We are new homeowners in Center Square, having recently purchased 221 Jay Street. We looked for a house in Center Square for months, and are very excited for our family to join the neighborhood.

We write to you now because we are seeking to replace the front-facing windows in our house. We have one young son who will be 2 years old in August, and are due with a baby girl any day now. Due to preexisting health circumstances, our family has a particularly acute concern over lead poisoning. For that reason, we brought in an independent environmental expert specializing in lead detection and abatement after purchasing the home. He highlighted the windows as a particular area of concern, and strongly recommended replacement.

Given this information, we have spoken to other families in the neighborhood with the goal of finding a solution that will protect our children's health while at the same time ensuring that our home continues to match the historic nature of the neighborhood. We have also met with contractors and reviewed window options in order to find the construction and design that will maintain our home's character. Many families are concerned with lead exposure in Center Square, and have been granted the opportunity to put in new, beautiful wooden windows identical to the ones we have chosen.

Thank you sincerely,

Joseph Giovannetti & Jennifer Clark
221 Jay Street

Erin M. Glennon

From: Jennifer Clark
Sent: Wednesday, July 19, 2017 9:46 AM
To: Steve Drozdyk
Cc: Erin M. Glennon;
Subject: Re: 221 Jay
Attachments: Lead-Based Paint Inspection Report, 221 Jay Street.pdf

Good morning, Erin-

Thank you for your attention to our request. Attached please find the Lead-Based Paint Inspection Report for 221 Jay Street, conducted by Alpine Environmental Services. As you can see in Table 1.0, the window sashes in every room are reported as a hazard. We spoke with Alpine about remediation for the window areas, and the specialist strongly recommended replacement. As you can see in the report, it is listed as the number one solution. We did discuss --with Alpine, with Bennett, and with others-- the alternate possibility of refurbishing or restoring the windows. Consistently, however, replacement was recommended over those options, given the health concerns.

Sincerely,
Joseph Giovannetti and Jennifer Clark

Lead-Based Paint Inspection Report

Performed for/ Building Owner: Jennifer Clark
221 Jay Street
Albany, New York 12210

Location of Inspection: 221 Jay Street
Albany, New York 12210

Results of Inspection: Lead-based paint was found in the following locations:
Window sashes, plaster walls, door stops, wainscoting, wooden cabinets, wood doors, doorjambs, stair treads, window sills, baseboards, radiators, window bench, fireplace trim, bathtub, door stops, fireplace mantle, exterior wood floor (entry), exterior brick walls

Alpine Project #: 17-21211-L
Date of Testing: June 30, 2017
Report Date: July 5, 2017
Report Expiration Date: June 30, 2018

Inspected By: Alpine Environmental Services, Inc.
438 New Karner Road
Albany, New York 12205
(518) 250-4047

Inspector: Paul Van Zandt
USEPA Certified Risk Assessor
NY-R-1262-5

Instrument: Niton XLp 301A
Data Interpretation: USEPA PCS
Source: Cadmium 109, 40mCi
Sourced On: 4/1/16

Description:

Jennifer Clark hired Alpine Environmental Services to perform a lead-based paint inspection using X-ray florescence (XRF) testing of 221 Jay Street, Albany, New York. A risk assessment differs from a lead-based paint inspection in that only lead hazards are identified in the risk assessment as opposed to all painted surfaces being tested for a lead inspection.

The building was a two-story, single-family brick structure with a basement built in 1856. The building abuts the adjacent buildings on either side. In the front of the building is a sidewalk. The basement was an apartment. The first and second floors were the main living area. Windows were wooden throughout. Walls were drywall or plaster throughout. The exterior was painted brick.

Conclusion:

The U.S. Housing and Urban Development (HUD) Guidelines for the Evaluation and Control of Lead-Based Paint in Housing (2012 Revision) define lead-based paint as having a lead content of 1.0mg/cm^2 as measured by XRF. Alpine Environmental Services, Inc. has concluded through XRF analysis that lead at or above 1.0mg/cm^2 was found in the following areas:

Location	Lead Painted Component(s)	Condition	Notes
Room B01	Window sashes	Intact	Friction/impact surface
	Plaster walls	Intact	Intact
	Door stops	Intact	Friction/impact surface
	Wainscoting	Intact	Intact
	Cabinet	Intact	Intact
Basement Hall	Closet doors	Intact	Friction/impact surface
	Cabinet doors	Intact	Friction/impact surface
Basement Kitchen	Door & door jambs	Intact	Friction/impact surface
	Wainscoting	Intact	Intact
	Window sashes	Intact	Friction/impact surface
Basement Bath	Door	Intact	Friction/impact surface
Basement Bedroom	Door	Intact	Friction/impact surface
	Window sashes	Intact	Friction/impact surface
Basement Entry	Closet door	Intact	Friction/impact surface
	Stair treads	Intact	Friction/impact surface
	Wood wall	Intact	Intact

Lead Painted Components Cont'd

Location	Lead Painted Component(s)	Condition	Notes
Room 100	Window sashes & sills	Intact	Friction/impact surface
	Walls	Intact	Intact
	Baseboards	Intact	Intact
	Doorjambs	Intact	Friction/impact surface
1st Floor Entry	Door & jambs	Intact	Friction/impact surface, main entry
Room 101	Doorjambs	Intact	Friction/impact surface
	Walls & baseboards	Intact	Intact
	Radiator	Intact	Intact
1st Floor Hall	Baseboards	Intact	Intact
1st Floor Bath	Door & jambs	Intact	Friction/impact surface
Kitchen	Baseboards	Intact	Intact
	Window sashes & sills	Intact	Friction/impact surface
Room 200	Window sashes	Intact	Friction/impact surface
	Window bench	Intact	Intact
	Baseboards	Intact	Intact
	Door & jambs	Intact	Friction/impact surface
	Fireplace trim	Intact	Intact
2nd Floor Bath	Walls	Intact	Intact
	Window sashes & sill	Intact	Friction/impact surface
	Radiator	Intact	Intact
	Bathtub	Intact	Intact
	Door & jambs	Intact	Friction/impact surface
2nd Floor Hall	Door & jambs	Intact	Friction/impact surface
	Baseboards	Intact	Intact
	Wainscoting	Intact	Intact
Room 201	Doors, jambs & stops	Intact	Friction/impact surface
	Window sashes & sill	Intact	Friction/impact surface
	Fireplace mantle & trim	Intact	Intact
Room 202	Doors & jambs	Intact	Friction/impact surface
	Floor	Intact	Friction/impact surface
	Baseboards	Intact	Intact
	Window bench	Intact	Intact
Exterior	Wood floor at front entry	Intact	Friction/impact surface
	Brick walls	Intact	Intact

*Please note that, although the above-mentioned components may not currently represent a lead hazard, lead safe work practices should be followed if they are part of the renovations.

The EPA and HUD consider the following lead in soil levels to be hazardous:

Play areas and gardens - 400ppm Other parts of the yard – 1,200ppm

The following are the soil sample results for the sample taken on June 30, 2017:

Sample #	Location	Lead Concentration ($\mu g/ft^2$)	Lead Hazard
1	Backyard	2,700	**Yes**

Recommendations:

See Table 1.0 Hazard Control Options.

It is recommended that any lead-based paint (LBP) be removed from friction or impact surfaces (doors, windows, etc.) prior to reoccupancy by the tenants. If LBP is to remain, it shall be kept in an intact state and/or covered with an impermeable layer (vinyl, aluminum, etc.).

Alpine recommends clearance dust wipes shall be taken and lead levels must be below the HUD limits following any interim control methods. All areas with elevated lead dust levels must be cleaned using proper techniques (HEPA vacuuming and wet cleaning) following interim control methods. All applicable requirements of U.S. Housing and Urban Development (HUD) Guidelines for the Evaluation and Control of Lead-Based Paint in Housing (2012 Revision) on lead-based paint interim control methods must be followed.

If Alpine Environmental Services, Inc. can be of further assistance, please contact our office at (518) 250-4047 ext. 314.

Sincerely,
ALPINE ENVIRONMENTAL SERVICES, INC.

Paul Van Zandt
USEPA Certified Lead Risk Assessor

Enclosures: Floor Plans, XRF Data Sheet, Soil Sample Results and Chains of Custody, EPA Company Certification, EPA Personal Certification, Laboratory Certification

Table 1.0 **Hazard Control Options for 221 Jay Street, Albany, New York**

Location	Lead Painted Component(s)	Condition	Lead Hazard	Notes	Suggested Interim Control Option	Option Chosen
Room B01	Window sashes	Intact	**Yes**	Friction/impact surface	1. Window replacement. 2. Lead-paint removal. 3. Ongoing monitoring/ maintenance.	
	Plaster walls	Intact	No	Intact	1. Ongoing monitoring/ maintenance.	
	Door stops	Intact	**Yes**	Friction/impact surface	1. Door & stop replacement. 2. Ongoing monitoring/ maintenance.	
	Wainscoting	Intact	No	Intact	1. Ongoing monitoring/ maintenance.	
	Cabinet	Intact	No	Intact	1. Ongoing monitoring/ maintenance.	
Basement Hall	Closet & cabinet doors	Intact	No	Intact, depends on frequency of use.	1. Ongoing monitoring/ maintenance.	
Basement Kitchen	Door & jambs	Intact	**Yes**	Friction/impact surface	1. Same as Room B01	
	Wainscoting	Intact	No	Intact	1. Ongoing monitoring/ maintenance.	
	Window sashes	Intact	**Yes**	Friction/impact surface	1. Same as Room B01	
Basement Bath	Door	Intact	**Yes**	Friction/impact surface	1. Same as Room B01	

Table 1.0 **Hazard Control Options for 221 Jay Street, Albany, New York** *Cont'd*

Location	Lead Painted Component(s)	Condition	Lead Hazard	Notes	Suggested Interim Control	Option Chosen
Basement Bedroom	Door	Intact	**Yes**	Friction/impact surface	1. Same as Room B01	
	Window sashes	Intact	**Yes**	Friction/impact surface	1. Same as Room B01	
Basement Entry	Closet door	Intact	No	Intact, depends on frequency of use	1. Ongoing monitoring/ maintenance.	
	Stair treads	Intact	**Yes**	Friction/impact surface	1. Tread covering with vinyl treads or carpeting. 2. Ongoing monitoring/ maintenance.	
	Wood walls	Intact	No	Intact	1. Ongoing monitoring/ maintenance.	
Room 100	Window sashes & sills	Intact	**Yes**	Friction/impact surface	1. Same as Room B01	
	Walls	Intact	No	Intact	1. Ongoing monitoring/ maintenance.	
	Door & jambs	Intact	**Yes**	Friction/impact surface	1. Same as room B01	
1st Floor Entry	Door & jambs	Intact	**Yes**	Friction/impact surface	1. Same as room B01	

Table 1.0 **Hazard Control Options** **<u>for 221 Jay Street, Albany, New York</u>** (*Cont'd*)

Location	Lead Painted Component(s)	Condition	Lead Hazard	Notes	Suggested Interim Control Option	Option Chosen
Room 101	Doorjambs	Intact	**Yes**	Friction/impact surface	1. Same as Room B01	
	Walls & baseboards	Intact	No	Intact	1. Ongoing monitoring/ maintenance.	
	Radiator	Intact	No	Intact	1. Cover with wood/metal cover. 2. Ongoing monitoring/ maintenance.	
1st Floor Hall	Baseboards	Intact	No	Intact	1. Ongoing monitoring/ maintenance.	
1st Floor Bath	Door & jambs	Intact	**Yes**	Friction/impact surface	1. Same as Room B01	
Kitchen	Baseboards	Intact	No	Intact	1. Ongoing monitoring/ maintenance.	
	Window sashes & sills	Intact	**Yes**	Friction/impact surface	1. Same as Room B01	
Room 200	Window sashes	Intact	**Yes**	Friction/impact surface	1. Same as Room B01	
	Window bench	Intact	No	Intact	1. Ongoing monitoring/ maintenance.	
	Baseboards	Intact	No	Intact	1. Ongoing monitoring/ maintenance.	
	Doors & jambs	Intact	**Yes**	Intact	1. Same as Room B01	
	Fireplace trim	Intact	No	Intact	1. Ongoing monitoring/ maintenance.	

Alpine Inc. ENVIRONMENTAL SERVICES

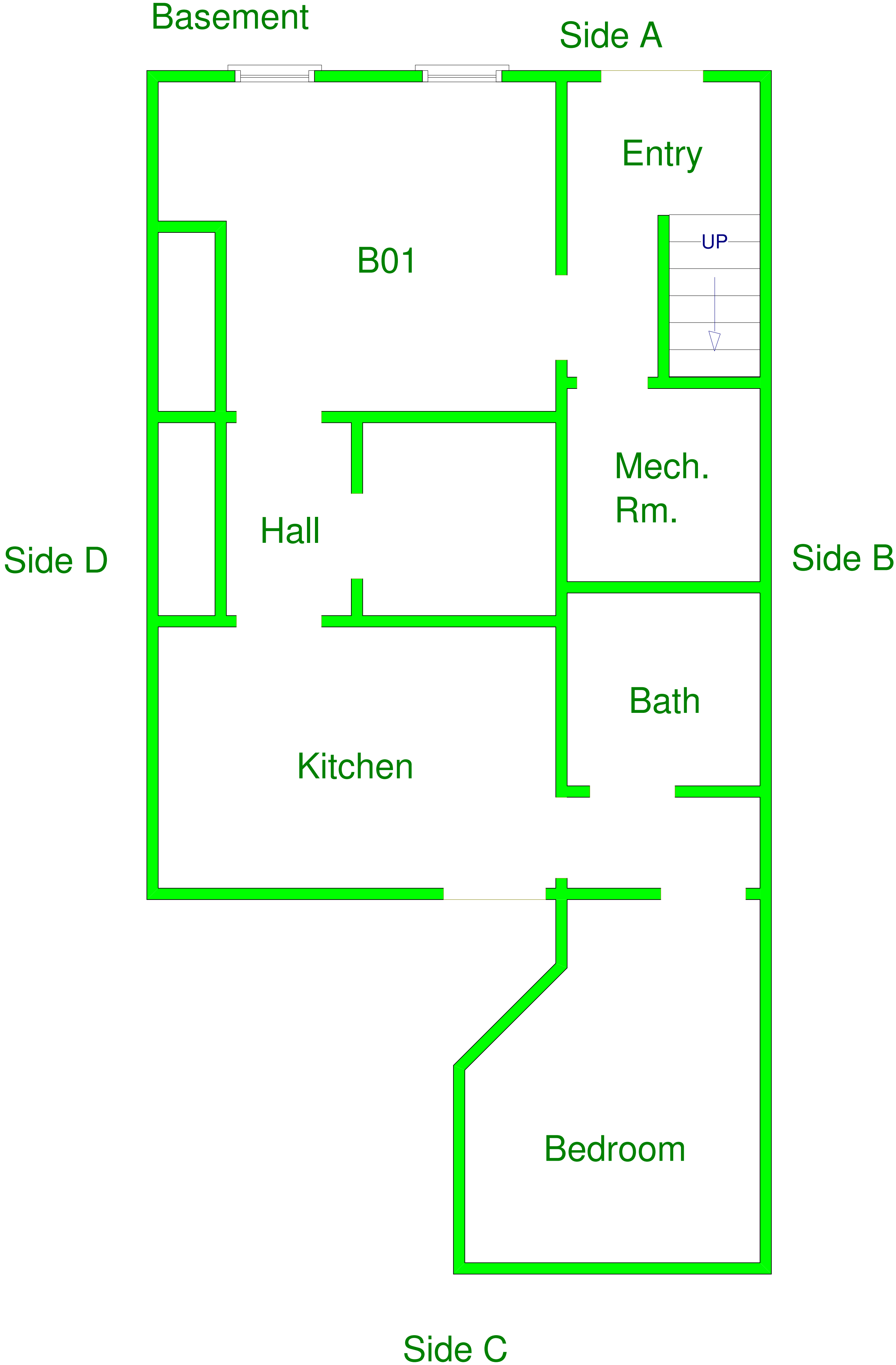
Table 1.0 **Hazard Control Options for 221 Jay Street, Albany, New York** (*Cont'd)*

Location	Lead Painted Component(s)	Condition	Lead Hazard	Notes	Suggested Interim Control Option	Option Chosen
2nd Floor Bath	Walls	Intact	**No**	Intact	1. Ongoing monitoring/ maintenance.	
	Window sashes & sills	Intact	**Yes**	Intact	1. Same as Room B01.	
	Radiator	Intact	No	Intact	1. Same as Room 101.	
	Bathtub	Intact	**Yes**	Intact	1. Remove/replace bathtub. 2. Use liner in tub. 3. Ongoing monitoring/ maintenance.	
	Door & jambs	Intact	**Yes**	Friction/impact surface	1. Same as Room B01	
2nd Floor Hall	Door & jambs	Intact	**Yes**	Friction/impact surface	1. Same as Room B01	
	Baseboards	Intact	No	Intact	1. Ongoing monitoring/ maintenance.	
	Wainscoting	Intact	No	Intact	1. Ongoing monitoring/ maintenance.	
Room 201	Doors, jambs & stops	Intact	**Yes**	Friction/impact surface	1. Same as Room B01	
	Window sashes & sills	Intact	**Yes**	Friction/impact surface	1. Same as Room B01	
	Fireplace mantle & trim	Intact	No	Intact	1. Ongoing monitoring/ maintenance.	

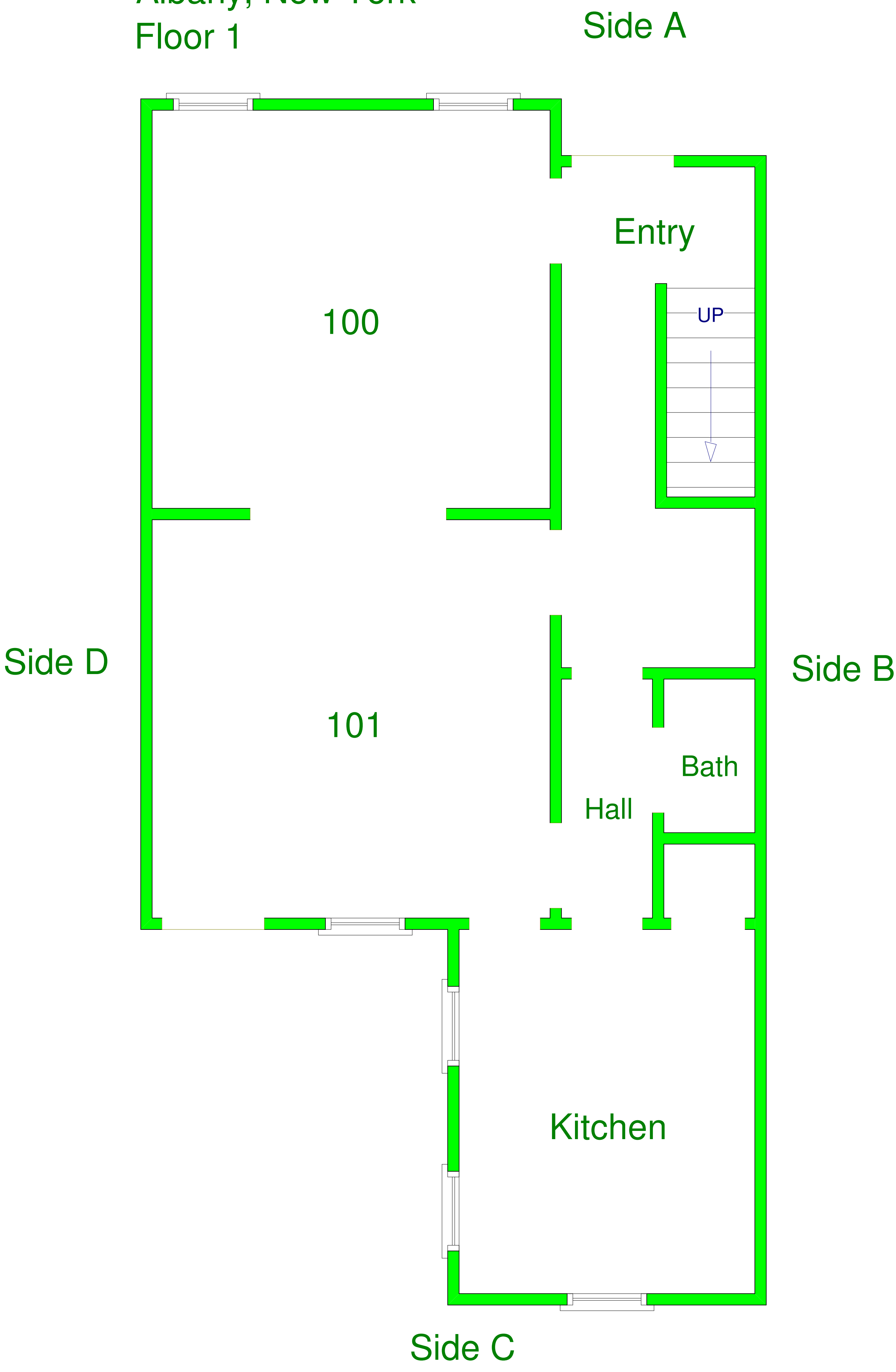
Table 1.0 **Hazard Control Options for <u>221 Jay Street, Albany, New York</u>** (*Cont'd*)

Location	Lead Painted Component(s)	Condition	Lead Hazard	Notes	Suggested Interim Control Option	Option Chosen
Room 202	Doors & jambs	Intact	**Yes**	Friction/impact surface	1. Same as Room B01	
	Floor	Intact	**Yes**	Friction/impact surface	1. Cover with carpet or sheet flooring. 2. Remove lead-based paint. 3. Ongoing monitoring/ maintenance.	
	Baseboards	Intact	No	Intact	1. Ongoing monitoring/ maintenance.	
	Window bench	Intact	No	Intact	1. Ongoing monitoring/ maintenance.	
Exterior	Wood floor at front entry	Intact	**Yes**	Friction/impact surface	1. Remove/replace floor. 2. Cover with wood. 3. Ongoing monitoring/ maintenance.	
	Brick walls	Intact	No	Intact	1. Ongoing monitoring/ maintenance.	
	Backyard soil	N/A	**Yes**		1. Soil removal/replacement. 2. Cover soil with mulch/gravel. 3. Plant grass/vegetation. 4. Ongoing monitoring for bare spots.	

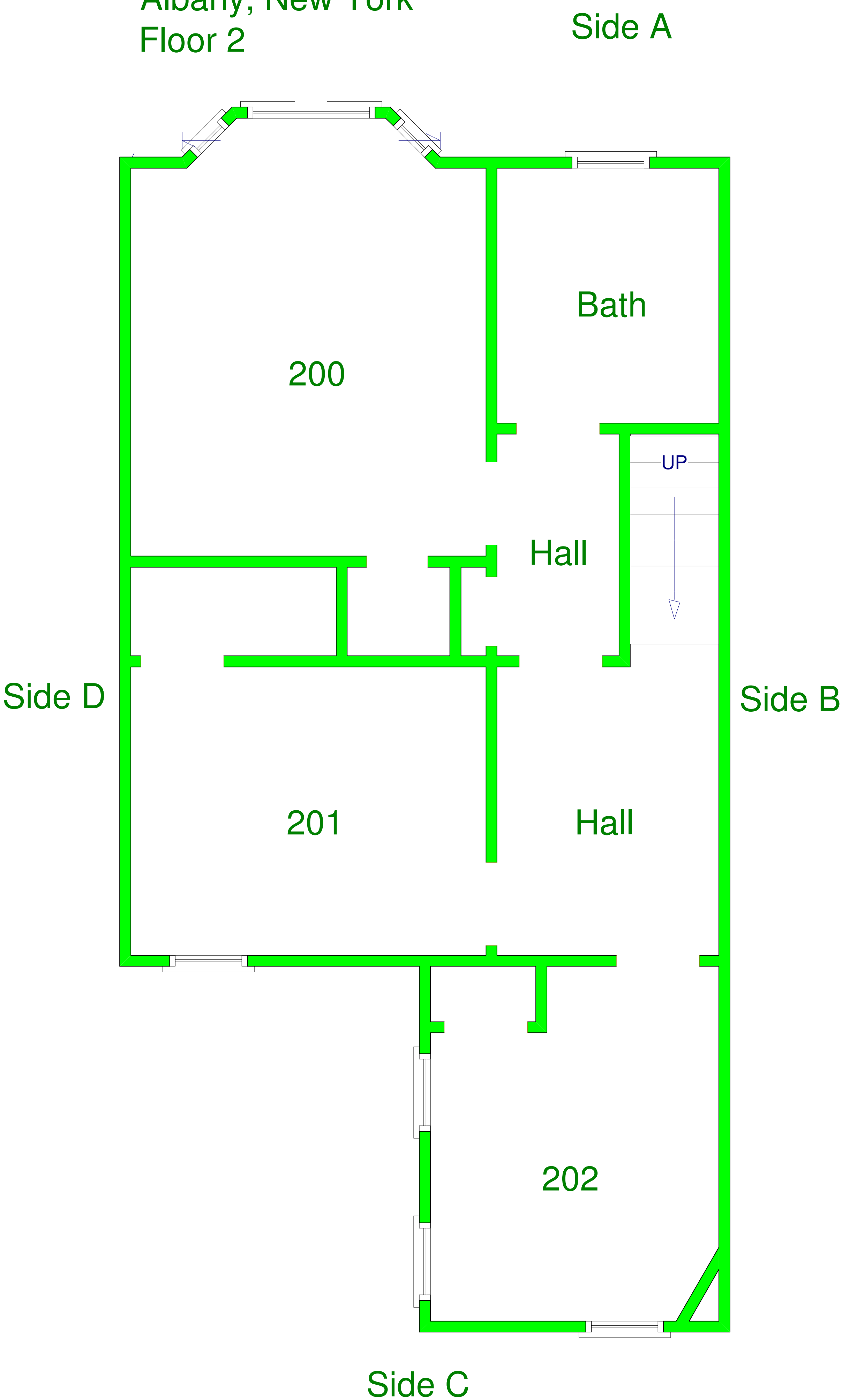
221 Jay Street
Albany, New York
Basement



221 Jay Street
Albany, New York
Floor 1



221 Jay Street
Albany, New York
Floor 2



Client: Jennifer Clark
Prepared by: Alpine Environmental Services, Inc.

221 Jay Street
Albany, New York

Project# 17-21211-L

No	Time	Fl	Room	Rm#	Sd	Compont	Feature	Condtn	Substr	Results	PbC	PbC Error	PbL	PbL Error	PbK	PbK Error	Units	Dpth	Dur
1	6/30/2017 8:21		Shutter Calibrate								3.76	0	0.64	0	0.01	0	cps		96.25
2	6/30/2017 8:24		Calibrate					Intact	Metal	***Positive***	1	0.1	1	0.1	1.1	0.4	mg/cm^2	1.11	20.36
3	6/30/2017 8:25		Calibrate					Intact	Metal	***Positive***	1.1	0.1	1.1	0.1	0.9	0.4	mg/cm^2	2.73	20.32
4	6/30/2017 8:25	B	Room	B01	A	Window	Sash	Intact	Wood	***Positive***	6.6	3.6	< LOD	1.05	6.6	3.6	mg/cm^2	6.44	1.89
5	6/30/2017 8:25	B	Room	B01	A	Window	Sill	Intact	Wood	Negative	< LOD	0.04	< LOD	0.04	< LOD	2.55	mg/cm^2	1	1.59
6	6/30/2017 8:26	B	Room	B01	A	Wall		Intact	Plaster	***Positive***	3.1	1.5	< LOD	0.6	3.1	1.5	mg/cm^2	10	3.5
7	6/30/2017 8:26	B	Room	B01		Ceiling		Intact	Drywall	Negative	< LOD	0.03	< LOD	0.03	< LOD	0.94	mg/cm^2	1	4.75
8	6/30/2017 8:27	B	Room	B01	B	Door	Stop	Intact	Wood	***Positive***	22.2	14.2	< LOD	5.4	22.2	14.2	mg/cm^2	4.78	0.95
9	6/30/2017 8:27	B	Room	B01	C	Wainscotting		Intact	Wood	***Positive***	9.5	4.3	< LOD	0.75	9.5	4.3	mg/cm^2	6.23	1.89
10	6/30/2017 8:27	B	Room	B01	C	Wall	Upr	Intact	Plaster	Negative	< LOD	0.16	< LOD	0.16	< LOD	1.5	mg/cm^2	7.85	3.51
11	6/30/2017 8:28	B	Room	B01	D	Cabinet		Intact	Wood	***Positive***	8.6	4.4	< LOD	1.35	8.6	4.4	mg/cm^2	6.37	1.59
12	6/30/2017 8:28	B	Hall		B	Closet	Door	Intact	Wood	***Positive***	1.5	0.4	1.5	0.4	1.5	0.8	mg/cm^2	5.05	4.44
13	6/30/2017 8:28	B	Hall		D	Cabinet	Door	Intact	Wood	***Positive***	6.6	3.1	< LOD	0.6	6.6	3.1	mg/cm^2	4.79	2.22
14	6/30/2017 8:29	B	Kitchen		A	Wall	Upr	Intact	Drywall	Negative	< LOD	0.03	< LOD	0.03	< LOD	1.19	mg/cm^2	1	3.19
15	6/30/2017 8:29	B	Kitchen		A	Door	Jamb	Intact	Wood	***Positive***	23.6	9.2	< LOD	2.85	23.6	9.2	mg/cm^2	10	1.27
16	6/30/2017 8:30	B	Kitchen		A	Wainscotting		Intact	Wood	***Positive***	28	16.4	< LOD	9	28	16.4	mg/cm^2	10	1.27
17	6/30/2017 8:30	B	Kitchen		C	Window	Sash	Intact	Wood	***Positive***	23.6	3.4	< LOD	13.8	23.6	3.4	mg/cm^2	3.97	3.18
18	6/30/2017 8:30	B	Kitchen		C	Door		Intact	Wood	***Positive***	24.5	9.6	< LOD	4.8	24.5	9.6	mg/cm^2	10	1.27
19	6/30/2017 8:31	B	Bath		C	Wall		Intact	Drywall	Negative	< LOD	0.03	< LOD	0.03	< LOD	1.14	mg/cm^2	1	3.17
20	6/30/2017 8:31	B	Bath		C	Door		Intact	Wood	***Positive***	5.3	3.4	5.6	2.3	5.3	3.4	mg/cm^2	3.67	1.58
21	6/30/2017 8:31	B	Bath		C	Door		Intact	Wood	Negative	< LOD	0.03	< LOD	0.03	< LOD	2.1	mg/cm^2	1	1.59
22	6/30/2017 8:32	B	Bedroom		A	Door		Intact	Wood	***Positive***	21.7	8.6	< LOD	15.9	21.7	8.6	mg/cm^2	10	1.27
23	6/30/2017 8:32	B	Bedroom		A	Door	Jamb	Intact	Wood	Negative	< LOD	0.05	< LOD	0.05	< LOD	2.25	mg/cm^2	1.43	1.9
24	6/30/2017 8:32	B	Bedroom		B	Wall		Intact	Drywall	Negative	< LOD	0.03	< LOD	0.03	< LOD	1.18	mg/cm^2	1	3.49
25	6/30/2017 8:33	B	Bedroom		D	Window	Sash	Intact	Wood	***Positive***	29.1	17.4	< LOD	4.8	29.1	17.4	mg/cm^2	9.38	0.95
26	6/30/2017 8:33	B	Bedroom		D	Wall		Intact	Drywall	Negative	< LOD	0.03	< LOD	0.03	< LOD	2.12	mg/cm^2	1	2.85
27	6/30/2017 8:34	B	Entry		A	Door		Intact	Wood	Negative	< LOD	0.03	< LOD	0.03	< LOD	3.41	mg/cm^2	1	1.9
28	6/30/2017 8:34	B	Entry		A	Door	Jamb	Intact	Wood	Negative	< LOD	0.1	< LOD	0.1	< LOD	2.18	mg/cm^2	2.65	1.58

Action Level = 1.0mg/cm^2

LOD = Limit of Detection

No	Time	Fl	Room	Rm#	Sd	Compont	Feature	Condtn	Substr	Results	PbC	PbC Error	PbL	PbL Error	PbK	PbK Error	Units	Dpth	Dur
29	6/30/2017 8:34	B	Entry		B	Closet	Door	Intact	Wood	***Positive***	15.5	2.5	1.8	0.9	15.5	2.5	mg/cm^2	10	3.48
30	6/30/2017 8:35	B	Entry		C	Stair	Tread	Intact	Wood	***Positive***	30.2	10.9	< LOD	16.2	30.2	10.9	mg/cm^2	7.1	1.26
31	6/30/2017 8:35	B	Entry		C	Wall		Intact	Wood	***Positive***	22.1	14.5	< LOD	118.2	22.1	14.5	mg/cm^2	8.54	1.27
32	6/30/2017 8:36	B	Entry			Stair	Wall	Intact	Plaster	Negative	0.3	0.14	0.3	0.14	< LOD	1.5	mg/cm^2	3.72	4.12
33	6/30/2017 8:39	1	Room	100	A	Window	Sash	Intact	Wood	***Positive***	27.3	3.7	7.5	3.8	27.3	3.7	mg/cm^2	10	3.17
34	6/30/2017 8:40	1	Room	100	A	Window	Sill	Intact	Wood	***Positive***	22.9	8	4	1.9	22.9	8	mg/cm^2	4.86	1.58
35	6/30/2017 8:40	1	Room	100	A	Wall		Intact	Plaster	***Positive***	1.5	0.3	1.5	0.3	< LOD	1.95	mg/cm^2	2.03	3.81
36	6/30/2017 8:40	1	Room	100	A	Wall	Bsbd	Intact	Wood	***Positive***	40.6	11.3	4.1	2	40.6	11.3	mg/cm^2	5	1.58
37	6/30/2017 8:41	1	Room	100	B	Door	Jamb	Intact	Wood	***Positive***	16.3	5.8	< LOD	3.6	16.3	5.8	mg/cm^2	10	1.9
38	6/30/2017 8:42	1	Entry		A	Door		Intact	Wood	***Positive***	13.5	5.8	8.4	5.1	13.5	5.8	mg/cm^2	7.36	1.58
39	6/30/2017 8:42	1	Entry		A	Door	Jamb	Intact	Wood	***Positive***	31.7	18.8	< LOD	30.3	31.7	18.8	mg/cm^2	9.6	1.27
40	6/30/2017 8:42	1	Entry		B	Wall		Intact	Plaster	Negative	< LOD	0.03	< LOD	0.03	< LOD	1.53	mg/cm^2	1	3.8
41	6/30/2017 8:43	1	Entry		B	Radiator		Intact	Metal	Negative	< LOD	0.36	< LOD	0.36	< LOD	4.2	mg/cm^2	2.91	1.91
42	6/30/2017 8:43	1	Entry			Stair	Tread	Intact	Wood	Negative	< LOD	0.1	< LOD	0.1	< LOD	2.08	mg/cm^2	1	2.23
43	6/30/2017 8:44	1	Room	101	A	Door	Jamb	Intact	Wood	***Positive***	35.5	19.7	< LOD	14.4	35.5	19.7	mg/cm^2	7.72	0.95
44	6/30/2017 8:44	1	Room	101	A	Wall		Intact	Drywall	***Positive***	1.6	0.6	1.6	0.6	< LOD	2.1	mg/cm^2	3.29	3.17
45	6/30/2017 8:44	1	Room	101	B	Wall	Bsbd	Intact	Wood	***Positive***	37.3	12.5	< LOD	7.35	37.3	12.5	mg/cm^2	9.29	1.27
46	6/30/2017 8:45	1	Room	101	C	Radiator		Intact	Metal	***Positive***	1.7	0.4	1.7	0.4	< LOD	1.95	mg/cm^2	3.42	3.81
47	6/30/2017 8:45	1	Room	101	C	Door		Intact	Wood	Negative	< LOD	0.37	< LOD	0.37	< LOD	3.94	mg/cm^2	2.79	1.9
48	6/30/2017 8:45	1	Room	101	C	Door	Jamb	Intact	Wood	***Positive***	8.6	4.2	< LOD	0.73	8.6	4.2	mg/cm^2	10	1.91
49	6/30/2017 8:45	1	Room	101	D	Wall		Intact	Plaster	***Positive***	31.1	11.1	7.4	4.3	31.1	11.1	mg/cm^2	5.81	1.26
50	6/30/2017 8:46	1	Room	101	D	Wall		Intact	Plaster	***Positive***	1.2	0.2	1.2	0.2	2	0.7	mg/cm^2	2.82	7.3
51	6/30/2017 8:46	1	Hall		D	Wall		Intact	Plaster	Negative	< LOD	0.03	< LOD	0.03	< LOD	1.93	mg/cm^2	1	2.54
52	6/30/2017 8:46	1	Hall		D	Wall	Bsbd	Intact	Wood	***Positive***	32.7	18.4	< LOD	4.2	32.7	18.4	mg/cm^2	10	0.95
53	6/30/2017 8:47	1	Bath		B	Wall		Intact	Drywall	Negative	< LOD	0.03	< LOD	0.03	< LOD	1.05	mg/cm^2	1	3.81
54	6/30/2017 8:47	1	Bath		D	Door		Intact	Wood	***Positive***	< LOD	19.8	< LOD	6.75	< LOD	19.8	mg/cm^2	10	0.95
55	6/30/2017 8:47	1	Bath		D	Door	Jamb	Intact	Wood	***Positive***	27.4	10	4.7	1.9	27.4	10	mg/cm^2	3.12	1.27
56	6/30/2017 8:48	1	Kitchen		A	Door	Jamb	Intact	Wood	Negative	< LOD	0.03	< LOD	0.03	< LOD	2.1	mg/cm^2	1	1.91

No	Time	Fl	Room	Rm#	Sd	Compont	Feature	Condtn	Substr	Results	PbC	PbC Error	PbL	PbL Error	PbK	PbK Error	Units	Dpth	Dur
57	6/30/2017 8:48	1	Kitchen		B	Wall		Intact	Plaster	Negative	0.4	0.1	0.4	0.1	< LOD	0.75	mg/cm^2	3.6	20.94
58	6/30/2017 8:49	1	Kitchen		B	Wall	Bsbd	Intact	Wood	***Positive***	23.1	15.2	< LOD	34.8	23.1	15.2	mg/cm^2	8.36	0.95
59	6/30/2017 8:49	1	Kitchen		D	Window	Sash	Intact	Wood	***Positive***	31.7	18.4	< LOD	12.45	31.7	18.4	mg/cm^2	4.15	0.95
60	6/30/2017 8:49	1	Kitchen		D	Window	Sill	Intact	Wood	***Positive***	32.3	10.1	< LOD	2.85	32.3	10.1	mg/cm^2	10	1.58
61	6/30/2017 8:50	1	Kitchen		D	Wall		Intact	Plaster	Negative	0.4	0.1	0.4	0.1	< LOD	0.9	mg/cm^2	3.21	12.96
62	6/30/2017 8:52	2	Room	200	A	Window	Sash	Intact	Wood	***Positive***	14	5.9	6.2	2.6	14	5.9	mg/cm^2	3.94	1.58
63	6/30/2017 8:52	2	Room	200	A	Window	Sill	Intact	Wood	Negative	< LOD	0.6	< LOD	0.6	< LOD	2.25	mg/cm^2	2.98	1.89
64	6/30/2017 8:52	2	Room	200	A	Window	Bench	Intact	Wood	***Positive***	4.5	1.5	4.5	1.5	< LOD	5.55	mg/cm^2	2.04	1.28
65	6/30/2017 8:53	2	Room	200	B	Wall		Intact	Plaster	Negative	< LOD	0.03	< LOD	0.03	< LOD	1.2	mg/cm^2	1	3.82
66	6/30/2017 8:53	2	Room	200	B	Wall	Bsbd	Intact	Wood	***Positive***	36.7	20.4	2.8	1.8	36.7	20.4	mg/cm^2	2.58	0.95
67	6/30/2017 8:54	2	Room	200	B	Door		Intact	Wood	***Positive***	< LOD	19.2	< LOD	48.6	< LOD	19.2	mg/cm^2	9.2	0.95
68	6/30/2017 8:54	2	Room	200	B	Door	Jamb	Intact	Wood	***Positive***	26.3	9.8	< LOD	10.5	26.3	9.8	mg/cm^2	7.6	1.27
69	6/30/2017 8:54	2	Room	200	C	Closet	Wall	Intact	Plaster	Negative	< LOD	0.03	< LOD	0.03	< LOD	1.16	mg/cm^2	1	3.17
70	6/30/2017 8:54	2	Room	200	D	Wall		Intact	Plaster	Negative	< LOD	0.03	< LOD	0.03	< LOD	1.2	mg/cm^2	1	3.8
71	6/30/2017 8:55	2	Room	200	D	Fireplace	Mantle	Intact	Wood	Negative	0.7	0.2	0.7	0.2	1	0.4	mg/cm^2	6.78	14.95
72	6/30/2017 8:55	2	Room	200	D	Fireplace	Trim	Intact	Wood	***Positive***	3	1	3	1	< LOD	3.45	mg/cm^2	2.75	1.91
73	6/30/2017 8:57	2	Bath		A	Wall		Intact	Plaster	***Positive***	1.7	0.6	< LOD	0.03	1.7	0.6	mg/cm^2	1	11.46
74	6/30/2017 8:57	2	Bath		A	Window	Sash	Intact	Wood	***Positive***	21.9	14.1	6.6	4.3	21.9	14.1	mg/cm^2	3.39	0.95
75	6/30/2017 8:57	2	Bath		A	Window	Sill	Intact	Wood	***Positive***	26.1	10	7.1	4.6	26.1	10	mg/cm^2	7.24	1.27
76	6/30/2017 8:57	2	Bath		A	Radiator		Intact	Metal	Null	< LOD	3.3	< LOD	3.3	< LOD	20.85	mg/cm^2	1.96	0.31
77	6/30/2017 8:57	2	Bath		A	Radiator		Intact	Metal	***Positive***	2.1	0.7	2.1	0.7	< LOD	4.65	mg/cm^2	1.91	1.9
78	6/30/2017 8:58	2	Bath		B	Bathtub		Intact	Metal	***Positive***	19.6	8.9	5.2	1.6	19.6	8.9	mg/cm^2	1.96	1.27
79	6/30/2017 8:58	2	Bath		B	Wall		Intact	Plaster	***Positive***	2.1	0.9	< LOD	0.03	2.1	0.9	mg/cm^2	1	5.4
80	6/30/2017 8:59	2	Bath		C	Door		Intact	Wood	***Positive***	22	8.8	< LOD	33.75	22	8.8	mg/cm^2	7.53	1.27
81	6/30/2017 8:59	2	Bath		C	Door	Jamb	Intact	Wood	***Positive***	31.9	11.5	9.3	5.4	31.9	11.5	mg/cm^2	5.47	1.27
82	6/30/2017 9:00	2	Hall		D	Door	Closet	Intact	Wood	***Positive***	22	9.1	5.7	2.7	22	9.1	mg/cm^2	4.01	1.27
83	6/30/2017 9:00	2	Hall		D	Door	Jamb	Intact	Wood	***Positive***	29.5	17.7	< LOD	13.8	29.5	17.7	mg/cm^2	7.11	0.95
84	6/30/2017 9:00	2	Hall		D	Wall		Intact	Plaster	Negative	< LOD	0.04	< LOD	0.04	< LOD	1.35	mg/cm^2	2.33	4.43

No	Time	Fl	Room	Rm#	Sd	Compont	Feature	Condtn	Substr	Results	PbC	PbC Error	PbL	PbL Error	PbK	PbK Error	Units	Dpth	Dur
85	6/30/2017 9:01	2	Hall		D	Wall	Bsbd	Intact	Wood	Null	< LOD	62.55	< LOD	1355.7	< LOD	62.55	mg/cm^2	8.83	0.32
86	6/30/2017 9:01	2	Hall		D	Wall	Bsbd	Intact	Wood	***Positive***	34.9	12	< LOD	40.35	34.9	12	mg/cm^2	6.93	1.27
87	6/30/2017 9:02	2	Hall		D	Wainscotting		Intact	Wood	***Positive***	7.8	3.6	< LOD	1.8	7.8	3.6	mg/cm^2	10	2.21
88	6/30/2017 9:03	2	Room	201	A	Closet	Wall	Intact	Plaster	Negative	< LOD	0.03	< LOD	0.03	< LOD	1.2	mg/cm^2	1	3.81
89	6/30/2017 9:03	2	Room	201	A	Closet	Jamb	Intact	Wood	***Positive***	37.2	12.5	5.6	2.4	37.2	12.5	mg/cm^2	3.34	1.27
90	6/30/2017 9:04	2	Room	201	A	Closet	Door	Intact	Wood	***Positive***	16.7	6.4	< LOD	4.35	16.7	6.4	mg/cm^2	10	1.58
91	6/30/2017 9:04	2	Room	201	A	Wall		Intact	Plaster	Negative	< LOD	0.03	< LOD	0.03	< LOD	1.05	mg/cm^2	1	3.81
92	6/30/2017 9:04	2	Room	201	A	Wall	Bsbd	Intact	Wood	Negative	< LOD	0.03	< LOD	0.03	< LOD	1.59	mg/cm^2	1	1.9
93	6/30/2017 9:05	2	Room	201	B	Door		Intact	Wood	***Positive***	22.3	7	4.4	1.6	22.3	7	mg/cm^2	3.66	1.9
94	6/30/2017 9:05	2	Room	201	B	Door	Stop	Intact	Wood	***Positive***	25	8.2	< LOD	3.15	25	8.2	mg/cm^2	10	1.59
95	6/30/2017 9:05	2	Room	201	C	Wall		Intact	Plaster	Negative	< LOD	0.03	< LOD	0.03	< LOD	1.2	mg/cm^2	2.62	3.49
96	6/30/2017 9:05	2	Room	201	C	Window	Sash	Intact	Wood	***Positive***	16	7.2	3.9	2.3	16	7.2	mg/cm^2	5.3	1.27
97	6/30/2017 9:06	2	Room	201	C	Window	Sill	Intact	Wood	***Positive***	1.4	0.3	1.4	0.3	1.6	0.8	mg/cm^2	4.22	4.46
98	6/30/2017 9:06	2	Room	201	C	Radiator		Intact	Metal	Negative	< LOD	0.25	< LOD	0.25	< LOD	3.78	mg/cm^2	2.18	1.91
99	6/30/2017 9:06	2	Room	201	D	Fireplace	Mantle	Intact	Wood	***Positive***	26.1	10.1	4.8	2.8	26.1	10.1	mg/cm^2	5.7	1.26
100	6/30/2017 9:06	2	Room	201	D	Fireplace	Trim	Intact	Wood	***Positive***	31.3	18	5.3	3.5	31.3	18	mg/cm^2	3.43	0.95
101	6/30/2017 9:07	2	Room	201	D	Wall		Intact	Plaster	Negative	< LOD	0.03	< LOD	0.03	< LOD	1.35	mg/cm^2	1	4.45
102	6/30/2017 9:07	2	Room	201		Ceiling		Intact	Plaster	Negative	< LOD	0.03	< LOD	0.03	< LOD	1.41	mg/cm^2	1	4.11
103	6/30/2017 9:09	2	Room	202	A	Closet	Wall	Intact	Plaster	Negative	< LOD	0.03	< LOD	0.03	< LOD	1.05	mg/cm^2	1	3.81
104	6/30/2017 9:09	2	Room	202	A	Closet	Door	Intact	Wood	***Positive***	18.7	7.8	4.6	2.7	18.7	7.8	mg/cm^2	5.66	1.27
105	6/30/2017 9:09	2	Room	202	A	Closet	Jamb	Intact	Wood	Negative	< LOD	0.18	< LOD	0.18	< LOD	1.79	mg/cm^2	6.22	2.22
106	6/30/2017 9:09	2	Room	202	A	Closet	Jamb	Intact	Wood	***Positive***	< LOD	13.6	< LOD	9.15	< LOD	13.6	mg/cm^2	4.5	0.95
107	6/30/2017 9:10	2	Room	202		Floor		Intact	Wood	***Positive***	2.4	0.3	2.4	0.3	2.6	1	mg/cm^2	1.98	3.8
108	6/30/2017 9:10	2	Room	202	A	Door		Intact	Wood	***Positive***	12	6.3	< LOD	1.2	12	6.3	mg/cm^2	5.21	1.26
109	6/30/2017 9:10	2	Room	202	A	Door	Jamb	Intact	Wood	***Positive***	13.6	6.5	< LOD	3.9	13.6	6.5	mg/cm^2	10	1.27
110	6/30/2017 9:10	2	Room	202	B	Wall		Intact	Plaster	Negative	< LOD	0.03	< LOD	0.03	< LOD	1.05	mg/cm^2	1	3.81
111	6/30/2017 9:11	2	Room	202	B	Wall	Bsbd	Intact	Wood	***Positive***	24.8	15.8	< LOD	5.85	24.8	15.8	mg/cm^2	4.4	0.94
112	6/30/2017 9:11	2	Room	202	C	Closet	Door	Intact	Wood	***Positive***	24.4	9.4	5.7	2.5	24.4	9.4	mg/cm^2	3.62	1.27

No	Time	Fl	Room	Rm#	Sd	Compont	Feature	Condtn	Substr	Results	PbC	PbC Error	PbL	PbL Error	PbK	PbK Error	Units	Dpth	Dur
113	6/30/2017 9:11	2	Room	202	C	Window	Bench	Intact	Wood	***Positive***	13.1	5.8	3.4	2.1	13.1	5.8	mg/cm^2	6.71	1.59
114	6/30/2017 9:12	2	Room	202	C	Radiator		Intact	Metal	Negative	< LOD	0.14	< LOD	0.14	< LOD	3.6	mg/cm^2	1.5	1.91
115	6/30/2017 9:12	2	Room	202		Ceiling		Intact	Drywall	Negative	< LOD	0.03	< LOD	0.03	< LOD	2.42	mg/cm^2	1	1.6
116	6/30/2017 9:14	1	Exterior		C	Wall		Intact	Brick	Negative	0.7	0.1	0.7	0.1	1.2	0.5	mg/cm^2	2.71	20
117	6/30/2017 9:15	1	Exterior		C	Window	Sill	Intact	Stone	Negative	0.8	0.1	0.8	0.1	1.8	0.9	mg/cm^2	1.97	6.66
118	6/30/2017 9:16	1	Exterior		C	Wall		Intact	Brick	Negative	0.5	0.1	0.5	0.1	< LOD	1.2	mg/cm^2	2.2	7.62
119	6/30/2017 9:19	1	Exterior		A	Floor	at Entry	Intact	Wood	***Positive***	4.5	2.7	1.5	0.7	4.5	2.7	mg/cm^2	3.69	2.54
120	6/30/2017 9:20	1	Exterior		A	Floor	Sill	Intact	Concr	Negative	0.14	0.05	0.14	0.05	< LOD	1.2	mg/cm^2	2.13	6.97
121	6/30/2017 9:20	1	Exterior		A	Handrail		Intact	Metal	Negative	< LOD	0.11	< LOD	0.11	< LOD	3.76	mg/cm^2	1	1.91
122	6/30/2017 9:21	1	Exterior		A	Stair	Tread	Peeling	Wood	Negative	< LOD	0.28	< LOD	0.28	< LOD	1.95	mg/cm^2	4.82	1.9
123	6/30/2017 9:22	1	Exterior		A	Wall		Intact	Brick	***Positive***	1.4	0.4	0.7	0.1	1.4	0.4	mg/cm^2	5.84	26.26
124	6/30/2017 9:22	1	Exterior		A	Window	Sill	Intact	Concr	Negative	< LOD	0.15	< LOD	0.15	< LOD	1.65	mg/cm^2	4.28	3.48
125	6/30/2017 9:25		Calibrate					Intact	Metal	Null	1	0.1	1	0.1	0.9	0.5	mg/cm^2	1.12	14.33
126	6/30/2017 9:26		Calibrate					Intact	Metal	***Positive***	1.1	0.1	1.1	0.1	< LOD	0.4	mg/cm^2	2.69	22.53

EMSL Analytical, Inc.
307 West 38th Street, New York, NY 10018
Phone/Fax: (212) 290-0051 / (212) 290-0058
http://www.EMSL.com manhattanlab@emsl.com

EMSL Order:	031719642
CustomerID:	ALPI50
CustomerPO:	
ProjectID:	

Attn: **PAUL VAN ZANDT**
Alpine Environmental Services
438 New Karner Road
Albany, NY 12205

Phone:	(518) 250-4047
Fax:	
Received:	07/01/17 10:31 AM
Collected:	6/30/2017

Project: **17-21211-A/ 221 JAY STREET, ALBANY, NEW YORK**

Test Report: Lead in Soils by Flame AAS (SW 846 3051A/7000B)*

Client Sample Description	*Lab ID*	*Collected*	*Analyzed*	*Lead Concentration*
1	*031719642-0001* Site: BACKYARD	6/30/2017	7/3/2017	2700 mg/Kg

M. Apfeldorfer
Miron Apfeldorfer, Laboratory Manager
or other approved signatory

*Analysis following Lead in Soil/Solids by EMSL SOP/Determination of Environmental Lead by FLAA. Reporting limit is 40 mg/kg based on the minimum sample weight per our SOP. Unless noted, results in this report are not blank corrected. This report relates only to the samples reported above and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities. Samples received in good condition unless otherwise noted. Results reported based on dry weight. "<" (less than) result signifies the analyte was not detected at or above the warning limit. Measurement of uncertainty is available upon request. The QC data associated with the sample results included in this report meet the recovery and precision requirements unless specifically indicated otherwise. Definitions of modifications are available upon request.

Samples analyzed by EMSL Analytical, Inc. New York, NY AIHA-LAP, LLC--ELLAP Accredited #102581, NYS ELAP 11506

Initial report from 07/05/2017 10:05:12

OrderID: 031719642

Alpine Environmental Services, Inc.
438 New Karner Road
Albany, NY 12205

031719642

Phone: (518) 250-4047

CHAIN OF CUSTODY

Client: Alpine Environmental Services, Inc.
438 New Karner Road
Albany, NY 12205

Contact: Paul Van Zandt

Phone/Email: 518 250-4047 paulv@alpineenv.com

Turnaround Time: ***24 Hr***

Project: 221 Jay Street, Albany, New York

Project Number: 17-21211-A

Sampled By: P. Van Zandt

Date / Time Collected: 6/30/17

Delivery:

Log No.	Sample No.	Sample Location	Sample Material	Analysis Performed	Notes
	1	Back Yard	Soil	**AAS Lead**	

EMSL MANHATTAN LAB RECEIVED 17 JUL -1 AM 10:31

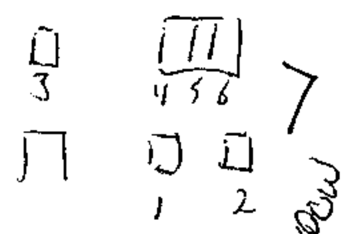
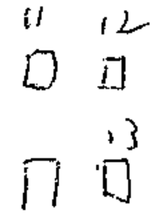
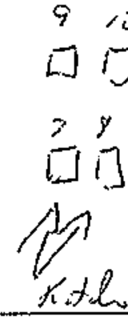
Disposition of Samples: Accept_____ Reject_____ Explain_____

Comments:

Relinquished By:	Received By:	Date:	Time:
PVZ	Kelli Atkins	7/1/17	10:31 AM

Page 1 of 1

FX 7795-3435-7241

Front	Rear	Left	Right
			

REPLACEMENT ALL WINDOW

Name: Joe (Jennifer) Giovenelli
Street: 221 Jay St.
City: Albany NY 12210
Estimator: SP
Job #: 13938
Work:
Cell: 928-8747
Home: JBN 1-585-750-1774

#	mfg	style	color	screen	glass	grids	int trim	ext trim	other	width	height
1	Pella	DH	W	1/2	Low E		Shoe		1	31	69 3/4
2					Argon		Stops		2	31	69 3/4
3	Atch. kitchen						New		3	31	65 3/4
4									4	28	65 1/4
5									5	39	65 1/4
6									6	28	65 1/4
7	Master bdrm					~~[illegible]~~			7	31	69 1/2
8									8	31	69 1/2
9									9	31	65 3/4
10									10	31	65 3/4
11	Sunroom								11	31	65 3/4
12									12	31	65 3/4
13									13	31	69 1/4 out of square
14											
15											
16											
17											
18											
19											
20											
21											
22											
23											
24											

NO grids

LEAD SAFE

Customer is Big on Lead Safe Practices

Bldg Permit?: ________ **Customers Approval:** ________

PRECISION FIT
DOUBLE-HUNG

DETAILED PRODUCT DESCRIPTIONS

Wood Exterior

LX Double-Hung

FRAME

- Select softwood, immersion treated with Pella's EnduraGuard® wood protection formula in accordance with WDMA I.S.-4. The EnduraGuard formula includes three active ingredients for protection against the effects of moisture, decay, stains from mold and mildew. Plus, an additional ingredient adds protection against termite damage.
- Interior exposed surfaces are [pine] [mahogany].
- Exterior surfaces are clad with aluminum.
- Pocket depth is 3-1/4" (83mm).
- Vinyl Jamb liner includes wood / clad inserts.

SASH

- Select softwood, immersion treated with Pella's EnduraGuard® wood protection formula in accordance with WDMA I.S.-4. The EnduraGuard formula includes three active ingredients for protection against the effects of moisture, decay, stains from mold and mildew. Plus, an additional ingredient adds protection against termite damage.
- Interior exposed surfaces are [pine] [mahogany].
- Exterior surfaces are [pine] [mahogany].
- Sash thickness is 1-13/16" (46mm).
- Upper sash has surface-mounted wash locks.
- Lower sash has concealed wash locks in lower check rail.

WEATHERSTRIPPING

- Water-stop Santoprene-wrapped foam at head and sill.
- Thermoplastic elastomer bulb with slip-coating set into lower sash for tight contact at check rail.
- Vinyl-wrapped foam inserted into jamb liner or jamb liner components to seal against sides of sash.

GLAZING SYSTEM(1)

- Quality float glass complying with ASTM C 1036.
- Silicone-glazed 11/16" dual-seal insulating glass [[annealed] [tempered]] [[clear] [[Advanced] [SunDefense™] [AdvancedComfort] [NaturalSun] Low-E coated, with argon] [[bronze] [gray] [green] Advanced Low-E coated, with argon]].
- Custom and high altitude glazing available.

EXTERIOR

- [Pine: factory primed with one coat acrylic latex] [Mahogany: [factory primed with one coat acrylic latex] [Unfinished, ready for site finishing]].

INTERIOR

- [Unfinished, ready for site finishing] [primed with one coat acrylic latex] [pine: [prefinished [White] [Linen White] [Bright White] [stain(4)]].

HARDWARE

- Galvanized block-and-tackle balances are connected to self-locking balance shoes which are connected to the sashes using zinc die cast terminals and concealed within the frame.
- Sash lock is [standard] [spoon-shaped]. Two sash locks on units with make width 37" and greater.
  - Finish is [baked enamel [Champagne] [White] [Brown]] [Bright Brass] [Satin Nickel] [Oil-Rubbed Bronze].
- Sash lift furnished for field installation. Two lifts on units with make width 37" and greater.
  - Finish is [baked enamel [Champagne] [White] [Brown]] [Bright Brass] [Satin Nickel] [Oil-Rubbed Bronze].

OPTIONAL PRODUCTS

Grilles

- Integral Light Technology® grilles
  - Interior grilles are [5/8"] [7/8"] [1-1/4"] ogee profile that are solid [LX: [pine] [mahogany] [alder] [douglas fir]] [SE: pine]. Interior surfaces are [unfinished, ready for site finishing] [factory primed] [pine: factory prefinished [White] [Linen White] [Bright White] [stain(4)]].
  - Exterior grilles are solid [5/8" putty profile] [7/8" [putty] [ogee] profile] [1-1/4" [putty] [ogee] profile] [2" ogee profile] that are pine. Exterior surfaces are water repellent, preservative-treated in accordance with WDMA I.S.-4, and are factory primed.
  - Patterns are [Traditional] [Prairie] [Top Row] [New England] [Victorian].
  - Insulating glass contains non-glare spacer between the panes of glass.
  - Grilles are adhered to both sides of the insulating glass with VHB acrylic adhesive tape and aligned with the non-glare spacer.

- or -

- Grilles-Between-the-Glass (2)
  - Insulating glass contains 3/4" contoured aluminum grilles permanently installed between two panes of glass.
  - Patterns are [Traditional] [Prairie] [Cross] [Top Row]
  - Interior color is [White] [Tan(3)] [Brown(3)] [Putty(3)] [Ivory] [Brickstone] [Harvest] [Cordovan].
  - Exterior colors is [White] [Tan] [Brown] [Putty] [Feature(4)].

- or -

- Removable grilles
  - [[3/4"] [1-1/4"] [2"] regular] [[1-1/4"] [2"] colonial] profile, with [Traditional] [Prairie] patterns that are removable solid pine wood Grilles steel-pinned at joints and fitted to sash with steel clips and tacks.
  - Interior [unfinished, ready for site finishing] [factory primed] [pine: prefinished [White] [Linen White] [Bright White] [stain(4)]].
  - Exterior [unfinished, ready for site finishing] [factory primed] [finish color matched to exterior cladding(5)].

Screens

- InView™ Screens
  - [Half-Size] [Full-Size] black vinyl-coated 18/18 mesh fiberglass screen cloth complying with SMA 1201, set in aluminum frame fitted to outside of window, supplied complete with all necessary hardware.
  - Spreader bar placed on units > 37" width or 64-1/4" make height
  - Screen frame finish is baked enamel, color to match window cladding.

- or -

- Vivid View® Screens
  - [Full-size] [Half-size] PVDF 21/17 mesh, minimum 78 percent light transmissive screen, set in aluminum frame fitted to outside of window, supplied complete with all necessary hardware.
  - Spreader bar placed on units >37" width or 64-1/4" make height.
  - Screen frame finish is baked enamel, color to match window cladding.

Hardware

- Optional factory applied limited opening device available for vent units in stainless steel; nominal 3-3/4" opening. Limiting device concealed from view.
- Optional window opening control device available for field Installation. Device allows window to open less than 4" with normal operation, with a release mechanism that allows the sash to open completely. Complies with ASTM F2090-10.

(1) Insulating glass with argon is Low-E coated. All other insulating glass is air-filled.

(2) Available in clear or Low-E insulating glass only. White exterior grille color is the only option available for clear insulating glass.

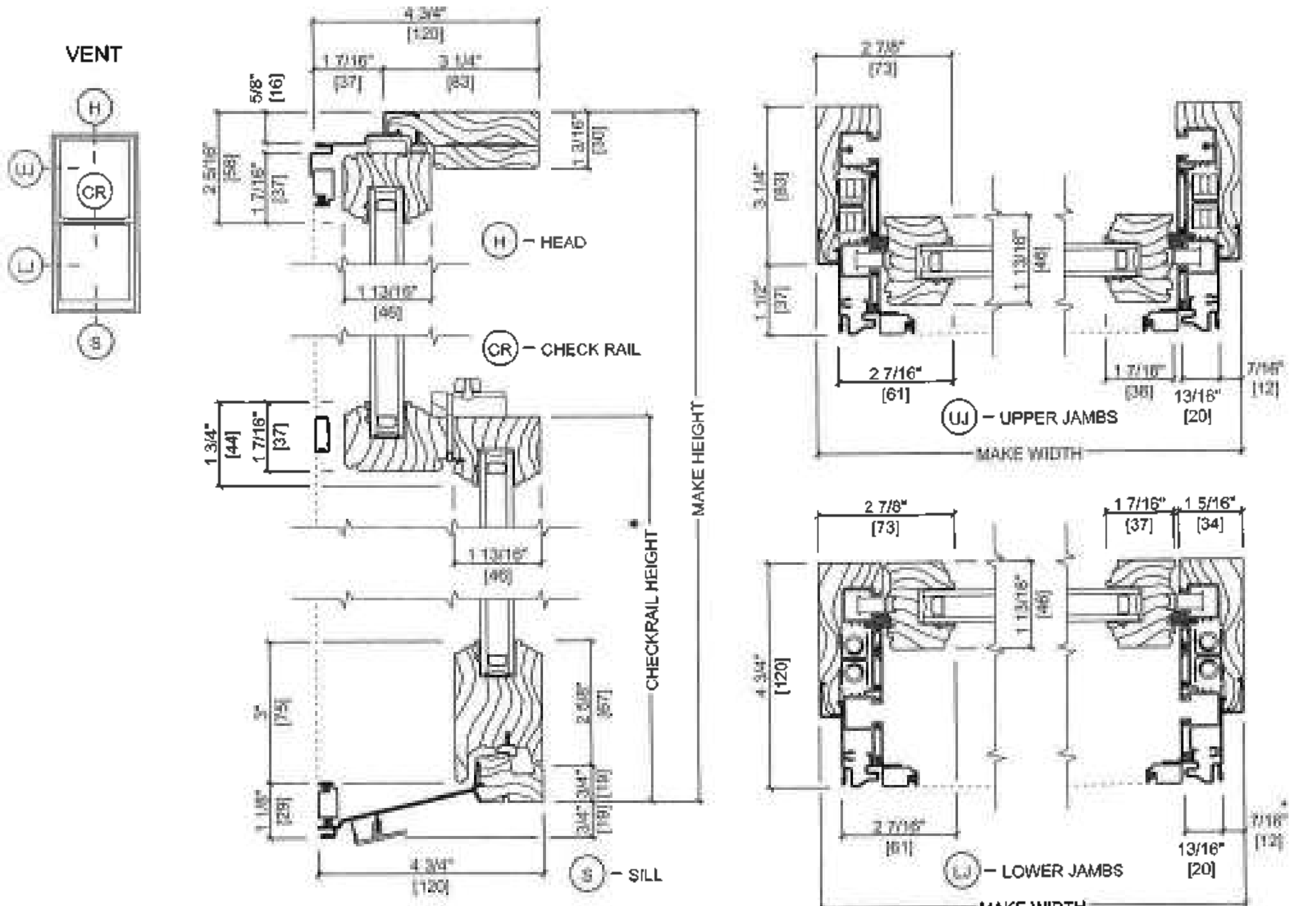
(3) Tan, Brown and Putty interior GBG colors are available in single-tone (Brown/Brown, Tan/Tan or Putty/Putty). Other interior colors are also available with Tan or Brown exterior.

(4) Contact your local Pella sales representative for current color options.

(5) Appearance of exterior grille color will vary depending on Low-E coating on glass.

UNIT SECTIONS
Primed Wood Exterior
LX Double-Hung

PRECISION FIT
DOUBLE-HUNG



* Dimension required for ordering units with unequal sash.

Scale 3" = 1' 0"

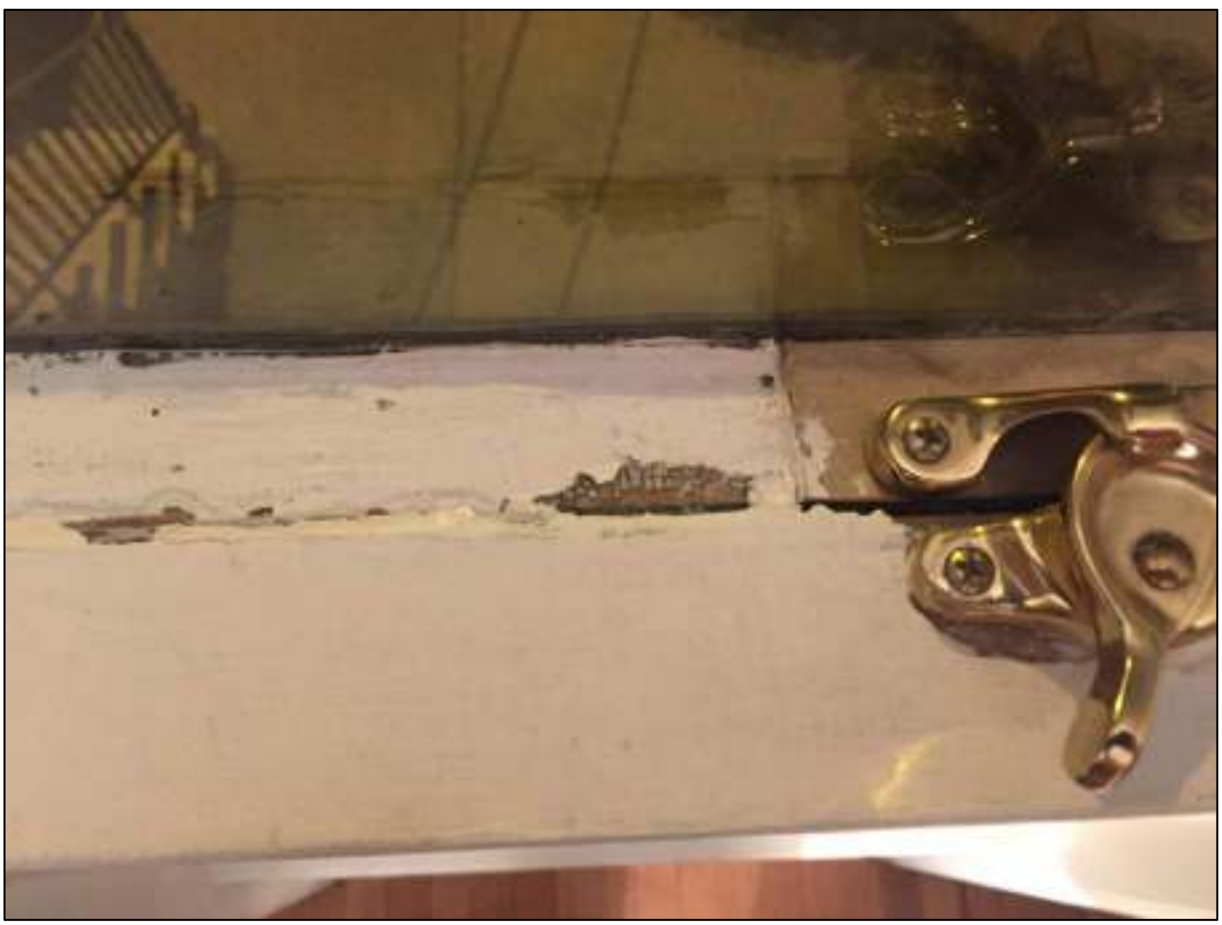
All dimensions are approximate.

For additional product information, visit **PELLAADM**.com

- Downloadable CAD files.

CITY OF ALBANY HISTORIC RESOURCES COMMISSION
Photographs

Front, South Elevation

FOR OFFICE USE ONLY 00140.001434 90NR0012
UNIQUE SITE NO. ~~00140-1434~~ ~~D04~~
QUAD
SERIES
NEG. NO.

BUILDING-STRUCTURE INVENTORY FORM

DIVISION FOR HISTORIC PRESERVATION
NEW YORK STATE PARKS AND RECREATION
ALBANY, NEW YORK (518) 474-0479

YOUR NAME: DATE: October 25, 1976 NOV 30 1976

YOUR ADDRESS: 545 Broadway TELEPHONE: 472-6643

ORGANIZATION (if any): Bureau of Cultural Affairs, Albany, N.Y.

* *

IDENTIFICATION

1. BUILDING NAME(S):
2. COUNTY: Albany TOWN/CITY: Albany VILLAGE:
3. STREET LOCATION: 221 JAY ST.
4. OWNERSHIP: a. public ☐ b. private ☒
5. PRESENT OWNER: Ralph MacDonald ADDRESS:
6. USE: Original: dwelling Present: dwelling
7. ACCESSIBILITY TO PUBLIC: Exterior visible from public road: Yes ☒ No ☐
   Interior accessible: Explain

DESCRIPTION

8. BUILDING MATERIAL: a. clapboard ☐ b. stone ☐ c. brick ☒ d. board and batten ☐ e. cobblestone ☐ f. shingles ☐ g. stucco ☐ other:
9. STRUCTURAL SYSTEM: (if known)
   a. wood frame with interlocking joints ☐
   b. wood frame with light members ☐
   c. masonry load bearing walls ☐
   d. metal (explain)
   e. other
10. CONDITION: a. excellent ☐ b. good ☐ c. fair ☐ d. deteriorated ☐
11. INTEGRITY: a. original site ☒ b. moved ☐ if so, when?
    c. list major alterations and dates (if known):

12. PHOTO:

13. MAP:

N

HP

14. THREATS TO BUILDING: a. none known [X] b. zoning [ ] c. roads [ ]
d. developers [ ] e. deterioration [ ]
f. other: ______

15. RELATED OUTBUILDINGS AND PROPERTY:
a. barn [ ] b. carriage house [ ] c. garage [ ]
d. privy [ ] e. shed [ ] f. greenhouse [ ]
g. shop [ ] h. gardens [ ]
i. landscape features: ______
j. other: ______

16. SURROUNDINGS OF THE BUILDING (check more than one if necessary):
a. open land [ ] b. woodland [ ]
c. scattered buildings [ ]
d. densely built-up [X] e. commercial [ ]
f. industrial [ ] g. residential [X]
h. other: ______

17. INTERRELATIONSHIP OF BUILDING AND SURROUNDINGS:
(Indicate if building or structure is in an historic district)

18. OTHER NOTABLE FEATURES OF BUILDING AND SITE (including interior features if known):

SIGNIFICANCE

19. DATE OF INITIAL CONSTRUCTION: c. 1856

ARCHITECT: ______

BUILDER: ______

20. HISTORICAL AND ARCHITECTURAL IMPORTANCE:

21. **SOURCES:** Assessors, City of Albany Assessment Rolls, 1855 - 1976

22. THEME:

CITY OF ALBANY HISTORIC RESOURCES COMMISSION

October 18, 2017

Supporting Documents

Preventing Lead Poisoning in Young Children: Chapter 8

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Chapter 8. Management of Lead Hazards in the Environment of the Individual Child

Summary

To eradicate childhood lead poisoning, lead hazards must be abated.

Environmental case management includes a number of actions prescribed for a child with lead poisoning.

Precautions must be taken to ensure that abatement is conducted in the safest and most effective manner possible.

Eradicating childhood lead poisoning requires a long-term active program of primary lead-poisoning prevention, including abatement of lead-based paint hazards in homes, day-care centers, and other places where young children play and live. For the child who is lead poisoned, however, efficient and effective interventions are needed as quickly as possible. Abatement means making the source of lead inaccessible to the child.

Lead-based paint is the most common source of high-dose lead poisoning. Complete abatement of lead-based paint means eliminating all lead- based paint in a housing unit as a source of lead for the child, either by removing the paint or by using permanent barriers. Complete abatement of the lead hazards in the child's environment is the most effective and only certain way to prevent further damage. Complete abatement is expensive, but once a dwelling is abated, many generations of children may live in that home and reap the benefits. Unfortunately, complete abatement may not always be possible, and shorter term, preventive maintenance procedures may have to be undertaken to minimize the potential for further damage.

Lead-based paint is rarely completely abated in many of the largest childhood lead poisoning prevention programs. Instead, various degrees of incomplete abatement—designed to eliminate the worst hazards and prevent near-term exposures—are conducted. Development of cost- effective, safe, simple, and widely applicable methods of complete paint abatement is a high priority.

Whether complete abatement or preventive maintenance is done, persons performing the work should be knowledgeable of the hazards of lead to themselves, to children, and to the environment. They should be trained in the proper procedures for abatement and preventive maintenance, since improperly performed work can actually increase the hazards to the child.

Each situation in which a child gets poisoned is unique and must be evaluated by a person or team of persons skilled and knowledgeable about lead poisoning, hazard identification, and interventions to reduce lead exposure, including abatement of lead-based paint in housing. Childhood lead poisoning prevention programs need to work closely with other relevant agencies (for example, housing and environmental agencies) to ensure that the quickest and most effective approach is taken to remediation the environments of poisoned children.

The 1985 CDC statement on *Preventing Lead Poisoning in Young Children* set the level for environmental intervention at 25 µg/dL. In this new statement CDC recommends environmental intervention for children with blood lead levels of > or = to 20 µg/dL, or of > or = to 15 µg/dL that persist. Where resources are limited, however, individual environmental intervention must first focus on those children with the highest blood lead levels. CDC also recommends that environmental interventions be directed at primary prevention of lead poisoning in communities with a large number or percentage of children with blood lead levels > or = to 10 µg/dL (Chapter 9 (Chapter9.htm)).

When resources are limited, environmental intervention must first focus on those children with the highest blood lead levels. When possible, abatement should be conducted for primary prevention of lead poisoning.

The Department of Housing and Urban Development has issued *Lead-Based Paint Interim Guidelines for Hazard Identification and Abatement in Public and Indian Housing*, hereafter called the HUD Guidelines (HUD, 1990, also published in the Federal Register 55FR14556). (The worker protection guidance was subsequently revised and published in the Federal Register, 55FR39873.) This document is referenced frequently in this Chapter because it contains the most comprehensive information on identifying and abating lead-based paint hazards available. It is not expected that every childhood lead poisoning prevention program or every homeowner will follow the guidelines completely. These guidelines were written for lead hazards in public and Indian housing, particularly for use during comprehensive modernization programs. Such programs, carried out when the property is vacant and in multiple units at one time, offer opportunities for very thorough and complete abatements. Most abatement of lead-based paint in the private sector does not occur in such a context. In the private sector, abatement is generally done in occupied housing scattered throughout an area, often with limited resources. In the context of this Chapter, the HUD guidelines are an information source on identifying and abating hazards.

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Environmental Case Management

Environmental case management includes

- Educating parents about the sources, effects, and prevention of lead poisoning.
- Investigating the environment to identify lead sources and effectively communicating the results of this investigation.
- Taking emergency measures to reduce lead exposure.
- Doing long-term interventions to reduce lead exposure.
- Evaluating the efficacy of the interventions.

Environmental case management includes a number of actions prescribed for a child with lead poisoning. Ideally, environmental case management should be conducted by a team of professionals in public health, environmental activities, medical management, and social management. A team approach to intervention will help ensure that followup is timely and effective. The management team may need to solve many related problems, such as whether to investigate supplemental addresses, where to find temporary alternative housing, and how to use community resources to assist the family in dealing with the lead-poisoned child.

A team approach to case management is most effective when all team members:

1. Demonstrate professionalism.
2. Show genuine concern for the poisoned child and family.
3. Support other team members.
4. Use similar terms, descriptions, and reference points to communicate with the child's family.
5. Meet specific time frames for followup.
6. Reinforce education of the family at every encounter.

Time Frames for Investigations and Interventions

The following guidelines describe the maximum time within which environmental interventions should be implemented. All children with blood lead levels > or = to 20 µg/dL should have environmental interventions conducted as quickly as possible. Children with blood lead levels > or = to 45 µg/dL require prompt chelation therapy. **The homes of these children must be remediated before they are allowed to return.**

Blood lead levels > or = to 70 µg/dL. Children with blood lead levels above 69 µg/dL constitute a medical emergency and must be hospitalized immediately. They are at highest risk for severe, permanent neurologic damage due to lead exposure and must be given highest priority for followup. Environmental investigation and intervention should be started within 24-48 hours and should include the child's home and potential sites of exposure, such as a relative's home or a day-care center. The homes of these children must be remediated before they are allowed to return.

Blood lead levels between 45 and 69 µg/dL. These children can be given a slightly lower intervention priority than the children classified as medical emergencies. Environmental investigation and intervention should begin within 5 working days and should include the same components as for children with higher blood lead levels. The homes of these children must be remediated before they are allowed to return.

Blood lead levels between 20 and 44 µg/dL. Environmental investigation and intervention should begin within 10 working days. Since many of these children will not be hospitalized and since allowing exposures to continue might lead to further increases in blood lead levels, environmental interventions for these children should be conducted as quickly as possible.

Blood lead levels between 15 and 19 µg/dL. Environmental investigation and intervention for children at this level should be based upon program resources and the ability of program staff to respond. At a minimum, these children and their families should have education regarding lead poisoning. If blood lead levels > or = to 15 µg/dL persist, environmental intervention should be made where possible—including assisting the parents in locating potential sources of lead contamination in and around the home and instructing them about how to reduce the risk of lead contamination. If resources permit, a full environmental inspection for lead-based paint should be done for such children.

Although full environmental investigation and abatement is not recommended as part of the management of children with blood lead levels below 15 µg/dL, the identification and reduction of lead hazards in all high-risk housing is an important primary prevention measure (Chapter 9 (Chapter9.htm)).

Educating Parents about Lead Poisoning

The parents of all lead-poisoned children should be educated about lead poisoning. In communities with a high incidence of lead poisoning, community wide educational efforts should be considered. These efforts should provide information similar to that in the anticipatory guidance provided by pediatric health care providers. Information provided should include:

1. Causes and effects of lead poisoning.
2. Relationship of the child's blood lead level to the potential for adverse health effects.
3. Need for followup blood lead testing of the child.
4. The child's possible sources of lead intake and practical means for reducing and eliminating these sources.
5. Role of nutrition in decreasing lead absorption.
6. Resources where parents can get further information (addresses and telephone numbers of local health-care providers or public health agencies).

Ideally, this information should be provided during a face-to-face meeting with the parents. When local resources are limited, however, written material (in an appropriate language) may be mailed to the child's family. Educating parents about lead poisoning is further discussed in Chapter 4 (Chapter4.htm).

Investigating the Environment and Communicating the Results

The technical aspects of inspecting a home for lead-based paint are discussed below. In general, an investigation of the environment of a lead poisoned child should include the following steps:

1. Determine the most likely sources of high-dose exposure to lead.
2. Investigate the child's home to identify possible sources of lead. Include both the interior and exterior environment and give special attention to painted surfaces, dust, soil, and water. (Details on how to test for lead-based paint are in the next section.)
3. Advise parents and caretakers about identified and potential sources of lead and ways to reduce exposure.
4. In cases in which the parent does not own the home, notify the property owner immediately that a child residing on the property has lead poisoning. Discuss the results of the environmental investigation and the abatement interventions required with the property owner. Emphasize the importance of prompt abatement. When a child with a medical emergency from lead poisoning is identified, an immediate, face-to-face meeting with the property owner may best demonstrate the need for emergency intervention.
5. Advise parents and property owners that no residents or personal belongings should remain in the home during abatement.
6. Monitor the effectiveness and timeliness of abatement procedures closely.
7. Coordinate environmental activities with those of other professionals, including the health-care providers and persons responsible for public health and social management. A team approach to intervention will help provide a timely and effective followup.

Emergency Measures to Reduce Lead Exposure

The first phase of environmental intervention may be to use short-term emergency interventions to temporarily reduce lead hazards. As soon as a blood lead level > or = to 20 µg/dL (or, if resources permit, > or = to 15 µg/dL) is confirmed, parents should be advised of the hazards of lead-based paint and lead dust. They should be told not to attempt abatement themselves improper abatement will most likely **increase** lead dust levels in the home and create additional, more severe exposure for the child. The temporary nature of interventions other than abatement should be emphasized.

When the source of lead is paint and paint-contaminated dust, parents can be instructed to stabilize the paint, wet-mop all floors, and wet-clean window sills and window wells at least twice per week. Cleaners high in phosphates appear to work particularly well. Sponges and rags used in this cleaning should be used for no other purpose. In particular, they should not be used to wash dishes or clean eating- or food-preparation surfaces, since dangerous contamination could result. Children's hands should be washed regularly, particularly before eating. Toys and pacifiers that are mouthed should be washed at least daily. Cribs and playpens should be moved away from chipping or peeling paint; furniture can be placed in front of areas that are not intact to make them less accessible. Dry sweeping of dust should be avoided, because it will stir up and spread the dust. Other measures to reduce lead exposure are discussed in Chapter 4 (Chapter4.htm).

Long-Term Measures to Reduce Lead Exposure

The next phase of environmental intervention involves long-term hazard reduction. If the source of lead is paint and paint-contaminated dust, the lead hazards are permanently abated only when all lead-based paint is completely removed or otherwise made permanently inaccessible. Less extensive practices, which are commonly used by childhood lead poisoning prevention programs, may be called "long term abatement." Certain maintenance procedures (for example, frequent cleaning and keeping walls freshly painted) may be classified as "preventive maintenance," but in general these procedures offer no absolute assurance of safety. In cases other than "permanent abatement," how long the hazard will remain under control depends on such factors as the quality of the workmanship, the thoroughness of the procedure, the soundness of the underlying structure, and the condition of the plumbing and roof. Moisture from leaky pipes or roofs can quickly cause paint that was smooth and intact to blister and scale, generating hazardous levels of lead dust. Except in unusual situations (such as in the case of housing that is not likely to be viable for more than a couple of years or when no alternative housing is available), temporary measures to reduce exposure should not be a substitute for abatement or an excuse for delaying abatement.

Technical aspects of lead-based paint abatement are discussed below.

Evaluating Intervention Activities

The effectiveness of any intervention for a lead-poisoned child should be evaluated by its impact on the child's blood lead level. Measurement of environmental lead levels may also be helpful.

Assessing the Lead Problem in the Child's Community

If a number of children are identified as being lead-poisoned in a community, communitywide interventions as described in Chapter 9 (Chapter9.htm) should be considered.

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Testing for and Abating Lead-based Paint

Tests for measuring the lead content of paint on walls have limitations; new tests for evaluating lead in paint are being developed. Proper abatement must be done by experts; untrained parents, property owners, workers or contractors should not attempt it.

NOTE: Remodeling or repainting homes with lead-based paint should be considered just as hazardous as abatement. Whenever lead-based paint must be disturbed by sanding, scraping, heating, or other forms of abrasion, the same precautions should be taken for remodeling or repainting as for abatement itself.

Inspection and testing

Several methods are available for determining the lead content of paint. These include XRF, wet chemical methods, and chemical spot tests. Although XRF analyzers are convenient, instruments available at the present time have limitations. A study by the National Institute of Standards and Technology (NIST, 1989) indicated possible substrate errors in the direct- reading XRF's of as much as + or - 2 mg/cm^2. These errors were caused by differences in base materials in walls and trim. (At very high readings, for example, above 3 mg/cm^2, this error has no practical significance). The spectrum analyzer, while considerably more expensive than the direct reader, provided much more accurate results. Only fully trained and experienced personnel should use XRF analyzers.

Wet chemical methods of analysis must be used if an XRF machine is not available or if it produces ambiguous results. Wet chemical methods require that a paint chip sample with all layers of paint on the surface be sent to a laboratory for analysis. Wet chemical analysis has two major disadvantages—results are not available immediately, and it is expensive.

Like XRF, chemical spot tests are performed on-site. A scratch is made through all layers of paint, and a chemical is placed on the scratch. If the scratch turns certain colors, further evaluation is needed. Chemical spot tests are qualitative, not quantitative, and the interpretation of the results is subjective. These tests are being refined and evaluated as to their safety, accuracy, and reliability.

Further information on proper testing procedures for lead-based paint is in the NIST study report and the HUD Guidelines.

The 1985 CDC statement on lead recommended an XRF value of 0.7 mg/cm^2 as the maximum level of lead in paint in a residence. The HUD standard, mandated by Congress, is 1.0 mg/cm^2. Several states have established their own XRF standards for lead in paint; these standards range from 0.7 mg/cm^2 to 1.2 mg/cm^2. The HUD document and some state regulations use a standard of 0.5% lead by weight for laboratory analysis.

Lead in paint should always be considered a "potential" hazard. An **immediate** lead hazard exists when lead-based paint is: 1) chipping, peeling or flaking; 2) is chalking, thereby producing lead dust; 3) is on a part of a window which is abraded through the opening and closing of the window; 4) is on any surface which is walked on (like floors) or otherwise abraded; 5) can be mouthed by a child (for example, window sills); or 6) is disturbed by repainting or remodeling. A potential lead hazard can easily become an immediate hazard through natural aging, plumbing or roof leaks, or the paint being disturbed. All lead-based paint exceeding the action level should, therefore, be abated whenever possible. Otherwise, complicated records must be kept of unabated surfaces, and those surfaces must be inspected frequently to make certain that they have not become immediate hazards.

When inspecting for lead-based paint hazards, care must be taken to evaluate **all** types of surfaces, including walls, ceilings, doors and windows, trim and jambs, woodwork, stairway components, porch components, garages, sheds, fences, play equipment, and any other structures on the premises. Because of legal requirements in some areas, it may be necessary to test every surface that may be painted with lead paint (that is, every window, every door, every piece of trim, etc.). Often, however, abatement decisions can be made without this costly and time-consuming approach. Even with an XRF, a full inspection of all surfaces in an average home may take 4 hours or more. Sometimes, extrapolating XRF results to untested surfaces may make sense. Such extrapolation, however, should only be used for positive results. For example, if test results for one window are positive for lead, it is safe to assume that all similar windows are painted with lead-based paint; if test results for one window are negative, it is **not** safe to assume that no windows have lead-based paint.

Recent studies have indicated that many children are poisoned by lead-contaminated dust ingested through normal hand-to-mouth activity. This dust can come from lead contaminated soil that is tracked into the home on shoes or from the clothes of a parent who works with lead. However, the most common source of lead dust in the average old house is lead-based paint. Some believe that the level of lead dust in a house can be used as a measure of the severity of the immediate hazard.

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Abatement

Proper abatement includes the following steps:

1. Proper training of all workers involved in the abatement.
2. Protecting those workers whenever they are in the abatement area.
3. Containing lead-bearing dust and debris.
4. Replacing, encapsulating, or removing lead-based paint.
5. Cleaning the abatement area thoroughly.
6. Disposing of abatement debris properly.
7. Inspecting to make certain the property is ready for reoccupancy.

Abatement should never be attempted by untrained parents, property owners, or contractors. The property owner's responsibility is not met until all the above steps have been completed.

Preparation: Just prior to abatement, all personal belongings, movable furniture, and drapes should be removed from the abatement area. In homes with deteriorated lead-based paint, furniture may be highly contaminated with lead dust. It is recommended that badly soiled carpets and drapes be discarded because of the difficulty of removing lead from them. Furniture should be cleaned before it is returned to the abated dwelling or it should be replaced. Wood, metal, glass and plastic surfaces should be washed with a high phosphate detergent. If possible, all upholstered furniture, carpets, drapes, and bare surfaces should be vacuumed with a High Efficiency Particle Accumulator (HEPA).

Precautions: Residents and their belongings should remain out of their homes during abatement. Under no circumstances should children and pregnant women be allowed to enter the dwelling unit during the abatement because abatement can generate large quantities of hazardous lead dust.

Training: All workers involved in a lead abatement project should be properly trained in the following: health effects of lead; proper procedures for worker protection, including procedures for personal hygiene and for wearing and caring for respirators; containment of an abatement project; various methods for abating lead-based paint and the safety and environmental hazards involved with each; and procedures for transporting and disposing of abatement debris properly.

Worker protection: All workers on a lead abatement project and their families must be protected from the hazardous lead dust that will be generated. The minimum acceptable protection would be coveralls (preferably disposable); shoe coverings; hair covering; gloves; goggles; and a properly fitted, negative-pressure, half-mask respirator with a HEPA filter. Other, more protective respirators may be needed to protect from hazards such as organic vapors. If the abatement methods used would generate significant quantities of lead dust or organic vapors, workers must wear more protective respirators, such as supplied air-respirators.

The potential hazard to workers of lead dust **ingestion** is as significant, if not more significant, than inhalation. Workers must not eat, drink, or smoke on the job; and hands and face must be washed before breaks and at the end of the day. On-sight showers should, if possible, be provided. If on-site showers are not available, workers must shower and wash their hair immediately upon returning home. They must be careful not to carry hazardous levels of lead dust home on their bodies, shoes, or clothing. Therefore, work clothes should not be worn home; either workers should wear protective work clothes instead of street clothes at the worksite or they should wear protective garments over their street clothes. Work clothes should be disposed of or laundered by the employer to prevent the contamination of automobiles, homes, etc. with dust; lead-contaminated clothing should be handled with care and should not be laundered with other clothing of the worker or his family.

Note: The Chapter in the HUD guidelines on worker protection was revised and published separately in the Federal Register on September 28, 1990 (55FR39873).

Containment: The work area should be contained with plastic (6 mil) to protect other living areas, yards, heating and ventilation systems, etc. from contamination. All nonmovable furnishings, such as counters, cabinets, and radiators should be covered with plastic. All floors should also be covered with plastic to prevent lead dust from being deposited in cracks and crevices and from being ground into the surface during the abatement.

Abatement: Abatement methods fall into three categories: 1) replacement, 2) encapsulation or enclosure, and 3) paint removal. These categories are discussed in more detail as follows:

> ***Replacement:*** Removing the building component (such as a window, door, or baseboard) and replacing it with a new one.
>
> ***Encapsulation:*** Covering a lead-painted surface with a material that will effectively prevent access to the lead-based paint and that will also prevent lead-bearing dust from that surface from entering the living environment.
>
> ***Paint Removal:*** Stripping paint by heat, chemical, or mechanical means. This can be done either on-site or at the premises of a chemical stripping firm.

Certain methods of removing lead-based paint may be particularly hazardous to both the worker and the building occupants and may be banned in some areas. They are —

1. Removing paint with an open-flame torch or other heating device that operates at temperatures likely to volatilize lead (the melting point of lead is 621°F).
2. Machine sanding surfaces with lead-based paint.
3. Sand blasting lead-based paint, except when the equipment is fitted with a vacuum device that prevents the dispersal of the debris.
4. Uncontained hydro-blasting.
5. Using chemical strippers containing methylene chloride. Methylene chloride is extremely toxic and protecting workers from exposure to this chemical is difficult.

If possible, all surfaces painted with lead-based paint should be abated by replacement, encapsulation, or paint removal. Ordinary paint is never an appropriate encapsulant; it is only part of a temporary maintenance procedure. Encapsulation materials should be durable and, where possible, affixed with both fasteners and adhesive. Paint-like coatings should be used with caution. Only coatings and adhesives that are proven to be safe and effective should be used. Any material that will eventually chip, peel, or flake upon aging or from water damage is not appropriate.

Paint removal is potentially the most hazardous abatement method because considerable amounts of lead dust and lead residue are generated. Paint removal from porous surfaces, such as wood or concrete, **always** leaves significant amounts of lead residue. This residue may not be visible and removing it requires extremely vigorous cleaning procedures (alternating washing with a high phosphate detergent and HEPA vacuuming (see below)). Painting over this residue can lead to lead dust problems when this paint begins to deteriorate or when it is abraded. Of particular concern are friction surfaces, such as window and door jambs.

Workers using any method that generates large volumes of dust or fumes should use caution. Such methods increase the difficulty of worker protection and the likelihood that hazardous levels of lead-bearing dust will remain in the dwelling unit or be deposited in the soil surrounding the home. Demolishing older structures with lead-based paint likewise can result in deposition of lead-bearing dust into the soil or on neighboring property, and dust suppression techniques should be used.

Clean-Up: All lead abatement activity is likely to generate quantities of hazardous lead dust. Unless this dust is properly cleaned, the dwelling unit will be more hazardous after abatement than it was before. This dust is difficult to remove. Daily clean-up, consisting of misting debris with water, carefully sweeping it, and placing it in double 4-mil or 6-mil plastic bags, is necessary to minimize the risk to workers of accumulated lead dust.

After abatement and before repainting, all surfaces in the dwelling must be thoroughly vacuumed with a HEPA vacuum; wet washed, preferably with a high phosphate detergent such as tri-sodium phosphate; and then vacuumed again. The property should be visually inspected before being repainted. The inspector should ascertain that all surfaces covered with lead-based paint have been abated and that no visible dust or debris remains on site.

Several states have adopted a post-abatement dust standard which has been included in the HUD Guidelines. This standard was set mainly on the basis of practicality rather than a health or risk assessment, and further research is needed on the adequacy and appropriateness of that standard. The standard allows the following maximum levels of lead in dust:

Floors	200 µg/ft^2
Window Sills	500 µg/ft^2
Window Wells	800 µg/ft^2

Inspectors and persons collecting dust samples and laboratories measuring dust lead levels should be thoroughly familiar with the recommended sampling and analysis protocols for dust in the HUD Guidelines.

After the inspection, abated surfaces should be repainted, if appropriate. Wooden floors should receive a coat of deck enamel or urethane, concrete floors should be sealed with deck enamel, and linoleum or tile floors should be waxed. Sealing the floors will bind any remaining dust particles and enable the occupants to clean those surfaces easily.

Disposal: Certain wastes from a lead-based paint abatement project, either liquid or solid, may be classified as hazardous. If so, they will have to be treated as such and handled by a licensed transporter or treatment firm. In any case, **all** debris from an abatement project, whether classified as hazardous or not, must be contained and transported in such a way as to prevent the dispersal of lead bearing dust, chips, or liquid into the environment. Lead debris should never be sent to a solid waste incinerator, a disposal method that disperses lead into the air.

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Replacing Windows Reduces Childhood Lead Exposure: Results From a State-Funded Program

David E. Jacobs, PhD, CIH; Matthew Tobin, MS; Loreen Targos, MS; Dale Clarkson, BS; Sherry L. Dixon, PhD; Jill Breysse, MHS, CIH; Preethi Pratap, PhD; Salvatore Cali, MPH, CIH

Context: Despite considerable evidence that window replacement reduces childhood lead exposure and improves energy conservation and market value, federal policies in childhood lead poisoning, home improvement, and weatherization programs all tend to discourage it. **Objective and Intervention:** To evaluate a state bond-financed pilot program that replaced old lead-contaminated windows with new lead-free energy efficient ones. **Design and Setting:** Pre-/post evaluation in 1 urban and 1 rural jurisdiction. **Participants:** Low-income households ($n = 96$). **Main Outcome Measures:** Dust wipe sampling, visual assessment, and physical and mental self-reported health at baseline and 1 year. **Results:** Geometric mean lead dust (PbD) from baseline to 1 year for interior floors, interior sills, and exterior troughs declined by 44%, 88%, and 98%, respectively ($P < .001$); 1 year later, levels remained well below baseline but rose slightly compared with clearance sampling just after intervention. PbD declined significantly on both sills and troughs in both the urban and rural jurisdictions from baseline to 1 year. On interior floors, PbD significantly declined by 58% ($P = .003$) in the rural area and 25% ($P = .36$) in the urban area, where the decline did not reach statistical significance. Households reported improvements in uncomfortable indoor temperatures ($P < .001$) and certain health outcomes. Economic benefits were estimated at $5 912 219 compared with a cost of $3 451 841, resulting in a net monetary benefit of $2 460 378. Residents reported that they were "very satisfied" with the window replacement work (87%). **Conclusion:** Local and state governments should fund and operate window replacement programs to eliminate a major source of childhood lead exposure, improve energy bills, increase home market value, and create local construction and industrial jobs. Federal agencies should encourage (not discourage) replacement of old windows contaminated with lead. In budget climates such as Illinois with reduced public expenditures, making wise investments such as lead-safe window replacement is more important than ever.

KEY WORDS: **childhood lead poisoning prevention, healthy housing, housing, lead, lead dust, lead poisoning, windows**

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The most recent data from the Centers for Disease Control and Prevention show that 535 000 children in the United States younger than 6 years have blood lead levels above the Centers for Disease Control and

Author Affiliations: The University of Illinois at Chicago, Chicago (Drs Jacobs and Pratap, Messrs Tobin, and Cali, and Ms Targos); Peoria City/County Health Department, Peoria, Illinois (Mr Clarkson); and National Center for Healthy Housing, Columbia, Maryland (Drs Jacobs and Dixon and Ms Breysse).

Jacobs is principal investigator; Tobin, Targos, and Clarkson are data collectors/analysts; Pratap is project manager; Dixon is statistician; Breysse is quality control officer, and Cali is environmental sampling supervisor; all participated in writing and reviewing the manuscript.

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Correspondence: David E. Jacobs, PhD, CIH, Environmental and Occupational Health Sciences Division, School of Public Health, The University of Illinois at Chicago, MC922, 2121 W. Taylor St, Chicago, IL 60612 (dejacobsdc@gmail.com).

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Prevention reference value of 5 $\mu g/dL$.[1] The 2 main sources of childhood lead exposure during the past few decades in the United States were leaded gasoline and lead paint.[2,3] Today, deteriorated lead-based paint and the contaminated residential dust and soil it generates are responsible for the majority of elevated blood lead levels.[4] The main childhood exposure pathway is normal hand-to-mouth contact and ingestion of lead-contaminated settled dust.[5-8]

A national housing survey shows that windows have average paint lead loadings about twice that of other building components.[9] Windows are also the most likely building component to be rated in "poor" condition. In homes constructed before 1940, 41% of window exteriors and 21% of window interiors have lead-based paint. Geometric mean (GM) sill and trough lead dust (PbD) loadings ($\mu g/ft^2$) are roughly 10 and 100 times higher than on floors, respectively.[9,10] Loading means unit weight of lead (micrograms) divided by unit surface area (square feet) and is how US regulatory PbD standards are expressed. These national findings are similar to earlier data in Illinois, where the present study was conducted.[11] Floor, sill, and trough PbD are all significantly correlated with children's blood lead levels, making PbD a good exposure metric.[7,8,12]

Abatement of leaded components, especially window replacement, is the most durable, longest-lasting option[13] but can be more expensive than other control methods such as paint stabilization. Beyond lead poisoning prevention, window replacement is also known to improve energy conservation and the market value of homes.[14]

However, federal programs have tended to discourage window replacement. For example, the Department of Energy's weatherization programs do not typically replace windows, because larger energy savings may be accomplished through insulation and air sealing, and weatherization assistance programs have a "walk away" policy if the cost of lead hazard control is deemed to be too large.[15] The Department of Housing and Urban Development's (HUD) lead hazard control program guidance requires time-consuming testing and photographing of virtually all windows before replacement, which is not required for any other building component.[16] Such federal weatherization and lead poisoning program policies discourage window replacement. This present study examines a state bond program that could help fill that gap.

In 2007, the Illinois General Assembly passed Public Act 095-0492, establishing the Comprehensive Lead Education, Reduction, and Window Replacement Program (ClearWin). The primary stated goal of ClearWin is "to assist residential property owners to reduce lead paint hazards through window replacement in pilot communities." The ClearWin program is a primary lead poisoning prevention program focusing on proactive window replacement in low-income, high-risk neighborhoods, instead of responding only to children who have already been poisoned. The Assembly mandated that the Illinois Department of Public Health administer the first window replacement program to be run by a public health agency in the nation.

The primary objectives were (1) to determine whether a state health department can cost-effectively conduct a window replacement program in both small and large cities such as Peoria and Chicago (Englewood neighborhood) using state bond financing; and (2) to quantify reductions in PbD in homes where windows are replaced from baseline to 1 year after treatment.

Methods

The study, approved by an institutional review board, examined approximately 100 housing units, equally divided between Chicago and Peoria, a convenience sample drawn from the 466 units treated under the larger ClearWin Program. PbD wipe samples were collected before, immediately after (clearance sampling), and nominally 1 year after window work was completed. Health interviews and housing condition visual assessments were done before the work and nominally 1 year after window replacement.

PbD was measured using the standard HUD wipe method, with analysis in laboratories accredited by the US Environmental Protection Agency National Lead Laboratory Accreditation program.[17] Interior floor, window sill, and window trough samples were collected at the interior entryway, in the living room, bedroom, and kitchen. Bare floors were preferred over carpets. For PbD values below the detection limit, the uncensored laboratory instrument output value was used if available, or if not, it was replaced with detection limit/$\sqrt{2}$. Fifty-five percent of the samples were below the detection limit, and instrument values were used for 99% of these measurements. For each sample type (entry floor, interior floor, interior window sill, and exterior window trough), the dwelling average PbD was calculated for each visit and transformed using the natural logarithm.

All ClearWin contractors were trained and followed "lead-safe window replacement" work practices that established containment to prevent the spread of lead dust during the work. To maximize energy benefits, the ClearWin protocol required high-efficiency (R-5) replacement windows, exceeding US Environmental Protection Agency's Energy Star standard (R-3.3) for

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efficient windows in Illinois' climate zone. The windows were manufactured in Illinois to maximize the program's job creation potential within the state. Contractors replaced old, painted, single-pane windows with new energy-efficient windows, removed debris, and conducted specialized cleaning. Clearance PbD testing was done either by or under the supervision of the Chicago or Peoria Health Departments to determine whether cleanup was adequate and to document compliance with Illinois clearance standards (40 $\mu g/ft^2$ on floors, 200 $\mu g/ft^2$ on interior window sills, and 400 $\mu g/ft^2$ on exterior window troughs).[18] For all analyses, the final clearance PbD value was used if recleaning and resampling was conducted. Clearance sampling ranged from 1 to 14 months after preintervention sampling (dependent on when windows were replaced), and 1 year postintervention interview data were collected from 5 to 22 months after window replacement (mean, 13 months).

Multivariable models were used to predict 1-year PbD and expressed the natural log-transformed PbD loading as a function of potential variables. These included variables, such as site, housing conditions, and characteristics (eg, building type [single family, 2-4 units or >4 units]), wiped surface types and conditions, time since clearance, seasonality, paint conditions (from visual paint inspection) in the home, resident characteristics, and reported cleaning habits. Backward elimination of nonsignificant independent variables ($P > .1$) was performed for the multivariable models, followed by additional steps to allow the addition and/or removal of variables with the SAS procedure PROC MIXED. A seasonality variable was retained regardless of significance because it has been shown to be important in other lead dust studies. For nominal variables with a missing category, the P value used tests for a significant difference between the nonmissing categories (ie, missing category was disregarded). For continuous variables with a dummy variable for missing values, the P values used tests for a significantly nonzero slope.

A standardized health interview was drawn from the Centers for Disease Control and Prevention National Health Interview Survey, the Behavioral Risk Factor Surveillance System, and the HUD National Survey of Lead and Allergens in Housing and previously used in several other healthy housing studies. It included physical and mental health questions about 1 adult and up to 4 children per household and also housing condition measures. The interview was used in an exploratory analysis to determine whether self-reported housing conditions and physical and mental health of adult and child residents changed between baseline and follow-up. For the Chicago urban group, interview data were available for 44 adults and 73 children living in 44 dwellings. For the Peoria rural group, interview data were available for 48 adults and 98 children living in 48 dwellings (totals: 92 dwellings, 92 adults, 171 children).

To assess mental health, the health interview included a measure of "serious psychological distress (SPD)" in adults and a "strengths and difficulties" score for children. Adult SPD included 6 measures (feeling sad, nervous, restless, hopeless, worthless, or that everything was an effort).[19] Each question asked how often the respondent experienced this symptom during the past 30 days (score 0-4), and the 6 scores were summed to yield a total score ranging from 0 to 24. Kessler's definition of SPD as a score of more than 13 was used.[20] To assess child behavior and emotions, adult participants were asked 4 questions from the "Strength and Difficulties Questionnaire", asking the respondent whether their child was poorly behaved, worried, unhappy, depressed or tearful, or had a poor attention span. The 4 responses were summed to yield a total Strength and Difficulties Questionnaire score ranging from 0 to 8, with higher scores indicating more difficulties.[21]

For dichotomous variables (eg, yes/no), the Cochran-Mean Haenszel test determined whether the percent "yes" was different at baseline versus 1 year postintervention. Weighted least squares determined whether the change in percent "yes" from baseline to 1 year postintervention differed for the Chicago and Peoria groups. For ordinal variables (eg, frequency of exhaust fan use, frequency of asthma symptoms), the Cochran-Mean Haenszel test determined whether mean pre- and postintervention scores differed. For continuous variables (eg, age), a 2-sample t test determined whether the Chicago and Peoria group mean differed. For nominal variables, the Fisher exact test determined whether the percentages in the Chicago and Peoria groups differed. We used SAS version 9.4 for all analyses.[22] Statistical significance is defined as $P < .05$ while marginal significance is defined as $.05 \leq P < .1$.

Results

Demographics

Nearly 100 homes had PbD sampling at baseline and 1 year (Chicago, n = 47; Peoria, n = 49) (see Supplemental Digital Content Table 1, available at: http://links.lww.com/JPHMP/A195). Of these, 92 households with 92 adults and 171 children completed health interviews administered by researchers, with the adult responding for both themselves and their children. The data show that the program succeeded in targeting

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TABLE 1 Lead Dust by Sample Type, Time of Visit, and Jurisdiction

Sample Type and Visit	ClearWin N	ClearWin % Exceed Standard[a]	ClearWin GM (95% CI)	HUD Natl Eval N	HUD Natl Eval GM (95% CI)	ClearWin GM Versus Natl Eval GM P^b	ClearWin Chicago N	ClearWin Chicago % Exceed Standard[a]	ClearWin Chicago GM (95% CI)	ClearWin Peoria N	ClearWin Peoria % Exceed Standard[a]	ClearWin Peoria GM (95% CI)	ClearWin Chicago Versus Peoria, P^c
Entry floor													
Baseline	95	15%	5.7 (4.0-8.1)	98	19.4 (14.0-26.8)	<.001	46	15%	6.6 (4.2-10.3)	49	14%	5.1 (2.9-8.7)	.438
Clearance	89	7%	2.4 (1.6-3.5)	98	8.4 (6.7-10.5)	<.001	44	11%	3.5 (2.0-6.1)	45	2%	1.6 (1.0-2.7)	.023
1 y	95	6%	3.5 (2.6-4.7)	98	12.0 (9.2-15.7)	<.001	46	9%	5.5 (3.5-8.6)	49	4%	2.3 (1.6-3.3)	.009
Interior floor													
Baseline	96	17%	7.6 (5.2-10.7)	98	18.3 (13.8-24.3)	<.001	47	17%	9.9 (5.9-16.7)	49	16%	5.7 (3.4-9.5)	.069
Clearance	96	2%	2.5 (1.9-3.3)	98	8.2 (6.8-9.9)	<.001	47	4%	3.1 (2.0-4.7)	49	0%	2.0 (1.4-2.9)	.155
1 y	96	5%	4.1 (3.1-5.6)	98	7.8 (5.8-10.4)	<.001	47	11%	7.5 (4.6-11.6)	49	0%	2.4 (1.7-3.3)	<.001
Window sill													
Baseline	96	38%	144 (94-223)	49	130 (67-252)	.540	47	34%	161 (89-288)	49	41%	130 (67-252)	.587
Clearance	96	3%	5 (4-7)	49	4 (3-7)	<.001	47	6%	6 (3-10)	49	0%	4 (3-7)	.455
1 y	96	8%	17 (12-25)	49	9 (5-16)	<.001	47	11%	32 (20-52)	49	6%	9 (5-16)	.001
Window trough													
Baseline	94	78%	2737 (1638 -4572)	77	1,984 (1046-3763)	.547	45	78%	2415 (1311-4451)	49	78%	3069 (1339-7037)	.579
Clearance	87	2%	7 (4-10)	77	14 (10-20)	.068	38	5%	13 (6-28)	49	0%	4 (3-6)	.009
1 y	94	11%	46 (29-73)	77	302 (206-443)	<.001	45	13%	171 (116-252)	49	8%	14 (7-27)	<.001

Abbreviations: CI, confidence interval; GM, geometric mean; HUD, Department of Housing and Urban Development.
[a]Federal clearance standards: floor = 40 $\mu g/ft^2$; interior window sill = 250 $\mu g/ft^2$; exterior window trough = 400 $\mu g/ft^2$.
[b]P value from the test that GM PbD for ClearWin is different from the National Evaluation for a specific visit.
[c]P value from the test that GM PbD for Chicago is different from Peoria for a specific visit.

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high-risk, low-income households with young children as intended. The majority of adults (67%) had an annual household income of less than $30 000. Adults in both groups were mostly female (79%), and approximately 41% had a high school education or less. Chicago and Peoria adults differed by age (Chicago adults 60 years of age versus Peoria adults 42 years of age, $P < .001$), but children in both cities averaged between 7 and 8 years. All Chicago participants were black, while Peoria participants were split almost evenly between non-Hispanic white and black. Chicago residents lived in their homes about 3 times longer on average ($P < .001$), and overall 93% of homes were in single family buildings (see Supplemental Digital Content Table 1, available at: http://links.lww.com/JPHMP/A195).

Trends in lead dust

There were large statistically significant reductions in interior floor, window sill, and window trough PbD from baseline to clearance, and those reductions were sustained through 1 year (Tables 1 and 2). Between baseline and 1 year postintervention, GM PbD for interior floors, interior sills, and exterior troughs declined by 44% ($P = .006$), 88% ($P < .001$) and 98% ($P < .001$), respectively. At baseline, the percentage of ClearWin units above clearance dust standards for floors, sills, and troughs was 17%, 38%, and 78%, but immediately following cleanup and window replacement, it declined to 2%, 3%, and 2% of the units, respectively. A year later, the percentage with PbD greater than clearance thresholds rose slightly on floors, sills, and troughs to 5%, 8%, and 11%, respectively, suggesting that levels remained well below baseline but that even with window replacement, ongoing cleaning by residents is still needed.

Baseline GM PbD was marginally significantly higher on interior floors in Chicago than Peoria ($P = .069$), but there were no significant differences on other surfaces. Although Peoria generally had lower GM PbD at subsequent visits than Chicago, the only statistically significant difference in the change in GM PbD between visits was for window troughs, which had greater reductions from baseline to clearance and 1 year postintervention than Chicago ($P = 0.024$ and $P < 0.001$, respectively). On window sills, Peoria had marginally greater reduction from baseline to 1 year ($P = .05$) and a marginally smaller increase from clearance to 1 year ($P = .06$), that is, the reduction on window surfaces in both urban and rural areas is not much different,

TABLE 2 Changes in Geometric Mean Lead Dust

Sample Type and Visit	ClearWin % Change	ClearWin P^a	HUD Nat'l Eval % Change	HUD Nat'l Eval P^a	ClearWin Versus Nat'l Eval P	ClearWin Chicago % Change	ClearWin Chicago P^a	ClearWin Peoria % Change	ClearWin Peoria P^a	ClearWin Chicago Versus Peoria P^b
Entry floor										
Overall	...	.002	...	<.001	.875	...	.179	...	.003	.369
Baseline to clearance	−59%	<.001	−57%	<.001	NA	−46%	NA	−68%	<.001	NA
Baseline to 1 y	−39%	.039	−38%	.069	NA	−16%	NA	−55%	.016	NA
Clearance to 1 y	46%	.120	44%	.022	NA	55%	NA	41%	.312	NA
Interior floor										
Overall	...	<.001	...	<.001	.287	...	.001	...	<.001	.224
Baseline to clearance	−67%	<.001	−55%	<.001	NA	−69%	<.001	−65%	<.001	NA
Baseline to 1 y	−44%	.006	−57%	<.001	NA	−25%	.373	−58%	.003	NA
Clearance to 1 y	67%	.031	−5%	.743	NA	140%	.007	18%	.155	NA
Window Sill										
Overall	...	<.001	...	<.001	.004	...	<.001	...	<.001	.096
Baseline to clearance	−96%	<.001	−92%	<.001	.010	−96%	<.001	−97%	<.001	.885
Baseline to 1 y	−88%	<.001	−70%	<.001	.002	−80%	<.001	−93%	<.001	.052
Clearance to 1 y	230%	<.001	285%	<.001	.587	443%	<.001	105%	.063	.072
Window trough										
Overall	...	<.001	...	<.001	.002	...	<.001	...	<.001	<.001
Baseline to clearance	−100%	<.001	−99%	<.001	.347	−99%	<.001	−100%	<.001	.024
Baseline to 1 y	−98%	<.001	−85%	<.001	<.001	−93%	<.001	−100%	<.001	<.001
Clearance to 1 y	586%	<.001	1,993%	<.001	.015	1,203%	<.001	246%	.007	.034

Abbreviation: HUD, Department of Housing and Urban Development; NA, not applicable.
[a] P value from the test that the relative change in GM PbD between the visits for the study group is nonzero.
[b] P value from the test that the relative changes in GM PbD between the visits are different for 2 jurisdictions.

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suggesting that the program worked well in both (Table 2).

Entry floors were analyzed separately from interior floors because of the potential for track-in. The change in GM PbD for entry floors over the 3 visits was significant for both cities combined ($P = .002$) and for Peoria (55% reduction; $P = .003$) but not for Chicago (16% reduction; $P = .18$). For both cities combined, baseline GM PbD on entry floors (5.7 $\mu g/ft^2$) was significantly greater than 1 year postintervention GM PbD (3.5 $\mu g/ft^2$) ($P = .04$) (Tables 1 and 2).

Comparing these results to the National Evaluation of the HUD Lead Hazard Control Grant program,[8] with the exception of baseline window sill ($P = .54$) and window trough GM PbD ($P = .55$), the National Evaluation had significantly higher GM PbD on entry floors, interior floors, sills, and troughs at all 3 visits (Table 1). The changes in GM PbD across the 3 visits for the National Evaluation were not significantly different from ClearWin on entry floors ($P = .88$) or interior floors ($P = .29$); however, on window sills and troughs, the reductions in GM PbD from baseline to clearance and baseline to 1 year were greater for ClearWin and the increases from clearance to 1 year were smaller for ClearWin (all $P < .001$) (Table 2).

Predictors of lead dust

The ClearWin only and combined interior floor models were very similar. Carpeting had lower PbD than hard surfaces while controlling for other predictors (see Supplemental Digital Content Table 2, available at: http://links.lww.com/JPHMP/A196). The higher PbD was on sills and entry floors, the higher it was on interior floors (all $P < .001$) (see Supplemental Digital Content Table 2, available at: http://links.lww.com/JPHMP/A196). Surprisingly, season was not a significant influence. In the combined model, site was significant ($P < .001$) but floor PbD as not significantly different for Chicago homes in ClearWin and the National Evaluation ($P = .3$).

The ClearWin only and combined window sill models were also very similar. The worse the condition of the wiped sills, the higher the sill PbD while controlling for other predictors. At 1 year, the higher the 1 year trough level was, the higher the sill PbD (both $P < .001$). The interaction of site (city) and baseline sill PbD was significant in the ClearWin only model ($P < .001$). In Chicago, higher baseline sill PbD was associated with higher 1 year sill PbD ($P < .001$), but in Peoria, they were not significantly associated ($P = .52$) (see Supplemental Digital Content Table 3, available at: http://links.lww.com/JPHMP/A197). In the combined model, higher baseline sill PbD was significantly associated with higher 1 year sill PbD ($P < .001$), but the interaction between site and baseline sill PbD was not significant. In the combined model, site was significant ($P < .001$) but sill PbD was not significantly different for Chicago homes in ClearWin and the National Evaluation ($P = .16$).

TABLE 3 Costs and Benefits ($N = 466$ units)

ClearWin Long-Term Monetized Benefits	Total
Installed window cost (A)	$3 071 841
Number of windows replaced	7747
Long-term energy benefit	$1 529 974
Other market (home resale) value	$770 885
Total market and energy value at $297/window (B)	$2 300 859
Housing built before 1940 (health benefit = $24 571 per child)	$3 341 656
Housing built 1940-1959 (health benefit = $10 068 per child)	$251 700
Housing built 1960-1979 (health benefit = $2572 per child)	$18 004
Total monetized health benefit (C)[a]	$3 611 360
Administrative cost (D)[b]	$380 000
Total benefits (B + C)	$5 912 219
Total costs (A + D)	$3 451 841
Net benefits (B + C − A − D)	$2 460 378

[a]Health benefits calculated from number of actual children living in ClearWin homes by age of housing.
[b]Costs do not include minor repairs and mandated program evaluation costs.

Health and housing condition

The overall mean score for satisfaction with window replacement was 1.2, between very satisfied (score of 1) and satisfied (score of 2) out of a 5-point scale from very satisfied to very unsatisfied. Chicago's mean score was 1.3, while Peoria's was 1.1 ($P = .17$, comparing the 2 mean scores), showing that people in both jurisdictions were equally satisfied with the program (data not shown). The percentage of people reporting uncomfortable indoor temperatures in both summer and winter improved greatly, as did dampness (Figure). At 1 year postintervention, fewer participants reported water or dampness issues in their home ($P = .06$), and the percentage of people reporting uncomfortable indoor temperatures in both summer and winter significantly decreased ($P = .001$ and $P < .001$, respectively) (Figure).

The percentage of children experiencing headaches, respiratory allergies, and 3 or more ear infections significantly improved between baseline and 1 year postintervention (7% improved, $P = .02$; 12% improved, $P < .001$; and 5% improved, $P = .06$, respectively). Mental health significantly improved for children in Chicago but not those in Peoria ($P = .01$ and $P = .32$,

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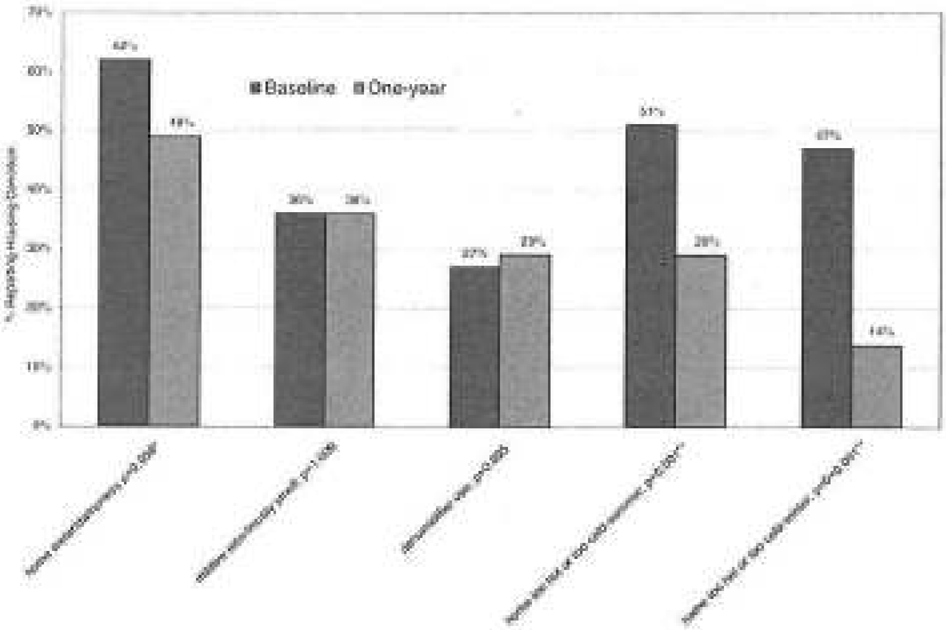
FIGURE Housing Moisture and Comfort Conditions From Baseline to 1 Year Postintervention



respectively). The general health score of children improved significantly at the 1-year postintervention visit ($P = .013$) (see Supplemental Digital Content Table 4, available at: http://links.lww.com/JPHMP/A198).

The percentage of adults experiencing sinusitis and hay fever improved from pre- to 1 year postintervention (18%, $P = .001$; and 5%, $P = .096$, respectively), although the percentage of those reporting hypertension ($P = .025$) and a heart condition marginally increased ($P = .08$) (see Supplemental Digital Content Table 5, available at: http://links.lww.com/JPHMP/A199). Both of these chronic ailment increases were primarily found in the Chicago group, whose mean age was more than that of the Peoria group. Overweight and chronic bronchitis also saw reductions in both groups combined, but these improvements did not reach statistical significance. There was no significant change in adult mental health as reflected in the SPD score.

Economic costs and benefits

Using a previously validated methodology,[33] total benefits are at least $6 million and net benefits are nearly $2.5 million (Table 3). The health economic benefit is predominately associated with gains in lifetime earnings due to avoided loss of IQ (higher IQ is associated with both higher lifetime earnings and reduced exposure to lead). The cost data show an installed window cost of approximately $400/window, demonstrating the savings from bulk purchase programs for window replacement as was done for ClearWin. Benefits are likely underestimated because factors such as reduced need for special education, reduction in stress, reduced property management costs, avoided litigation from lead poisoned children, reduced cardiovascular disease associated with reduced blood lead level, reduced criminal and antisocial behavior in later life associated with early childhood lead exposure, and others could not be assigned a dollar value easily.

Discussion

The economic analysis clearly shows that Illinois' investment in windows is dwarfed by the benefits of the program and that the program is ready to expand beyond its pilot phase, which was limited to Chicago and Peoria. In difficult budget climates in states such as Illinois, making wise investments such as those in ClearWin is more important than ever.

There was very little attrition in the ClearWin study (100 homes enrolled at baseline, 96 homes had PbD data at both baseline and 1 year [Chicago: N = 47, Peoria: N = 49], and 92 completed health interviews, including 44 adults and 73 children in Chicago; in the Peoria group, interview data were available for 48 households with 48 adults and 98 children).

This study shows that window replacement achieves large sustained reductions in PbD on window sills and troughs over at least a year and probably much longer given the low levels of reaccumulation. Reductions on

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floors tended to be less than those on windows, especially in Chicago perhaps because of track-in of exterior PbD or other factors. In Peoria, the reduction in interior floor GM PbD from baseline to 1 year was 58% ($P = .003$), compared with 25% in Chicago ($P = .37$). For entry floor GM PbD from baseline to 1 year, Peoria declined by 55% ($P = .02$) and Chicago declined by 16% ($P = .18$). The data also show that clearance testing is needed for window replacement programs to ensure that cleanup is done properly (initial failure rates were as high as 30% for some contractors). One possible reason for the slightly better PbD trends in Peoria may be due to smaller size of urban area.

A 6-year follow-up study of lead hazard control in units treated under the HUD Lead Hazard Control Grant program found that window replacement, sash replacement, and/or window jamb liners yield lower PbD on window sills and troughs than window painting and/or cleaning, although that study combined replacement with friction reduction and was thus limited in its ability to examine the independent effect of window replacement.[24] A more recent study of 12-year follow-up data showed that lower floor PbD levels were associated with window replacement performed as part of federally funded lead hazard control programs aimed mostly at already poisoned children.[25]

There are several possible explanations for the lower sill PbD values observed in ClearWin. The National Evaluation units likely had higher PbD after window work because clearance standards were higher in the 1990s and ambient air lead standards were also higher in the 1990s than during the more recent ClearWin study. The National Evaluation study data were mostly collected during the mid- to late-1990s.

For the ClearWin health interview data, the exploratory analysis suggested that some health improvements could conceivably be related to window replacement, such as headaches and sinus problems, perhaps due to the effect of less drafty homes associated with improved windows, although another possible explanation could be seasonal influences or other influences not measured. It also showed other health improvements that could less plausibly be associated with window replacement, such as overweight or increased use of bait traps (data not shown). The percentage of children with learning disabilities and with asthma increased slightly between the 2 visits ($P = .025$ and .046, respectively), but it seems unlikely that this would be due to window replacement and may be spurious.

Limitations

A limitation of this study is that there were no soil or blood lead measurements, although it is known that PbD is correlated with both[26] and is thus a good marker for housing-related lead dust exposures. Indeed, blood lead measurements are confounded by other nonhousing sources of exposure such as diet. Soil measurements may have been able to show why window trough levels increased slightly over the follow-up period if reentrainment of soil lead occurred and then settled onto window troughs.

Another limitation of the present study was that Pb levels in paint and exterior dust could not be collected. ClearWin homes focused on window replacement, but the Evaluation housing units typically had additional lead hazard controls implemented, although clearance standards for the latter were higher, suggesting that Evaluation homes may have had higher PbD at postintervention. The homes studied here were a convenience sample that may reduce the generalizability of the results to the broader cohort of ClearWin homes due to unknown sources of bias, although nearly all homes in both groups were single family houses in low-income neighborhoods at high risk of lead poisoning with a high prevalence of lead-based paint hazards. Lead-based paint hazards (including high dust lead levels) are present in 24 million housing units, including both low- and moderate-income populations.[9]

The time frame for various interview questions fluctuated. For example, preintervention questions about certain health conditions (eg, headaches in children and sinusitis in adults) asked whether the person had experienced the condition in the "last 12 months." In the 1-year postintervention interview, this phrase was changed to "since window replacement." In some of the housing condition questions (eg, resident used traps, bait stations, or poisons to control mice/rats), no time frame was specified in the preintervention question but the phrase "since window replacement" was added to the 1-year postintervention question. Because the 1-year postintervention visits were conducted between 5 and 22 months after window replacement work was completed (mean 13 months), the preintervention and 1-year postintervention time frames for such questions were not always equal. The impact of unequal time periods on participants' answers is unknown but likely had some minor effect.

The exploratory analysis on health outcomes associated with window replacement requires further research. Although reduced drafts and moisture intrusion could plausibly be associated with respiratory conditions, such as ear infections or respiratory allergies, asthma and overweight indicators showed conflicting trends, perhaps due to nonwindow unmeasured factors such as medication and diet.

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Conclusions

The results show that a state health department can successfully implement a window replacement program that dramatically reduces childhood lead exposure. This pilot program in 2 communities shows that the program should be expanded. Dust lead levels declined and the reductions were sustained, showing that children benefited from the program. Because dust lead is significantly correlated with blood lead levels, it is likely that children in the present study had a decline in blood lead level. Furthermore, the economic benefits far outweigh the costs, making investment in window replacement a wise use of funds.

On average, residents gave the program high marks, reporting that they were "very satisfied" with the window replacement using a 5-point scale (very satisfied, satisfied, neither satisfied nor dissatisfied, somewhat dissatisfied, very dissatisfied).

Local and state governments should fund such window replacement programs to eliminate a major source of childhood lead exposure, create jobs, and improve energy efficiency, and federal agencies should encourage window replacement in order to prevent exposure and realize large monetary benefits for the nation.

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Window replacement and residential lead paint hazard control 12 years later ☆

Sherry L. Dixon [a], David E. Jacobs [a,*], Jonathan W. Wilson [a], Judith Y. Akoto [a], Rick Nevin [a], C. Scott Clark [b]

[a] National Center for Healthy Housing, 10320 Little Patuxent Parkway, Suite 500, Columbia, MD 21044, USA
[b] University of Cincinnati, 2180 East Galbraith Road, Room 241, GR Building A, ML 0505, Cincinnati, OH 45237-1625, USA

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ABSTRACT

Window replacement is a key method of reducing childhood lead exposure, but the long-term effectiveness has not been previously evaluated. Windows have the highest levels of interior lead paint and dust compared to other building components. Our objective was to conduct a follow-up study of residential window replacement and lead hazard control 12 years after homes were enrolled in an evaluation of the HUD Lead Hazard Control Grant Program, sampling settled lead dust in housing in four cities ($n=189$ homes). Previous work evaluated lead hazard controls up to 6 years after intervention using dust lead measurements and two years after intervention using both dust and blood lead data. But the earlier work could not examine the effect of window replacement over the longer time period examined here: 12 years. The individual homes were assigned to one of three categories, based on how many windows had been replaced: all replacement, some replacement, or non-replacement. Windows that were not replaced were repaired. We controlled for covariates such as site, housing condition, presence of lead paint, and season using longitudinal regression modeling. Adjusted floor and sill dust lead geometric mean dust lead loadings declined at least 85% from pre-intervention to 12 years after the intervention for homes with all replacement windows, some windows replaced and no windows replaced. Twelve years after intervention, homes with all replacement windows had 41% lower interior floor dust lead, compared to non-replacement homes (1.4 versus 2.4 μg/ft^2, $p<0.001$), and window sill dust lead was 51% lower (25 versus 52 μg/ft^2, $p=0.008$) while controlling for covariates. Homes with some windows replaced had interior floor and window sill dust lead loadings that were 28% (1.7 versus 2.4 μg/ft^2, $p=0.19$) and 37% (33 versus 52 μg/ft^2, $p=0.07$) lower, respectively, compared to non-replacement homes. The net economic benefit of window replacement compared to window repair (non-replacement) is $1700–$2000 per housing unit. Homes in which all windows were replaced had significantly lower lead dust. New windows are also likely to reduce energy use and improve home value. Lead-safe window replacement is an important element of lead hazard control, weatherization, renovation and housing investment strategies and should be implemented broadly to protect children.

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1. Introduction

Although lead exposures have declined in recent decades, they still remain, making continued source identification and exposure reduction important. Phase-out of lead use in gasoline, new paint, food canning, and ongoing efforts to address existing lead paint hazards in housing and other sources of lead exposure have resulted in an 84% reduction in children's blood lead levels ≥ 10 μg/dL from 1988–1991 to 1999–2004, with a geometric mean of 1.9 μg/dL in the most recent reporting period (Jones et al., 2009). (Geometric mean is a measure of central tendency used for data that are log-normally distributed.) No safe level of lead exposure has been established, and the current geometric mean blood lead level in children is still about 2 orders of magnitude above the "natural" background blood lead level (BPb), which is estimated to be 0.016 μg/dL (Smith and Flegal, 1992). A recent review suggested that about 70% of excessive exposures are related to housing with paint lead (PPb), dust lead (DPb), and soil lead (SPb) hazards (Levin et al., 2008). In 2001, the

Abbreviations: DPb, dust lead; PPb, paint lead; SPb, soil lead; BPb, blood lead; μg/ft^2, micrograms of lead dust per square foot of surface area; mg/cm^2, milligrams of lead paint per square centimeter of surface area; GM, geometric mean; HUD, U.S. Department of Housing and Urban Development; LHC, lead hazard control

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* Corresponding author. Fax: +443 539 4150.
E-mail addresses: sdixon@nchh.org (S.L. Dixon), djacobs@nchh.org (D.E. Jacobs), jwilson@nchh.org (J.W. Wilson), jakoto@nchh.org (J.Y. Akoto), c.scott.clark@uc.edu (C. Scott Clark).

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nation established a goal of eliminating childhood lead poisoning from residential lead paint by 2010 (Jacobs et al., 2000), which still has not been met (Lanphear, 2007). Identifying and controlling the remaining sources of exposure are essential to reduce and eliminate childhood lead poisoning, a disease that is entirely preventable.

Windows are prominent as a remaining lead source, because they have the highest likelihood of containing lead paint and the highest amounts of lead dust (Jacobs et al., 2002). In a previous article published in Environmental Research, lead-safe window replacement has been shown to have a net benefit of billions of dollars (Nevin et al., 2008) and its ability to predict trends in lead poisoning has been validated (Jacobs and Nevin, 2006). This current article updates those findings. For these and other reasons, such as energy savings, windows have emerged as a key aspect of residential lead hazard control. Previous work has not examined whether all or only some windows should be replaced in a given housing unit, whether windows should be repaired instead of replaced, or the precise pathway through which windows influence lead dust on floors. Window dust has been shown to be correlated with children's blood lead level (Lanphear et al., 1995). This study examined the longevity of intervention effects related to lead hazards associated with windows and the influences from floors, exterior dust, and soil lead.

HUD has been providing Lead-Based Paint Hazard Control Grants to assist states and local governments in controlling PPb, DPb and SPb hazards in low-income, private homes since 1992. To measure the technical and cost effectiveness of the federally funded interventions undertaken to reduce lead hazards, HUD initiated an evaluation covering a range of interventions, which were implemented by 14 state and local lead hazard control (LHC) grantees (Dixon et al., 2005). Data collection for the study was completed in late 1998 and included nearly 3000 dwelling units. At 1, 2, and 3 years after treatment, DPb and children's BPb were at significantly reduced levels compared to baseline (Dixon et al., 2005; NCHH and UC, 2004; Clark et al., 2011), showing that the interventions were successful for at least 3 years.

A subset of units from 4 jurisdictions in the HUD evaluation study was examined 6 years after intervention. In those dwellings, DPb remained quite low (Wilson et al., 2006). In the 6-year study, dust lead loadings on both floors and window sills declined significantly from baseline, but there was no association between the floor dust lead loadings and extent of window treatment (Wilson et al., 2006). ("Loading" means micrograms of lead divided by the surface area and "concentration" means micrograms of lead divided by the total weight of dust in the sample.) The U.S. EPA regulations that define a dust lead "hazard" are expressed in "loading" units, because loading is known to be more predictive of children's blood lead level (Lanphear et al., 1995). Although dwellings with window "treatments" (full replacement, stripping, sash replacement, or jamb liners) had lower dust lead loadings on window sills and troughs compared to dwellings where windows were only painted/cleaned, they did not have lower dust lead loadings on floors. However, window replacement and other window treatments were combined in the 6-year study, so the independent effect of window replacement could not be assessed.

Previous studies have examined the effectiveness of lead hazard control (LHC) interventions, but except for the 6-year study, they have not examined effects beyond 3 years post-intervention. Measurement of long-term effectiveness is important, because LHC interventions are generally categorized as either abatement or interim controls. Abatement refers to measures that permanently eliminate lead-based paint hazards (e.g., removal, enclosure). Interim controls are methods that temporarily reduce lead-based paint hazards (e.g., specialized cleaning, stabilization of deteriorated paint) (U.S. HUD, 1995). LHC programs often employ strategies that incorporate both abatement and interim control measures (e.g., window replacement and paint stabilization, respectively). Comprehensive abatement of PPb, when followed by a thorough cleaning of all horizontal surfaces, has been shown to significantly reduce dust lead loadings up to three and a half years following treatment (Farfel and Chisholm, 1990; Farfel et al., 1994). Comprehensive abatement as cited in the Farfel and Chisholm papers included fixing water leaks, treating all lead-painted surfaces with replacement and enclosure methods, replacing windows, making floors smooth and cleanable, and thorough cleaning with wet washing and HEPA vacuuming. Studies conducted since then have examined the effectiveness of strategies that incorporate interim control measures as part of the treatment approach. By definition, interim controls require some degree of ongoing maintenance to maintain their effectiveness. An early randomized trial of interim control measures in Boston observed slight reductions in floor dust lead loadings 6 months after intervention and greater reductions in window sill and trough dust lead loadings (Ashengrau et al., 1998). The sample size of the study was limited, however, and none of the changes were statistically significant. A study in Baltimore of 3 levels of LHC intervention reported significant declines in DPb loadings from pre-intervention through 2 years post-intervention, with the higher intensity interventions showing greater reductions (Farfel et al., 1997).

An earlier study of the HUD evaluation cohort showed that children's PbB declined 37% over two years (Clark et al., 2011). The new study we report here is different in several respects from earlier HUD evaluation cohort studies. First, the followup period is substantially longer. Second, this study investigated the effect of replacing all windows or only some windows or no windows, while in the earlier studies, these were merged. Third, the earlier study included blood lead metrics, which integrate all exposure sources, while this new study focused exclusively on environmental dust lead inside the housing and its relationship to window replacement. Finally, the current study is especially timely given the vast amount of window replacement underway in the U.S. in the context of weatherization.

Because this new study reports environmental lead levels 12 years following intervention, it is the largest and longest assessment of modern lead hazard controls in housing reported to date. The objectives of this study were to determine if window replacement is more effective than non-replacement window treatments (interim controls) in maintaining low floor and window sill DPb loadings approximately 12 years after treatment, after controlling for confounders and effect modifiers (e.g., housing condition, paint condition, recent renovation).

2. Methods

The methods used in the 3-year HUD evaluation have been described elsewhere (Galke et al., 2005). Of the original 14 jurisdictions, we selected 4 that collectively were likely to have a mix of window replacement and non-window replacement: Vermont (Burlington, Bennington, Springfield, and scattered locations), Minnesota (Minneapolis, St Paul, and Duluth), Cleveland, and Chicago. To ensure that units were assigned to the correct window group, the unit was examined prior to enrollment in the current study to determine if windows had been replaced at some point after the initial work had been completed. If more than 3 windows had been replaced after the lead hazard control work in a dwelling with a non-replacement intervention, then the dwelling was not eligible for the current study (11 units). Dwellings with window replacement interventions had to have at least 4 replacement windows at the conclusion of the HUD Evalation intervention work to be eligible for the current study. Dwellings were also ineligible if they were boarded up, or if the resident declined to participate. All dwellings had to have baseline dust lead results available to be eligible. Additional phases of dust sampling (clearance, 6-months, 1-, 2-, 3-, and 6-years post-intervention) were used in the analysis if available. The study did not designate a specific anniversary date for enrollment, but the average unit was enrolled 12 years after intervention and 90% of units were enrolled within 1 year of that date. An additional 9% were between 13 and 18 months of the target 12-year anniversary date and two units had sampling conducted at 20 and 25 months past the 12-year anniversary.

Each home was assessed using a standardized 16-question interview (e.g., demographics, cleaning practices, tenure), a visual review of 8 structural elements of the dwelling to assess deterioration (e.g., condition of doors, windows, roofs), and a visual assessment of paint condition on 5 specific building components in every room/location and on the exterior. The assessor also examined a 4-block area around the home for possible generators of exterior dust lead, e.g., presence of nearby demolition, battery plants, smelters or other potential lead sources. Up to 10 single-surface settled dust wipe samples were collected from floors, interior window sills, and window troughs in 5 rooms/locations and the floor at the interior entryway in each dwelling using the same procedure and the same location as in the 3-year evaluation (NCHH and UC, 2004) and 2 composite soil samples (if soil was present) were collected at each building. The same windows that were sampled approximately 12 years earlier were sampled in the current study. Data gathered did not report whether windows where dust samples were collected had been replaced. One exterior DPb sample was collected at every dwelling or building from the step or sidewalk just outside of the main entrance to the building to help assess whether tracked-in contaminated dust was a significant contributor to interior DPb.

Analysis was performed by a laboratory recognized by the EPA National Lead Laboratory Accreditation Program, with evidence of proficiency under the Environmental Lead Proficiency Analytical Testing Program. All dust wipe samples were analyzed for total lead by flame atomic absorption spectroscopy using EPA method SW-846 or equivalent. The laboratory had a minimum detection limit of 1.6–1.8 μg/sample for the 12-year samples. Laboratory methods used for the data before 12 years are described elsewhere (Galke et al., 2005; Dixon et al., 2005; Wilson et al., 2006). Thirty-four percent of the floor samples and 21% of the window samples for the data presented in this article were below the lab's minimum detection limit. Actual machine values were used for approximately 75% of these measurements.

Each home was assigned to one of 3 groups. The "all-replacement group" included only those units that had at least 4 windows replaced in the intervention and resulted in all replacement windows. The "partial replacement group" included only those that had at least 4 windows replaced in the intervention and resulted in less than all replacement windows in the unit. Non-replaced windows in this group may have received lesser treatments. The "non-replacement group" consisted only of those units that had no more than 3 windows replaced during and after intervention and had no more than 3 replacement windows in the dwelling after the intervention. Sixty-four percent of the units in this final group had some work conducted on the windows. Work included partial sash replacement, paint stripping, window repair, and repainting.

An arithmetic mean (average) DPb loading was calculated for the floors and window sills within each dwelling to represent the unit-wide dust lead level, because the arithmetic mean is used in the EPA regulations. Geometric means (GM) were used in statistical modeling, because the dust lead data were log-normally distributed. The DPb at the entryway was not included in the floor dust lead average, because it is more likely to reflect exterior sources. Time was represented by a categorical variable for 6 months, 1 year, 2 years, 3 years, 6 years, or 12 years after intervention. Models that expressed the natural log-transformed DPb loading as a function of a number of potential variables, such as pre-intervention and immediate post-intervention DPb loading, exterior DPb loading, SPb, housing conditions and characteristics (e.g., building type [single family, 2–4 units or >4 units]), exterior work, and cost of non-window interior work and others, were used to evaluate differences in window replacement groups across time. We also accounted for the effects of baseline PPb, baseline DPb, and time to interact with window replacement group. The effect of the window replacement group was allowed to vary across time. To provide an accurate prediction of DPb without eliminating large fractions of the study sample because of missing values, we fit an intercept term for each variable that had a missing value. The models accounted for the anticipated positive correlation between dust lead loadings in different dwellings within the same building.

Backward elimination of insignificant independent variables ($p \geq 0.1$) was performed, followed by additional steps to allow the addition and/or removal of variables with the SAS procedure PROC MIXED. For nominal variables with a missing category, the p-value used tests for a significant difference between the non-missing categories (i.e., missing category was disregarded). For continuous variables with a dummy variable for missing values, the p-values used tests for a significantly non-zero slope. Seasonality and grantee (site) effect were included in all the models.

We updated a previous cost-benefit analysis using a method described elsewhere (Nevin et al., 2008) to estimate the net benefit of window replacement compared to window repair (non-replacement). The analysis uses data on the cost of new windows vs. window repair, the fraction of units with young children, the resulting avoided increase in children's BPb from DPb and associated incremental average lifetime earnings increase, monetary estimates on home energy utility savings, property value increases due to new windows, and a resulting 12-year net present value. This method is conservative (likely to underestimate true net benefits) because it does not include other health effects associated with reduced childhood lead exposure, such as reduced stature, hearing loss, kidney disease and cardiovascular effects, and because benefits of window replacement are likely to last longer than 12 years. Partial replacement was not included in this analysis due to the wide range of window replacement/non-replacement in this category. Additional details on the methods and data sources used in the economic analysis are available at www.nchh.org.

3. Results

Two hundred units were enrolled, but 11 units were excluded because they did not have window replacement as part of the original intervention but did have more than 3 replacement windows at 12 years post-intervention. One hundred and eighty-nine dwellings in 124 buildings remained in the analysis, with slightly more than half in one of the 4 jurisdictions (Vermont) and the rest equally split among the remaining three. The vast majority of households were low income at 12 years, with 65% under $20,000/year, 17% from $20,000–$29,999/year, and 18% $30,000 or more per year.

Seventy-seven of the dwellings were in the all-replacement group (41%), 80 were non-replacement (42%) and 32 were partial replacement (17%). Of the 80 non-replacement units, 63 (79%) had no replacement windows, and the remaining 21% had between 8% and 33% replacement windows. In the partial replacement group, the percent of replacement windows ranged from 42% to 93% (median 82%). In Cleveland and Vermont, slightly more than half of dwellings were all-replacement, with most of the remainder in the non-replacement group. Work was conducted on the building exterior at 54% of the dwellings.

Most of the units were in buildings built before 1910 (53%) or between 1910 and 1919 (20%). Geometric mean baseline window PPb was 1.4 mg/cm^2 and ranged from <0.1 to 9.5 mg/cm^2. Interior and exterior deterioration of key building components was observed in 9% and 12% of the homes, respectively, and 29% had an exterior DPb point source in the neighborhood. Fifty-nine percent of units had at least one painted floor, and on average 10% of all floors were painted. Fourteen percent of units had at least one carpeted floor, and on average 30% of all floors were carpeted. On average, 80% of the window sills that were sampled were painted.

3.1. Pre-intervention (baseline) results

Geometric Mean (GM) baseline floor DPb loadings were not significantly different across the 3 window replacement groups ($p=0.808$), but GM baseline sill DPb loading was lower for all replacement units compared to non-replacement units (152 and 328 μg/ft^2, respectively) ($p=0.014$) (Table 1). Sill GM baseline DPb loading was no different for partial replacement compared to no replacement or all replacement ($p=0.211$ and $p=0.517$, respectively).

3.2. Modeling results

After controlling for confounders, time and window replacement group were both significant predictors of post-intervention floor and sill DPb loadings, and the effect of window replacement group was found to be constant from 6 months to 12 years post-intervention. Homes with all replacement windows had 41% lower floor DPb loading compared to non-replacement homes (1.4 versus 2.4 μg/ft^2, $p=0.006$) (Table 2, Fig. 1). Homes with partial replacement had 28% lower floor DPb loading compared to the non-replacement group (1.7 versus 2.4 μg/ft^2,

Table 1
Dust lead loading and percent exceeding federal hazard standards[a] by Window Replacement Group.

Sample location	Phase	All				Non-Replacement				Partial Replacement				All Replacement			
		N	GM	GSD	% Exceed standard	N	GM	GSD	% Exceed standard	N	GM	GSD	% Exceed standard	N	GM	GSD	% Exceed standard
Floor	Pre-intervention	189	20.8	5.5	26	80	21.2	5.8	26	32	24.3	8.2	28	77	19.3	4.3	26
	Clearance	183	9.5	2.5	8	74	10.8	2.4	7	32	10.1	3.2	19	77	8.2	2.4	5
	6-Months post-intervention	163	9.2	4.6	17	69	10.3	5	14	25	17.7	3.3	32	69	6.5	4.3	14
	1-Year post-intervention	169	8.2	3.9	15	70	9.1	3.4	13	28	18.9	3	29	71	5.4	4.1	11
	2-Years post-intervention	44	8.3	4.5	14	28	11.1	4.4	14	3	56.7	2.4	67	13	2.8	2.2	0
	3-Years post-intervention	38	5.0	11	11	23	9.5	10.2	17	3	4.5	29.6	0	12	1.5	7.4	0
	6-Years post-intervention	53	2.7	5.7	4	30	3.5	5.3	7	6	2.0	8.2	0	17	1.8	5.7	0
	12-years post-intervention	189	2.2	7.8	4	80	1.7	6.3	3	32	3.7	9.7	9	77	2.2	8.6	4
Window sill	Pre-intervention	188	221	7	43	80	328	8.5	55	32	198	5.2	44	76	152	5.8	30
	Clearance	180	19	3.8	2	73	30	3.8	3	31	17	2.8	0	76	14	3.0	1
	6-Months post-intervention	161	64	5.1	21	68	91	4.5	25	25	107	5	32	68	38	5.1	13
	1-Year post-intervention	167	52	4.6	19	69	86	4.6	28	28	91	4.7	18	70	39	4.1	10
	2-Years post-intervention	44	60	5.2	20	28	64	6.3	21	3	145	2	33	13	43	3.8	15
	3-Years post-intervention	38	48	2.9	5	23	59	3.1	9	3	69	2.1	0	12	30	2.5	0
	6-Years post-intervention	53	30	9.3	13	30	47	8.2	13	6	62	11.6	17	17	24	11.2	12
	12-Years post-intervention	188	32	9.5	13	80	54	7.3	18	32	42	9.3	13	76	16	10.5	8

[a] 40 μg/ft^2 for floors and 250 μg/ft^2 for window sills (U.S. Environmental Protection Agency Lead Dust Hazard Standard (40 CFR Part 745), Federal Register Jan 5, 2001, p. 1206)

$p = 0.194$) and the all replacement homes were 18% lower in floor DPb loading compared to the partial replacement group ($p = 0.348$), but both of these latter comparisons were not statistically significant.

Preliminary modeling did not include a variable for the jurisdiction (site), but we found that it was statistically significant for both floors and sills ($p < 0.001$) when added to the models. Factors that we were unable to control for contributed to higher DPb in the more urban settings of Chicago and Cleveland than in the sampled homes in Minnesota and Vermont. Perimeter SPb was a predictor of post-intervention floor DPb loading ($p = 0.038$) only in the model where site was not controlled because perimeter SPb is more homogenous within a site than between sites.

Exterior work and season were both significant influences, but the cost of non-window interior work was not. Homes where exterior work was conducted had post-intervention entry DPb loading that was 28% lower ($p = 0.048$) compared to units without exterior work. Season of DPb sampling was associated with post-intervention floor DPb loading ($p < 0.001$), with the highest levels observed in mid-August and the lowest in mid-February. Not surprisingly, higher floor DPb loading immediately following the work, exterior DPb loading, and exterior point sources (e.g., local demolition) were all significant or at least marginally associated with higher post-intervention floor DPb loadings ($p = 0.097$, 0.007, and 0.015, respectively). Homes with a painted floor had floor post-intervention DPb loading that was 130% higher than homes without a painted floor ($p < 0.001$) and a worse bare floor condition was associated with higher floor post-intervention DPb loading ($p = 0.04$). Homes with 2 or more exterior system deteriorations (e.g., broken steps, severe foundation cracks, roof damage) had higher floor post-intervention DPb loading, compared to homes with no deteriorations ($p = 0.031$). In homes with one deterioration, DPb loading was only marginally higher than the DPb loading in homes with no deteriorations ($p = 0.064$).

Across all three window groupings, floor DPb loading levels gradually declined over time ($p < 0.001$), probably because all three groups had undergone lead hazard control earlier. At 6 months, 1 year, 2 years, and 3 years, DPb loading was higher than at 6 years and 12 years (all $p < 0.001$). At 6 years, there was only marginally higher DPb loading than at 12 years ($p = 0.083$).

Homes with all replacement windows had post-intervention sill DPb loading that was 51% lower than non-replacement homes (25 versus 52 μg/ft^2, $p < 0.001$) (Table 2, Fig. 2). Homes with partial replacement had post-intervention sill DPb loading that was 37% lower than non-replacement homes (33 versus 52 μg/ft^2, $p = 0.074$). There was no significant difference between partial-replacement and all-replacement homes ($p = 0.254$).

As with floors, season was associated with post-intervention sill DPb loading ($p = 0.024$) and higher sill baseline DPb loading and exterior DPb loading were associated with higher post-intervention sill DPb loadings ($p < 0.001$ and $p = 0.004$, respectively). Higher baseline window PPb was associated with higher post-intervention sill DPb loading ($p = 0.002$) across all window groups, probably because window paint lead is associated with other paint lead levels inside and outside the dwelling. Alternatively, window sills may not have been replaced when windows were. The geometric mean exterior entry DPb was 13 μg/ft^2 (range < 1 to 1262 μg/ft^2).

Housing condition was also important. A worse wiped surface condition was associated with higher post-intervention sill DPb loadings ($p < 0.001$) and homes with exterior roof, gutter or downspout deterioration had sill post-intervention DPb loading that was higher than homes without deterioration ($p < 0.001$).

Table 2
Parameter estimates for the linear longitudinal log interior floor and window sill DPb loading (μg/ft²) models.

Effect	Levels	Interior floor			Window sill		
		Estimate (std err)	p-Value (parameter)	p-Value (Overall)	Estimate (std err)	p-Value (parameter)	p-Value (Overall)
Intercept	–	−0.943(0.299)	0.002	0.002	1.756(0.479)	< 0.001	< 0.001
Seasonality	Cosine	−0.390(0.085)	< 0.001	< 0.001	−0.146(0.091)	0.108	0.024
	Sine	−0.431(0.078)	< 0.001		−0.136(0.084)	0.107	–
Building type	2–4 Units	–	–	–	-0.493(0.205)	0.016	0.041
	> 4 Units	–	–	–	−0.514(0.270)	0.058	–
	Single	–	–	–	0	.	–
Percent bare wiped floors (0 to 100%) [a]	–	0.079(0.265)	0.766	0.766	–	–	–
Percent bare wiped floors (0 to 100%) [a] *Condition bare wiped floors (1 = Good to 3 = Poor)	–	0.338(0.166)	0.042	0.042	–	–	–
Wiped surface condition (1 = good to 3 = poor)	–	–	–	–	0.735(0.134)	< 0.001	< 0.001
Any painted floors in wipe sample (1 = Yes, 0 = No)	–	0.835(0.224)	< 0.001	< 0.001	–	–	–
Log baseline window sill DPb (μg/ft²)	–	–	–	–	0.151(0.041)	< 0.001	< 0.001
Exterior point source	Missing	0	.	0.015[b]	–	–	–
	No	−0.476(0.194)	0.015	–	–	–	–
	Yes	0	.	–	–	–	–
No exterior work (1 = Yes, 0 = No)	–	0.333(0.168)	0.048	0.048			
Log baseline window paint Pb (mg/cm²)	Slope	–	–	–	0.268(0.064)	0.002	< 0.001
	Intercept for Missing	–	–	–	−1.012(0.479)	0.035	
Log clearance DPb (μg/ft²)	Slope	0.130(0.078)	0.097	0.152	–	–	–
	Intercept for Missing	0.805(0.523)	0.124		–	–	–
Log exterior DPb (μg/ft²)	Slope	0.090(0.033)	0.007	0.009	0.100(0.035)	0.004	0.003
	Intercept for Missing	1.505(0.972)	0.122		2.089(1.020)	0.041	
Number of exterior systems with deterioration	Missing	−0.103(0.277)	0.711	0.023 [b]	–	–	–
	Two to four	0.766(0.354)	0.031		–	–	–
	One	0.380(0.205)	0.064		–	–	–
	Zero	0	.		–	–	–
Roof, gutter, or downspout deterioration	Missing	–	–		−0.053(0.383)	0.890	0.001[a]
	No	–	–		−0.937(0.282)	0.001	
	Yes	–	–		0	.	
Post-intervention visit	6 months	1.752(0.155)	< 0.001	< 0.001	0.795(0.162)	< 0.001	< 0.001
	1 year	1.533(0.155)	< 0.001		0.565(0.162)	< 0.001	
	2 years	1.864(0.242)	< 0.001		0.434(0.260)	0.096	
	3 years	1.528(0.259)	< 0.001		0.146(0.278)	0.601	
	6 years	0.384(0.221)	0.083		0.298(0.234)	0.205	
	12 years	0	.		0	.	
Window replacement group	Non-Replacement	0.536(0.196)	0.006	0.023	0.720(0.194)	< 0.001	0.001
	Partial Replacement	0.203(0.216)	0.348		0.257(0.225)	0.254	
	All replacement	0	.		0	.	
Grantee/site	Chicago	1.534(0.258)	< 0.001	< 0.001	1.222(0.276)	< 0.001	< 0.001
	Cleveland	0.654(0.269)	0.015		0.618(0.293)	0.035	
	Minnesota	0.501(0.211)	0.018		0.307(0.235)	0.191	
	Vermont	0	.		0	.	

[a] The percentage is expressed in its fractional form 0 to 1.0.
[b] Overall p-value does not include the missing category.

Single family homes had higher post-intervention sill DPb loading than homes in buildings with 2–4 units or > 4 units ($p = 0.017$ and 0.058, respectively), but post-intervention sill DPb loading in buildings with 2–4 units and > 4 units are not significantly different ($p = 0.930$).

Post-intervention sill DPb loadings decreased over time ($p < 0.001$). At 6 months there was higher DPb loading than at 3 years, 6 years, and 12 years (all $p < 0.05$). Post-intervention sill DPb loading by grantee site was significantly different ($p < 0.001$).

Figs. 1 and 2 present least square mean DPb loading by phase and window replacement group for floors and window sills, respectively. Least square means are model-predicted values with all variables in the model (other than time and window replacement group) held at their mean values.

3.3. *Economic results*

We also examined the costs and benefits of window repair (non-replacement) versus window replacement for different-sized housing units. The incremental cost of replacing instead of repairing windows varied from $1953 to $4464 per unit. The incremental health benefit of window replacement versus window repair reflects additional reductions in childhood exposure to DPb associated with window replacement. Because there is also an economic benefit associated with improved house appearance and energy savings (Nevin et al., 2008), the net economic benefit of window replacement instead of window repair varies from over $1700 to over $2000 per unit (Table 3). Of course, net benefits would be much greater if the

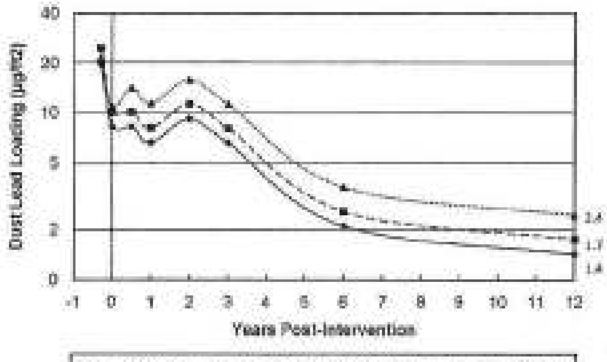

Fig. 1. Adjusted geometric mean floor dust lead loading by window replacement group from pre-intervention to 12-years post-intervention.

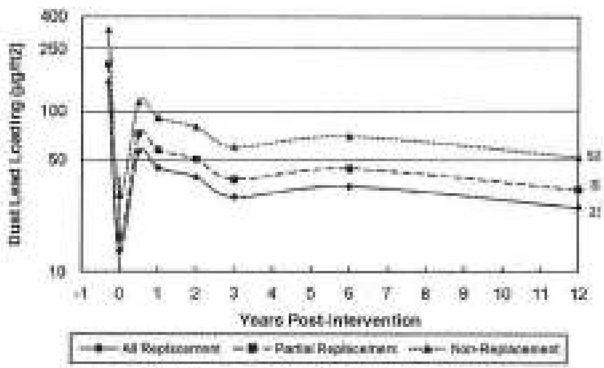

Fig. 2. Adjusted geometric mean sill dust lead loading by window replacement group from pre-intervention to 12-years post-intervention.

Table 3
Incremental costs and benefits of lead-safe window replacement.

	Size of housing unit		
	800 ft² Attached 7 Windows	1200 ft² Detached 10 Windows	1800 ft² Detached 16 Windows
Net window replacement cost	$1953	$2790	$4464
Lifetime earnings benefits per unit[a]	$1871	$1871	$1871
Appearance value	$700	$1000	$1600
Energy efficiency value	$1301	$1951	$3250
Net economic benefit	$1719	$1832	$2057

[a] Lifetime earnings benefit is calculated from avoided IQ loss due to lower DPb exposure (see www.nchh.org for details).

comparison was to windows with lead hazards that are left entirely unattended.

4. Discussion

Floor and sill DPb were substantially and significantly reduced from baseline to 12 years for all three window groups. Adjusted geometric mean baseline DPb declined from 19 to 1.4 µg/ft² on floors and 152 to 25 µg/ft² on sills at 12 years for the replacement window group. Adjusted geometric mean baseline DPb declined from 24 to 1.7 µg/ft² on floors and 198 to 32 µg/ft² on sills at 12 years for the partial replacement group. Adjusted geometric mean baseline DPb declined from 21 to 2.4 µg/ft² on floors and 327 to 52 µg/ft² on sills at 12 years for the non-replacement group.

The difference in DPb was largest when comparing the non-replacement to the all replacement group. Housing with all replacement windows had 41% lower floor and 51% lower sill DPb loading than non-replacement units, while controlling for other significant covariates ($p=0.006$ and $p<0.001$, respectively). Partial replacement units had lower floor and sill DPb loading than non-replacement, but the difference was non-significant on floors and marginally significant on sills ($p=0.194$ and 0.074, respectively). Although all replacement units had lower floor and sill DPb loading than partial replacement, these differences were not statistically significant ($p=0.348$ and 0.254, respectively).

The actual differences in DPb loading among the window replacement groups depend on the conditions and characteristics of the housing. Although the percent difference between the least square means (i.e., adjusted predicted GM 12 Year DPb loading) for the all-replacement and non-replacement units is the same for each site due to the log-linear modeling, the magnitude of the differences varies by site. For floors, the difference between the replacement and non-replacement groups ranged from 0.6 µg/ft² for Vermont (0.9 and 1.5 µg/ft², respectively) to 2.9 µg/ft² for Chicago (4.0 and 6.9 µg/ft²). For sills, differences ranged from 18 µg/ft² in Vermont (17 and 35 µg/ft²) to 62 µg/ft² for Chicago (58 and 120 µg/ft²).

Only 4% of units exceeded the current federal lead dust hazard standard of 40 µg/ft² on floors and 13% of units exceeded the federal standard of 250 µg/ft² on sills at 12 years post-intervention. Other research based on the National Health and Nutrition Examination survey indicates that the hazard standards should be reduced to approximately 10 µg/ft² on floors and 100 µg/ft² on sills (Dixon et al., 2009). Twenty-four percent of units exceeded 10 µg/ft² on floors and 28% of units exceeded 100 µg/ft² on sills at 12 years post-intervention.

The results show that replacing all windows with high levels of PPb and DPb will have the greatest effect on reducing both floor and sill DPb over a substantial time period. This public health benefit adds to other benefits associated with window replacement, including reduced energy costs and increased home value.

Although we asked residents about remodeling or repair work in the 6 months before DPb sampling, that variable was not found to be a predictor of floor or sill DPb. That may be because the question did not discriminate between activities that could or could not disturb lead-based paint.

This study has several limitations. The study units were a subset of homes treated from 1994 to 1999 as part of the evaluation of the HUD lead-based paint hazard control grant program. It was not feasible to randomize the interventions in the evaluation, because the interventions were determined by each jurisdiction. It is also possible that the selection of the four sites for this current study created some bias in the results. Because one of the four sites had many of the all-replacement windows, it is possible that site is confounded with the window replacement results, even after statistical modeling.

Data on condition of household maintenance by residents were missing in nearly 40% of the homes, so they were not included in the models discussed above. Using the limited data available, however, we did find that the study interviewer's assessment of basic general upkeep and cleanliness was associated with higher post-intervention floor and sill DPb loadings ($p=0.004$ and 0.036, respectively). More adults living in the unit and a unit being vacant were associated with higher post-intervention sill DPb loadings ($p=0.01$ and 0.09, respectively). This is consistent with the previous 6-year study (Wilson et al., 2006) and with other publications from the HUD evaluation.

Similar to other recent studies, DPb loadings were quite low and many were below limits of detection. Although we attempted to overcome this using an analytical method with a low detection limit, it is possible that we may have been able to detect additional significant variables or larger effect sizes had DPb loadings been higher. Nevertheless, the fact that DPb loadings have remained so low for such a long time increases the likelihood that modern lead hazard control methods are effective for a substantial time period.

5. Conclusions

Because older windows have high levels of PPb and DPb and can be major sources of energy loss and significant indicators of housing price, window replacement is likely to have multiple public health, environmental, and economic benefits, many of which have not been previously recognized. This study also shows that there are multiple lead factors that influence post-treatment interior DPb loading. Any community lead hazard control strategy should address all sources including lead on the exterior of homes and the demolition of nearby buildings with lead-based paint. Although window replacement alone may not eliminate all lead-based paint hazards at a given housing unit, this study demonstrates that complete window replacement is likely to have a significant positive impact on the lead safety of homes over the long run. Public and private sector initiatives are needed to promote window replacement to achieve such benefits and to move toward longer-lasting and healthier housing.

Competing interests

The authors declare they have no competing interests. The study was approved by an Institutional Review Board.

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Chapter 12: Abatement

FIGURES

TABLES

Chapter 12: Abatement

Abatement – How To Do It

1. **Arrange for risk assessment or paint inspection**. Have a lead hazard risk assessment or lead-based paint inspection performed by a certified risk assessor or a certified inspector who is independent of the abatement contractor.

2. **Develop hazard control plan**. Develop a site-specific lead hazard control plan based on the hazards (risk assessment) or lead-based paint (inspection) identified and financing available. Prepare the work area (see Chapter 8); avoid high-dust jobs and procedures.

3. **Obtain waste permits**. Have the contractor obtain any necessary building or waste permits; notify local authorities if the local jurisdiction requires it.

4. **Select needed materials**. Together with the contractor (or designer or risk assessor), select specific building component replacement items, enclosure materials, paint removal equipment and/or chemicals, tools, and cleaning supplies. Consider waste management and historic preservation implications of the selected treatment.

5. **Develop specifications**. Develop specifications (usually for large projects only).

6. **Schedule other construction work**. Schedule other construction work so that leaded surfaces are not inadvertently disturbed and unprotected workers are not placed at risk. Include time for clearance examinations and laboratory dust sample analysis in the scheduling process (see Chapters 3 and 15).

7. **Select a contractor**. Select a certified abatement contractor using the lowest *qualified* bidder.

8. **Conduct preconstruction conference**. Conduct a preconstruction conference to ensure the contractor fully understands the work involved (for large projects only).

9. **Notify residents**. Notify residents of the dwelling and adjacent dwellings of the work and the date when it will begin. Implement relocation (if appropriate).

10. **Correct housing conditions that might impede work**. Correct any existing conditions that could impede the abatement work (e.g., trash removal, structural deficiencies).

11. **Post warning signs**. Post warning signs and restrict entry to authorized personnel only. Implement the worksite preparation procedures.

12. **Consider a pilot project**. For large projects only, consider conducting a pilot project to determine if the selected abatement method will actually work (pilot projects are sometimes completed before step 4).

13. **Consider collecting soil samples as an option**. As an optional quality control procedure, consider collecting pre-abatement soil samples, which may not have to be analyzed until post-abatement soil samples have been collected, analyzed, and compared to clearance standards. If post-abatement soil levels are below applicable limits, the pre-abatement samples need not be analyzed (see Chapter 15). Soil sampling is not required by EPA regulations as part of clearance. This is an optional activity (see Chapter 15).

14. **Execute construction work**. Execute abatement work. See the other sections of this chapter for step-by-step summaries for building component replacement, enclosure, paint removal, and soil abatement methods. See Chapter 13 for encapsulation methods. Observe local or State regulations if applicable.

15. **Store waste**. Store all waste in a secure area (see Chapter 10).

16. **Cleanup**. Conduct daily and final cleanup (see Chapter 14). Execute waste disposal procedures.

17. **Arrange for clearance**. Have an independent certified inspector technician or risk assessor conduct a clearance examination after waiting at least 1 hour after cleanup has been completed to let dust settle (see Chapter 15).

18. **Repeat cleaning if clearance fails**. If clearance is not achieved, repeat cleaning and/or complete abatement work. Repeat clearance examination and, if clearance is achieved, obtain any required formal release or, if required by the U.S. Department of Housing and Urban Development (HUD) or local authorities, owner's certification that the project has been completed required.

19. **Notify Residents.** Notify residents of affected dwellings of the nature and results of the abatement work.

20. **Pay contractors**. Pay contractor and clearance examiner.

21. **Conduct periodic monitoring**. Conduct periodic monitoring and reevaluation of enclosure or encapsulation systems (if applicable) or lead-based paint that was not abated as indicated in Chapter 6. Maintain records of all abatement, monitoring, reevaluation, and maintenance activities, and turn them over to any new owner upon sale of the property as part of lead disclosure. Provide proper disclosure and notification to tenants. See Appendix 6 for more information.

Building Component Replacement – How To Do It

1. **Prepare work area and plan new component installation**. Prepare the work area (see Chapter 8); avoid high-dust jobs and procedures. Plan how the new component will be installed. Whenever possible, use new, energy efficient window, door, and insulating systems.

2. **Prepare building component for removal**. Prepare the building component for removal. Turn off and disconnect any electrical circuits inside or near the building component to be removed.

3. **Mist component**. Lightly mist the component to be removed (unless electrical circuits are nearby).

4. **Score seams**. Score all painted seams with a sharp knife.

5. **Remove screws**. Remove any screws, nails, or fasteners.

6. **Pry component**. Use a flat pry instrument (crowbar) and hammer to pry the component from the substrate.

7. **Remove nails**. Remove or bend back all nails.

8. **Wrap component**. Wrap and seal bulk components in plastic and take them to a covered truck or secured waste storage area along pathways covered with plastic. Shovel any debris; see Chapter 10 for proper disposal methods.

9. **Vacuum dust**. Vacuum any dust or chips in the area where the component was located.

10. **Replace component** (optional).

11. **Cleanup**. Conduct cleaning (see Chapter 14).

12. **Conduct clearance**. Conduct clearance and reclean if necessary.

Enclosure Methods – How To Do It

1. **Post warnings on affected components**. Stamp, label, or stencil all lead-based painted surfaces that will be enclosed with a warning approximately every 2 feet both horizontally and vertically on all components. The warning should read: "Danger: Lead-Based Paint." Deteriorated paint should not be removed from the surface to be enclosed.

2. **Determine whether low- or high-dust job**. Prepare the worksite in accordance with guidance in Chapter 8; avoid high-dust jobs and procedures.

3. **Identify enclosure**. Attach a durable drawing to the utility room or closet showing where lead-based paint has been enclosed in the dwelling.

4. **Plan for monitoring**. Plan for annual monitoring of the enclosure by the owner.

5. **Repair substrates**. Repair unsound substrates and structural members that will support the enclosure, if necessary.

6. **Select enclosure material**. Select appropriate enclosure material (drywall or fiberboard, wood paneling, laminated products, rigid tile and brick veneers, vinyl, aluminum, or plywood).

7. **Prepare electrical fittings**. Install extension rings for all electrical switches and outlets that will penetrate the enclosure.

8. **Clean floors**. If enclosing floors, remove all dirt with a vacuum to avoid small lumps in the new flooring.

9. **Seal seams**. Seal and back-caulk all seams and joints. Back-caulk means applying caulk to the underside of the enclosure.

10. **Anchor enclosures**. When installing enclosures directly to a painted surface, use adhesive and then anchor with mechanical fasteners (nails or screws).

11. **Conduct cleanup**.

12. **Arrange for clearance**. Have a certified risk assessor or inspector technician conduct clearance testing and provide documentation.

Paint Removal Methods – How To Do It

1. **Use only approved removal methods**. Be sure all paint-removal methods are not prohibited methods. Avoid the following:

    a. Open flame burning or torching.

    b. Heat guns operating above 1100 °F.

    c. Machine sanding or grinding without a HEPA vacuum exhaust tool.

    d. Abrasive blasting or sandblasting without a HEPA vacuum exhaust tool.

    e. Paint stripping in a poorly ventilated space using volatile stripper.

    f. Dry scraping (except for limited areas).

2. **Determine whether low- or high-dust job**. Prepare the worksite in accordance with guidance in Chapter 8; avoid high-dust jobs and procedures.

3. **Ensure safe use of heat guns**. For heat gun work, provide fire extinguishers in the work area and ensure that adequate electrical power is available. Use for limited areas only. Train workers to avoid gouging or abrading the substrate.

4. **When using mechanical tools, USE only HEPA-equipped tools**. Be sure workers keep the shroud against the surface being treated. Vacuum blasting and needle guns should not be used on wood, plaster, drywall, or other soft substrates. Observe the manufacturer's directions for the amount of vacuum airflow required.

5. **Wet scrape**. For wet scraping, use a spray bottle or wet sponge to keep the surface wet while scraping. Apply enough water to moisten the surface completely, but not so much that large amounts run onto the floor or ground. Do not moisten areas near electrical circuits.

6. **Use off-site chemical stripping facilities, if feasible**. For chemical paint removers, determine if the building component can be removed and stripped off-site. Off-site stripping is generally preferred to on-site paint removal. Observe all manufacturers' directions for use of paint removers.

7. **Remove components carefully**. For off-site stripping, determine how to remove the component. Score the edges with a knife or razor blade to minimize damage to adjacent surfaces. Punch or tag the building component if similar building components are also being stripped off-site (e.g., doors). This will ensure that the individual component is reinstalled in the original location. Inform the off-site paint remover that lead-based paint is present before shipping. Wrap the component in plastic and send to the off-site stripping location. Clean all surfaces before reinstallation to remove any lead residues by vacuuming all surfaces, cleaning with other lead specific or all-purpose cleaners detergents, and vacuuming again. Conduct cleanup and clearance.

8. **Test effectiveness of on-site stripper, if used**. For on-site paint removal, first test the product on a small area to determine its effectiveness. Chemical paint removers may not be effective or desirable on exterior, deteriorated wood surfaces, aluminum, and glass. Provide neoprene, nitrile, rubber, or polyvinyl chloride (PVC) gloves (or other type of glove recommended by the manufacturer); face shields; respirators with combination filter cartridges for leaded-dust and organic vapors (if appropriate); and

chemical-resistant clothing. Be sure to select the right type of organic vapor filter cartridge, gloves, and clothing for the specific chemical being used. Portable eyewash stations capable of providing a 15-minute flow must be on-site. Apply the chemical and wait the required period of time. Maintain security overnight to prevent passersby from coming into contact with the chemical. For caustic chemical paint removers, neutralize the surface before repainting using glacial acetic acid (not vinegar). Repaint and conduct cleanup and clearance.

9. **Dispose of waste properly** (see Chapter 10).

10. **Conduct cleanup**.

11. **Arrange for clearance**. Have a certified risk assessor or lead-based paint inspector conduct a clearance examination and provide documentation (see Chapter 15).

Soil and Exterior Dust Abatement – How To Do It

1. **Identify any soil hazard**. Determine if a soil-lead hazard exists. For a hazard to exist, a total of at least 9 square feet of soil in a single yard or area must be bare and soil concentrations must be equal to or exceed either 1,200 µg/g of lead for the yard or building perimeter or 400 µg/g of lead for small, high-contact play areas. Bare soil above these levels should be treated by either interim controls or abatement. Soil abatement is most appropriate when levels of lead are extraordinarily high (equal to or greater than 5,000 µg/g) and when use patterns indicate contact frequency and exposure will be high.

2. **Optionally, collect pre-abatement soil samples**. As an option, collect pre-abatement soil samples to determine baseline levels. These samples need not be analyzed if post-abatement soil samples are below applicable clearance levels.

3. **Determine soil abatement method**. Determine the method of soil abatement (soil removal and replacement, soil cleaning, or paving). Soil cultivation (rototilling or turning over the soil) is not recommended.

4. **Prepare carefully for paving**. If paving, use a high-quality concrete or asphalt. Observe normal precautions associated with traffic load weight and thermal expansion and contraction. Obtain any necessary permits. Keep soil cultivation to a minimum.

5. **Plan soil removal carefully**. If removing and replacing soil:

   ✦ Determine if waste soil will be placed in an on-site or off-site burial pit. Prepare vehicle operation and soil movement plan. Test new replacement soil (should not contain more than 400 µg/g lead).

   ✦ Contact the local information source to determine location of underground utilities, including water, gas, electric, cable TV, and sewer, or contact each utility individually. Mark all locations to be avoided.

   ✦ Remove fencing if necessary to allow equipment access and define site limits with temporary fencing, signs, or yellow caution tape.

   ✦ Tie and protect existing trees, shrubs, and bushes.

   ✦ Have enough tools to avoid handling clean soil with contaminated tools.

- Remove soil.
- Clean all walkways, driveways, and street areas near abatement area.
- Replace soil at proper grade to allow drainage.
- Replacement soil should be at least 2 inches above existing grade to allow for settling.
- Install new soil covering (grass or sod) and maintain it through the growing season.
- Have enough workers and equipment available to complete the job in 1 day.

6. **Manage disposal of soil waste carefully** (see Chapter 10).
7. **Conduct final cleanup and visual inspection for clearance** (see Chapter 15).
8. **Provide walk-off mat(s) for residents**. Provide walk-off doormats to residents and educate them on the benefits of removing shoes at the dwelling entryway.

I. Principles of Lead-Based Paint Hazard Abatement

A. Longevity of Abatement

There are several approaches to abatement. Abatement is either: the removal of the building component, the removal of the paint itself, or the long-lasting – at least 20 years – enclosure or encapsulation of lead-based paint hazards. (For enclosure, see Section III of this chapter, and for encapsulation, see Chapter 13.) From a public health perspective, properly conducted abatement is the preferred permanent or long-lasting response to lead hazards. Abatement has two principal advantages: it provides a long-term solution, and little (if any) monitoring or reevaluation of the treated surface is necessary because failure is less likely to occur. Abatement treatments provide longer-lasting safe conditions than interim controls because the effectiveness of the work is less dependent on resident action, maintenance of housing stock, the conscientiousness of property managers, and the attention of maintenance workers during repair.

As used in this chapter, abatement can mean either correction of lead-based paint *hazards* (as defined in Title X) or removal, "permanent" encapsulation or "permanent" enclosure of all lead-based paint, as describe below. The methods explained in this chapter apply to abatement of both lead-based paint hazards *and* lead-based paint. From the Federal perspective, construction activities intending only to remodel, renovate or paint, are not considered abatement. Abatement does include work intending to permanently eliminate lead-based paint or lead-based paint hazards.

Interim controls, abatement, or a combination of the two are acceptable methods of addressing lead-based paint hazards. In contrast to interim controls, lead-based paint abatement refers to a group of measures that can be expected to eliminate or reduce exposures to lead hazards for at least 20 years under normal conditions. As 20 years is the expected lifespan of many commonly used building components, abatement is the closest one can get to a "permanent" solution in housing. The abatement methods described in this chapter should be capable of lasting 20 years under typical conditions. Any methods developed in the future that also last 20 years will be acceptable as abatement methods. This orientation toward performance standards should provide owners and the abatement industry with opportunities for innovation and flexibility, ensuring that the abatement method selected is the one that is most cost effective for a particular component.

The term "abatement" also includes a number of other activities that are not directly related to the work itself, but that must be included in the overall effort for the abatement to be successful. These activities include lead hazard evaluation, planning, cleaning, clearance, and waste disposal and are covered elsewhere in these *Guideline*s. The reader must study and understand the material in these other chapters prior to undertaking an abatement project. This chapter alone does not provide all the information necessary to complete a successful abatement job. When abatement is performed inadequately, or without sufficient protection, lead exposures to children increase (Amitai, 1987; Chisholm, 1985; Farfel, 1990; Rabinowitz, 1985a). When performed properly, abatement is known to be effective (Amitai, 1991; Staes, 1994; HUD, 1991; Jacobs, 1993a; Farfel, 1994a; Staes and Rinehart, 1995).

Abatement refers to any measure designed to permanently eliminate lead-based paint or lead-based paint hazards in accordance with standards established by the U.S. Environmental Protection Agency (EPA) pursuant to Title IV of the Toxic Substances Control Act (TSCA). Abatement strategies include removal of lead-based paint; enclosure of lead-based paint; encapsulation of lead-based paint (according to the standards and procedures set forth in Chapter 13); replacement of building components coated by lead-based paint; removal of lead-contaminated dust; removal or covering of lead-contaminated soil with a durable covering (not grass, gravel, or sod, which are considered interim control measures); and preparation, cleanup, disposal, post-abatement clearance testing, recordkeeping, and monitoring (if applicable).

More than any other abatement method, on-site paint removal involves the greatest degree of disturbance and dust generation. Therefore, on-site removal of lead-based paint from a substrate should be carried out only if abatement rather than interim control is required and no other abatement method is feasible. For example, removal of paint from metal doorframes may be the only feasible abatement option, especially if the frames cannot be removed or enclosed and the paint cannot be stabilized. Paint removal may increase the level of lead in household dust and make effective cleaning more difficult. Even if dust clearance standards are met, any increase in leaded-dust levels over baseline levels means some increase in exposure. Furthermore, all paint removal methods leave behind some residues embedded in the substrate, which could continue to pose a hazard if the surface from which the paint is removed is later disturbed. Therefore, paint removal is the most invasive of abatement methods and should be avoided if possible.

Abatement also offers the greatest challenge to planning, since it is often performed in the context of other building construction work, while interim controls are more likely to be performed alone or as part of other maintenance work.

In fact, many forms of abatement require special construction skills in addition to protective measures and dust control techniques. For example, one of the most common forms of lead-based paint abatement is window replacement. Abatement contractors need to possess adequate carpentry skills to install (for example) new windows, as well as the demolition, dust containment, and cleaning skills held by abatement contractors. While providing some guidance, this chapter is not intended to impart carpentry, painting, resurfacing, and other construction knowledge required for most types of abatement. Abatement contractors should either subcontract this type of construction work or acquire the necessary construction skills before the job begins. Of course, all construction work must be performed in accordance with local code requirements and all abatement work must be done by certified firms and individuals.

Many forms of abatement can be integrated into construction work, which provides an opportunity to install systems that will have long-term impact. For example, whenever building components, such as doors and windows, are replaced, the *Guidelines* recommend that they be replaced with products that are more energy efficient. This will help reduce energy consumption and increase cost efficiency.

EPA has established standard training curricula and regulations for the training and certification of all individuals engaged in lead-based paint risk assessment, inspection, and abatement, and minimum performance standards for the purpose of certifying individuals who supervise lead abatement projects and conduct clearance examinations. EPA's regulations are generally implemented through State, Tribal, or territorial programs. All abatement contractors and firms must be certified to perform this type of work, and all abatement workers and supervisors must be trained and certified. Certification of abatement contractors and completion of clearance examinations by independent, certified risk assessors, lead-based paint inspectors or sampling technicians, ensures that abatement work is conducted properly and safely.

For exterior work, as an optional quality control procedure, consider collecting pre-abatement soil samples, which may not be analyzed until post-abatement soil samples have been collected, analyzed and compared to clearance standards. If post-abatement soil levels are below applicable limits, the pre-abatement samples need not be analyzed. Soil sampling is not required by EPA regulations as part of clearance. This is an optional activity (see Chapter 15).

B. Prohibited Abatement Methods

HUD and EPA prohibit certain techniques (see 24 CFR 35.140, and 40 CFR 745.227(e)(6), respectively) because they are known to produce extremely high levels of lead exposure and make dwellings difficult to clean up. In addition, for abatement in federally-owned and assisted residences, HUD prohibits an additional technique if toxic volatile chemical stripping compounds are used, in order to prevent hazardous levels of the chemicals in the air of the residence being abated. See Table 12.1. State and local regulations may also prohibit some or all of these techniques or other techniques.

These *Guidelines* recommend strongly against the use of uncontained hydroblasting. Removal of paint using this method can spread paint chips, dust, and debris beyond the work area. Pressure washing is also discouraged. Contained pressure washing at less than 5,000 pounds per square inch (PSI) can be done within a protective enclosure to prevent the spread of paint chips, dust, and debris. Water runoff should also be contained (see Chapter 8).

Table 12.1 Prohibited Lead-Based Paint Abatement Methods.

1. Open flame burning or torching (includes propane-fueled heat grids).
2. Machine sanding or grinding without HEPA local vacuum exhaust tool.
3. Abrasive blasting or sandblasting without HEPA local vacuum exhaust tool.
4. Heat guns operating above 1100° F or charring the paint.
5. Dry scraping (except for limited surface areas).
6. Paint stripping in a poorly ventilated space using volatile stripper.

C. Vacuum Cleaning

In this chapter, vacuum cleaning is recommended a number of times. These *Guidelines* recommend that a HEPA-filtered (high-efficiency particulate air) vacuum should be used if possible, but that a high-quality household or commercial vacuum should be used if a HEPA vacuum is not available. (Note that, for RRP work, EPA's RRP Rule requires that any vacuum cleaners used be HEPA-filtered; see Chapter 11.) See Section III.A of Chapter 14 for a discussion of factors in choosing an effective vacuum cleaner and Section V of Chapter 11 for cleaning of carpets.

D. Periodic Monitoring and Reevaluation

Among the advantages of abatement compared to interim controls is that ongoing monitoring by the owner is either unnecessary (in the case of complete lead-based paint removal) or relatively simple (in the case of enclosure or encapsulation). Failures of enclosures and encapsulations are relatively easy to observe visually. (Failures should be repaired immediately. See Chapter 6.) Also, whereas professional independent reevaluation may be required at 2-year intervals for some federally assisted multi-family properties that have been treated with interim controls or standard treatments, such reevaluation is not necessary for properties that have had all lead-based paint abated. This is true even if lead-based paint has been enclosed or encapsulated, *provided* ongoing visual monitoring and lead-safe maintenance are performed by the owner in assisted units as recommended in Chapter 6. (Also see Chapter 5 on reevaluation.)

Abatement can be undertaken after lead-based paint inspections or risk assessments determine the presence of lead-based paint or other lead hazards (see Chapters 3, 5 and 7 for a description of the differences between risk assessments and inspections). If this initial evaluation phase is not completed, then all painted surfaces must be presumed to contain lead-based paint. This presumption may be cost-effective if it is likely that all surfaces that might be treated contain lead-based paint or if the housing unit is to be rehabilitated and all surfaces and components will be either covered or replaced.

The cost of a carefully conducted lead-based paint inspections or risk assessments, however, is usually recovered by a more focused abatement effort, especially when component replacement or enclosure is considered. The cost savings of a more targeted abatement effort based on complete testing are noteworthy in the case of abatement as opposed to interim controls, because the costs of abatement are initially much higher than interim controls.

Recordkeeping

Recordkeeping is essential for all abatement methods. The location of enclosed or encapsulated lead-based paint must be made known to future residents and owners, who may undertake remodeling or repair efforts that could disturb the remaining lead-based paint and thereby create a lead-based paint hazard. Depending on the jurisdiction, the location of enclosed or encapsulated lead-based paint may need to be filed with the appropriate municipal agency for future reference when the agency needs to issue construction permits for renovation. Provide proper disclosure and notification to current tenants as well (see Appendix 6).

E. Types of Abatement

This chapter covers four types of abatement:

- Building component replacement.
- Enclosure systems (this section does not include encapsulation, which is addressed in Chapter 13).
- On-site and off-site paint removal.
- Soil removal or covering.

The available information on paint abatement methods is summarized in Table 12.2. The reader should not conclude that a particular method is not permitted simply because it is not discussed here. With the exception of the prohibited techniques listed above, new techniques should be developed, studied, and reported to HUD, the Centers for Disease Control and Prevention (CDC), EPA, and other

Government agencies for distribution to the public.

F. Encapsulation

Encapsulants are coatings or rigid materials that rely on adhesion to a lead-based painted surface and are not mechanically fastened to the substrate. Encapsulants are considered separately in Chapter 13. *Enclosures* (not to be confused with encapsulants) are defined as durable, rigid construction materials that are mechanically fastened to the substrate with screws, nails, or other mechanical fastening system that can be expected to last at least 20 years under normal conditions. (See Section III of this chapter on enclosures.) These *Guidelines* do not consider encapsulation to be the same as enclosure. Depending on the particular circumstances and product, encapsulation can be either a form of paint stabilization (an interim control) or abatement (see Chapter 13).

G. Relationship to Renovation, Repainting, Remodeling, Rehabilitation, Weatherization, and Other Construction Work

Many forms of abatement involve the same physical work as other types of construction often performed in housing. In many cases, only the intent of the work differs. Lead-based paint abatement is intended to produce conditions that prevent lead poisoning. Other construction work is intended, among other things, to improve aesthetic living conditions, bring the dwelling up to code, preserve historical evidence, and promote energy efficiency. For example, depending on its intent, window replacement could be considered to be a lead-abatement method, renovation work, or energy conservation/weatherization work.

HUD's Lead Safe Housing Rule requirements vary depending on the type and amount of federal housing assistance (see Appendix 6) (HUD, 1999). The Rule applies to certain private owners and specific federally-funded housing activities. Individuals at the State or local level who are responsible for making determinations about weatherization or rehabilitation projects must have a clear understanding of the federal requirements applicable to specific funding sources. DOE-funded weatherization work is considered to be "renovation" under EPA's RRP rule (See Chapter 4; see also DOE, 2002).

It is well known that lead-based paint-disturbing activities have the potential to create dust-lead hazards. Therefore, regardless of funding source, HUD strongly recommends that all activities disturbing known or presumed lead-based paint use trained workers, lead-safe work practices and undergo a clearance examination.

While the intentions of each of these activities differ, experience shows that many of them can be combined in order to yield savings. In the public housing program, for example, most of the abatement occurs in the context of housing modernization or rehabilitation work. This approach has proven to be feasible and cost effective.

Congress recognized the wisdom of combining lead abatement with rehabilitation work. Under Title X, any residential construction job receiving more than $25,000 per dwelling unit in Federal rehabilitation funds is *required* to have all lead-based paint hazards on the property abated. If $5,000 to $25,000 per dwelling unit in Federal rehabilitation funding is received, either interim controls or abatement must be implemented (HUD, 2009).

Finally, lead abatement procedures cannot guarantee that children will not be exposed to lead in the future. Enclosure systems or encapsulants could fail, exposing the hazard again. Soil coverings could also fail, or other sources of lead could recontaminate the soil, resulting in exposures. Surfaces that were made cleanable may deteriorate or may not be kept clean, allowing leaded dust to re-accumulate to hazardous levels. Nevertheless, abatement constitutes the most extensive and protective intervention currently available. If practiced properly, abatement will greatly reduce the risk of lead poisoning.

II. Building Component Replacement

Building component replacement is defined as the removal of doors, windows, trim, and other building items that contain lead-based paint hazards and their replacement with new lead-free components. Component replacement is the most desirable abatement method because it offers a permanent solution to the lead-based paint problem for the particular component(s); but it may not be feasible for all of the LBP present. If done properly, it also minimizes contamination of the property and exposure of the workers. In addition, building component replacement can be integrated into general building rehabilitation activities. Components, such as doors and windows, should be replaced with more energy efficient models, which will help to reduce energy consumption and increase cost efficiency. In some cases, component replacement may cost less than abatement, especially when ongoing maintenance and energy costs are considered. Component replacement may be more expensive, however, especially for historic preservation projects, as new building components that match the originals may have to be custom made. For some historic preservation projects, replacement may not be permitted (see Chapter 18).

The skills required to perform building component replacement properly are similar to those of the skilled carpenter. For example, it is important to know how the various building components were joined so that they can be taken apart with minimal contamination and damage to adjoining surfaces.

The owner may choose to simply remove certain types of components without replacement. This is acceptable as long as applicable codes are observed. HUD does not recommend reinstalling salvaged building components containing lead-based paint in other properties unless the lead-based paint is removed.

A. Worksite Preparation

The appropriate worksite preparation level should be selected based on the size of the building component, its state of deterioration, and the ease of removal. The more deteriorated the component and the larger the surface area to be disturbed, the higher the worksite preparation level should be. Certified risk assessors or certified abatement supervisors or trained project designers may determine the appropriate worksite preparation for a project (see Chapter 8).

1. Security

Security of the premises is an important issue. If windows and doors are removed but not replaced on the same day, it may be necessary to install temporary barriers over window and door openings to prevent vandalism and theft over night. Therefore, every effort should be made to remove and replace doors and windows on the same day.

Table 12.2 Comparison of Lead-Based Paint Abatement, Component Removal and Enclosure

	Abatement and Removal						Enclosure			
Attributes	HEPA Needle Gun	Heat Gun	HEPA Sanding	Remove/ Replace	Caustic Paste/ Solvent	Off-site Stripping	Plywood Paneling	Gypsum	Prefab Metal	Wood, Metal, Vinyl Siding
Skill Level	High	Moderate	Moderate	High	Moderate	Moderate	Moderate	Moderate	High	Moderate
Aesthetics (1)	Erodes surface	Gouges	Gouges/ roughens	Good	Gouges	Good	Good	Good	Good	Good
Applicability	Very low, limited to metal and masonry	Wide, can damage some components	Low, limited by surface contour	Wide, dependent on skill	Wide, can damage some components	Low, components only	Wide, walls	Wide, walls and ceilings	Varied, limited by components	Wide, walls
Lead Presence	Largely removed	Largely removed	Largely removed	Removed	Largely removed	Largely removed	Remains	Remains	Remains	Remains
Generation of Hazardous Waste (2)	Low to moderate	Low to moderate	Low to moderate	Low	High	High, but maintained off-site	Low	Low	Low	Low
Weather Limitations	Moderate	High	Moderate	Minimal	High	None	Minimal	Minimal	Minimal	Minimal
Applicable to Friction Surface	Some	Yes	Some	Yes	Yes	Yes	No	No	Yes	No
Surface Speed of Methodology	Slow	Slow	Slow	Moderate	Slow	Can be slow, requires coordination	Moderate	Moderate	Moderate	Moderate
Training Required	High	Moderate	Moderate	High	Moderate	Moderate	High	High	High	High
Capital Required	High	Low	Moderate	Moderate	Low	Low	Low	Low	High	Moderate
Worker Protection Required (3)	High	High	High	Moderate	High	Moderate	Low	Moderate	Low	Low
Finish Work Required	Tentatively	Moderate	Moderate	Low	Moderate	Moderate	Wide	Wide	Limited	Wide
Product Availability	Limited	Moderate	Limited	Wide	Moderate	Limited	Moderate	Moderate	Wide	Wide
Durability	Long	Long	Long	Long	Long	Long	Moderate	Moderate	Moderate	Moderate
Labor Intensity	High	High	High	High	High	Moderate	High	High	High	High
Overall Safety (3)	Moderate	Moderate	Moderate	Very high	Moderate	High	High	High	High	High
Surface Preparation	None	None	None	None	Minimal-adjacent areas	Minimal-hardware removal	Minimal	Minimal	Minimal	Minimal
Cost	High	High	High	High	High	High	Moderate	Moderate	High	Moderate

Notes: (1) – The degree of damage to the surface will depend on the expertise of the operator.

(2) – Concentrated lead-based paint waste or sludges from paint removal using caustic or organic solvent removers have to be TCLP tested to determine if they are hazardous waste. See Chapter 10.

(3) – Any construction work involves increased safety risks.

2. Planning for Waste Storage

While most lead hazard control work in housing is exempt from hazardous waste regulation, discarded architectural components must still be properly managed (see Chapter 10). All building components coated with lead-based paint should be stored in a secure, locked area, as should all lead-contaminated waste until it is disposed of. They should not be sold or released to anyone who might reinstall them in another dwelling unless all of the lead-based paint is removed first. Therefore, it is important to identify where waste will be stored and how it will be secured during the project. (See Section II.D, Transportation and Storage of Waste, below.)

B. General Procedures for Building Component Replacement

- Using a garden sprayer or atomizer, lightly mist the component to be removed with water to help keep the dust down during the removal process. Before applying the water, be sure there are no electrical circuits inside the component. (If electrical circuits are present inside the component, they must be turned off and disconnected before removal. No water mist should be applied even if electrical circuits are turned off or de-energized.)

- Using a utility knife or other sharp instrument, carefully score all affected painted seams. This will provide space for a pry instrument and will minimize paint chipping and dust generation during removal.

- Remove any screws or other fasteners. Using a flat pry instrument and a hammer, carefully pry the affected building component away from the surface to which it is attached. The pry bar should be inserted into the seam at the nail (or other fastening device) at one end of the component and pressure applied. This process should be repeated at other fastening locations until the end of the component is reached. The component will be removed intact and chip and dust generation will be minimized when prying is done this way. A pry point pad or softener may be required to minimize damage to adjoining substrates. Wider replacement trim can sometimes be used to cover adjacent area damage.

- As there is often a considerable amount of leaded-dust underneath or behind the component being removed, begin cleanup immediately after the individual component has been removed.

- Carefully remove or bend back all nails (or other fastening devices) and wrap the component in durable, puncture-resistant plastic sheeting and seal with duct tape. Wrapping components in plastic may not be necessary if the dwelling is vacant and if the truck and the pathway to the truck are lined with plastic. Use a vacuum to remove any dust that may have accumulated behind the components as soon as they have been removed. Vacuuming may be performed by another person while the removal is underway. Preparing the area for the new component (e.g., squaring, reducing, or enlarging openings) may also release accumulated dust that should be removed. Dispose of wrapped components properly.

- Bring new lead-free components into the work area only after all dust-generating activity is complete and the dust has been cleaned up by at least one vacuuming.

C. Removal and Replacement Procedures for Specific Components

1. Baseboards, Casings, and Other Trim

The term "other trim" applies to such components as window casings, interior sills (stools), aprons, door casings, baseboards (including caps and shoe moldings), chair rails, exterior fascia, soffits, shutters, and crown moldings (see Figure 12.1). Components with lead-based paint should be removed as described in the previous section.

FIGURE 12.1 Removing and Replacing Trim: interior (left), exterior (right).

New lead-free components should be installed in a professional manner using standard carpentry practices. In situations where trim is being applied to lead-based painted walls, ceilings and floors that were enclosed, or casings for windows or doors where the jambs have been enclosed, the trim should be back-caulked before installation as an added precaution. Back-caulking refers to the application of caulk to the perimeter of the backside of rigid building materials to seal them before installation, preventing leaded-dust from entering the living space through cracks and crevices. Use a high quality caulk that is warranted for at least 20 years.

2. Windows

The term "window" applies to the sash, the stop and parting beads, window jambs, door frame and trim. Affected components should be removed as described in Section B. Window replacement can involve the removal of a wooden or metal unit and the installation of a wood, vinyl, or metal unit in its place (see Figure 12.2 and 12.3). If the jamb is not removed, it can often be enclosed by the new window frame system, which should be caulked and fastened. The remaining exterior portion of the jamb, if any, can be wrapped with coil stock (aluminum or vinyl or equivalent) after back-caulking. In situations where window units must be replaced in kind (e.g., historic preservation), the jambs should be removed and replaced also to make sure that no friction surfaces coated with lead-based paint remain. Generally, friction surfaces should not be painted.

FIGURE 12.2 Protecting the interior of a unit for exterior window abatement.

FIGURE 12.3 Replacement window system.

Depending on the building construction, it may be possible to remove the entire window system. The new lead-free components should be installed in a professional manner using standard carpentry practices. Windows may be replaced from the interior or exterior of the property. If windows are replaced from the exterior and only exterior clearance is planned, the interior of the unit must be protected by polyethylene sheeting.

3. Interior and Exterior Doors

Interior and exterior doors include the doorstops, door jambs and door frame (see Figure 12.4). Affected components should be removed as described above. Typical door replacement usually involves the removal of a wooden unit and the installation of a pre-hung wooden unit in its place. In this type of door replacement, the jamb is rarely removed, but is usually saved and enclosed with the new doorjamb after back-caulking. Wooden jamb extensions or coil stock, properly back-caulked, can be used to enclose any remaining portion of the jamb. In situations where pre-hung door units are not permissible (e.g., code requirements, historic preservation regulations), the original jamb should also be removed and replaced, if possible, to make sure that no friction surfaces coated with lead-based paint remain. If the jamb cannot be replaced, the stop should be removed and replaced with new material after the old jamb is carefully stripped.

Primers on Metal Components

In regard to whether lead-containing primers applied at the factory to metal doors, door frames, railings and other metal building components could create a hazard to people, if it can be determined that the lead on metal doors and frames resides only in the primers, and that the primers were factory applied and are in sound condition, then the primers themselves need not be abated or removed. , This is an exception to the general lead hazard control requirement, However, finish coats of paint that cumulatively contain lead of 1 milligram per square centimeter or greater, or the alternative standard of 0.5 percent by weight or greater, are treated as lead-based paint. If laboratory analyses of samples of the field-applied finishes are negative (no lead-based paint), the metal doors and frames do not require abatement but should be monitored to ensure that

FIGURE 12.4 Pre-and post-abatement interior doors.

the lead-bearing primer does not become defective. If the base metal is exposed while sampling the field-applied finish paint, then the existence of a permanent bond cannot be assumed and the entire sample should be analyzed for presence of lead. Any damage to the primer resulting from sample collection should be repaired immediately in a manner that restores the integrity of the primer coat.

For the metal doors and frames under this exception, primers should be intact and doors should be operating properly, free from impact or abrasion between moving parts that will damage any surfaces. If this exception for factory-applied primers is used, risk assessors should advise property owners or building managers of the importance of continued monitoring of the paint surfaces to ensure that subsequent surface deterioration or other factors do not result in exposing defective lead-based paint surfaces (the primers). Under this exception, property owners or building managers must commit to a plan for ongoing monitoring of the condition of the painted surfaces. The subsequent appearance of rust indicates a failure of the paint and primer, and the component must be abated.

Although unlikely, adhesion of the primer could be a problem. A simple “x” cut or crosshatch test will show if this is a problem. If adhesion is poor, the paint will tend to flake away from a cut. An adhesion test should also give an indication of the number of coats; color of finish versus primer (which would be orange if pigmented with red lead or bright colors such as yellow if pigmented with lead chromate); and thickness of layers. Of course, other colors of lead-based paint may also be present. Any damage resulting from an adhesion test should be repaired immediately in a manner that restores the integrity of the primer and finish coats to prevent subsequent deterioration.

When it can be determined that lead-based paint is present in a field-applied coating over an intact factory-applied primer, and paint removal is the abatement method of choice, only the field-applied finish coatings need to be removed. An intact primer need not be removed.

4. Kitchen and Bathroom Cabinets

Old lead-based painted kitchen and bathroom cabinets can be removed and replaced. Affected cabinets should be removed as described above. Lead-based paint on walls to which cabinets are attached should not be disturbed during cabinet removal. Applying masking tape around the cabinet perimeter and vacuuming immediately after removal will help to control leaded-dust.

5. Railings

Railings include the railing caps, banisters, posts and spindles (balusters), and newel posts that can be removed and replaced (see Figure 12.5). Railings may or may not be part of a stair system. Affected components should be removed as described in Section B. New lead-free components should be installed in a professional manner using standard carpentry practices. Metal railings and other grillwork can be removed and taken off-site for contained abrasive blasting or other forms of paint removal, then reinstalled after repainting. See Section II.C.3, above, regarding lead-containing factory-applied primers.

FIGURE 12.5 A metal railing before abatement.

6. Exterior Siding

Many materials are used on a dwelling's exterior walls. Materials of concern are generally painted wood or brick. Under most conditions, deteriorated siding identified as a lead hazard will be abated through enclosure without removing the original material. However, in restoration or historically significant projects, it may be replaced. Siding is now available that closely resembles wood. If the siding is to be replaced, the affected siding should be removed. Care must be taken to avoid contamination of soil walkways, window air conditioners, and the building interior (see Figures 12.6 and 12.7).

FIGURE 12.6 Installation of replacement siding.

FIGURE 12.7 Certified workers are needed to replace siding when the project's intent is lead abatement.

7. Interior Walls

If abatement is performed along with gut rehabilitation, old lead-based painted interior walls and ceilings may be removed and replaced. This activity, unlike those previously described, is more like demolition work. In addition to the layers of heavy duty plastic used to protect the floors from contamination, sheets of plywood should be placed over the plastic to protect it from damage during aggressive demolition, and to make cleanup of debris easier. Prior to demolition, affected areas should be sprayed lightly with water. Workers should wear ribbed rubber boots when walking on slippery, wet plastic. If ladders must be used, the plastic should be punctured to provide secure anchoring of the footings to the surface underneath. Ladder footings should not be placed on top of the plastic because this will create a slip hazard. Excessive water should not be applied, and the creation of puddles and streams that may flow through breaks or gaps in the containment should be prevented.

Removing plaster walls as a means to remove all of the old lead-based paint generates a great deal of dust. Unless this is required as part of a renovation occurring at the time of the abatement, the option of enclosure should be considered when determining abatement strategies.

D. Transportation and Storage of Waste

Building component replacement and demolition generate a considerable amount of waste material. Lead-contaminated building components and demolition debris should be handled carefully (see Chapter 10). Bulk debris such as doors, windows, and trim should be wrapped in durable puncture resistant plastic sheeting and sealed with tape. Smaller debris should be swept into heavy duty plastic bags after spraying. Exterior ground surfaces must also be protected. Outside storage needs to be secure and protect the ground (see Figure 12.8)

All debris should be removed from the site as soon as possible. In larger jobs where a dumpster is being used, it may be possible to eliminate the wrapping and bagging of bulk debris as long as the dumpster has a lockable lid and is lined with plastic and secured with a fence and signs.

FIGURE 12.8 Line surfaces with plastic in the work area (left) and pathways (right)

Contaminated building components and demolition debris should be transported in covered vehicles to an appropriate disposal facility. Old building components coated with lead-based paint should not be recycled unless the paint is removed beforehand. See Chapter 10 for a full discussion of waste disposal.

III. Enclosure Methods

A. Definition

Enclosure is the installation of a rigid, durable barrier that is mechanically attached to building components, with all edges and seams sealed with caulk or other sealant. Surfaces with lead-based paint are enclosed to prevent access and exposure and to provide a dust-tight system. Unlike encapsulation, the enclosure system is not dependent on the painted surface of the substrate for its durability. Enclosures should have a design life of at least 20 years. While adhesives are frequently used for initial mounting purposes and for assistance in covering the lead-based painted surface with the enclosure material, it is primarily mechanical fasteners that give enclosures their longevity.

Standard construction materials are employed to create a solid and relatively rigid end product (see Appendix 7.2 for a description of materials commonly employed for lead-based paint enclosure). The primary differences between enclosure for lead-based paint and ordinary construction include careful sealing of all edges, joints, and seams to create a dust-tight (not necessarily air-tight) enclosure; site containment; worker safety (particularly during any needed surface or substrate repairs); and special cleanup. There is generally little or no hazardous waste disposal and little degradation of the lead-based paint as part of the enclosure process, unless substrate repairs are necessary. The hazard and expense of removing deteriorated paint can be avoided when the enclosure material is mounted flush to a structurally sound lead-based painted substrate and all the seams are sealed. This method produces little leaded-dust (HUD, 1991). These advantages hold down labor costs compared to paint removal and building component replacement, although cleanup and clearance are still required. A lower level of containment can often be used as less dust is generated.

For broad surfaces such as walls, ceilings, floors, and siding, enclosure is often considerably cheaper and less hazardous than building component replacement and paint removal. However, enclosure does not remove lead-based paint from the property; instead, it makes the dwelling lead-safe.

B. Longevity of Enclosures

There is little doubt that hurricanes, earthquakes, tornados, and flooding can substantially compromise an enclosure's viability. Less dramatic but more common events can also increase the risk of lead exposure, such as damage to the enclosure by the occupant or water damage from a leaking roof, overflowing tubs, or broken pipes. Any type of enclosure is potentially vulnerable to water damage. Future occupants can also be threatened by remodeling endeavors that break through the enclosure.

1. Labeling of Surfaces to be Enclosed

A few simple procedures should be followed to promote lead safety in case an enclosure is breached. The surface to be enclosed should be labeled with a warning, "Danger: Lead-Based Paint." The label, spray-paint, or stamp lettering should be in permanent ink.

A durable drawing of the property floor plan should be mounted on a sturdy metal or wood base and affixed with screws to a wall in the utility room next to the electrical panel or at any other closet location that can be easily seen by maintenance personnel (see Figure 12.9). The drawing should be covered with plastic for protection. Enclosures should be highlighted on the diagram and identified as hazardous. (For a multi-family property, another copy of the drawing should be maintained in the property management office's file.)

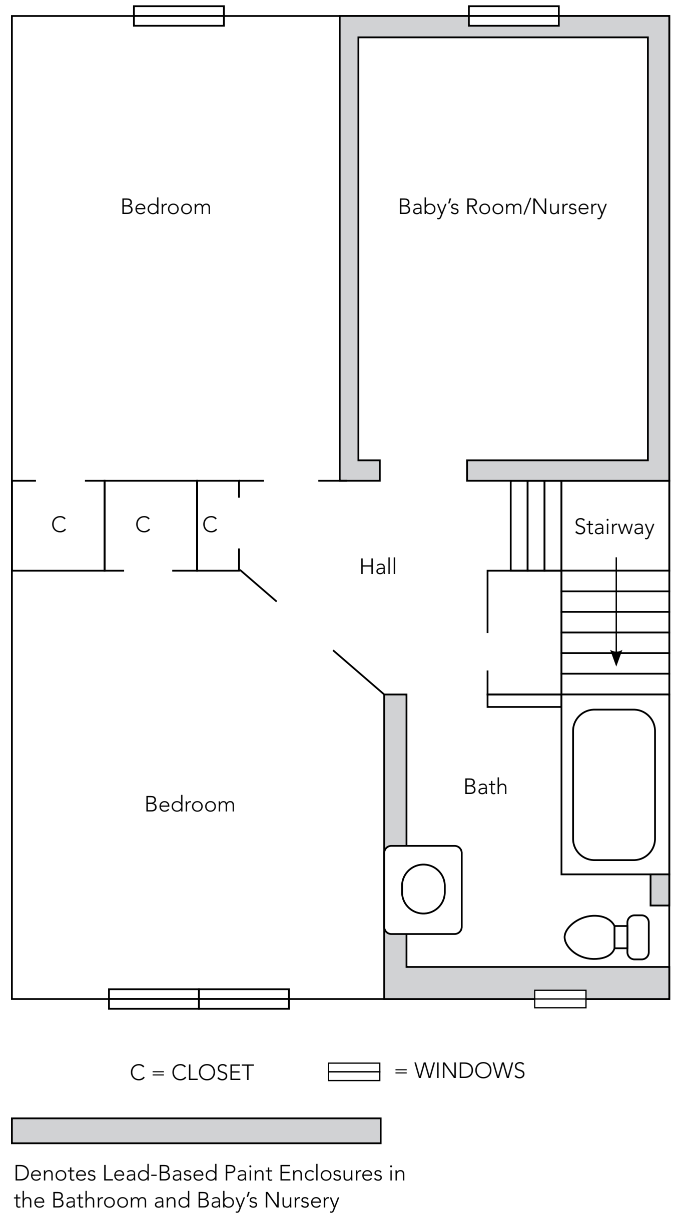


FIGURE 12.9 Example of a Diagram Showing the Location of Lead-Based Paint Enclosures.

2. Unsound Substrates

Any substrate material can be enclosed, including plaster, concrete block, brick, and concrete. All soft, moveable, or otherwise structurally unsound structural members should be repaired prior to enclosure if they are needed to support the enclosure. If repair is not feasible, then the defective area will need to be removed and enclosure will not be possible. Hazards associated with preparing the site for enclosure increase as more remedial work is needed. Structural repairs may require lead-based paint removal or component replacement, with all the accompanying safety protocols these practices entail. If the substrate is sound but the paint is deteriorating, stabilization or removal of deteriorated paint before the enclosure is installed should *not* be done because it will generate dust.

3. Ongoing Monitoring and Reevaluation

Because the building components used for enclosure may be impacted during building use, or may shift or deteriorate, the property owner or manager must arrange for regular monitoring and repairs, as needed. Visual monitoring should be performed no less often than every two years. If signs of wear or deterioration are apparent from visual assessments or other observations by maintenance and repair workers or during any reevaluation examination, the enclosure should be repaired using lead-safe work practices using a certified firm and workers, followed by clearance. In addition, residents should be instructed to notify management of the need for repairs on a timely basis. For HUD-assisted housing that is subject to periodic reevaluation, the monitoring of the performance of the enclosure should be part of that reevaluation to determine if deterioration or failure of the enclosure has occurred since the previous reevaluation.

C. Interior Surface Enclosure Materials

1. Wood Paneling

Wood paneling is an appropriate enclosure material, except for ceilings. It is of limited use, however, because of the difficulty of sealing seams around electrical outlets, switch boxes, and heating, ventilation, and air conditioning (HVAC) registers. There should be no gaps in the seams, outlets, boxes, and registers, which should all be screwed directly to the paneling and to any framing behind the panels. All seams should be caulked. Paneling made of composite board backing materials is vulnerable to dampness, particularly in below-grade situations such as basements. In some instances, the use of these materials may violate building and/or fire codes. On the other hand, plywood paneling may be stronger, more impact resistant, and more water resistant than other enclosure materials, such as drywall.

Paneling can be glued and mechanically fastened directly to the substrate, but the appearance is improved when the area to be covered is first furred or framed out and the paneling is anchored to these braces. The paneling should not extend past the depth of door or window frames or other trim pieces. Baseboards can be removed and the new cove base then glued directly to the paneling. Even heavy grades of paneling flex and vibrate when receiving mild impact. Over time, this could compromise the seal of the seams that join the paneling with other building components. Joints and edges must be fully supported; furring strips should be installed at the appropriate distance from each other, usually 12 inches apart. All seams at these transition points should be caulked before panel trim and corner moldings are installed as finish pieces.

2. Laminated Products

Laminated wall sheeting products, such as Marlite™, are designed to withstand surface moisture and are commonly used in bathrooms and kitchens. Their surfaces have a high sheen and clean easily. However, they may become defective when moisture gets behind the board's placement. This can occur from a leaking pipe or a seam opening in the bathtub/ shower area. When a significant leak is detected, the enclosure must be reexamined.

3. Rigid Tile and Brick Veneers

Plastic and ceramic tile, synthetic brick and stone veneers, and other similar products are either glued or cemented directly to the painted surface. These products qualify as rigid encapsulants rather than enclosures because they are not mechanically fastened to the substrate. Regardless of whether they are enclosures or encapsulants, they tend to be inappropriate for broad application: The cost associated with labor and materials is often prohibitive for anything more than incidental use.

4. Drywall and Fiberboard

The steps to install drywall and fiberboard are shown in Table 12.3 and detailed specifications are provided by the Gypsum Association in Washington, DC (202-289-5440) Application and Finishing of Gypsum panel Products (GA-216-04). Available at ***http://www.gypsum.org/download.html***.

Gypsum drywall or fiberboard is a very common and cost-effective interior finish. It is not difficult to locate skilled workers to install this product. Training materials are available from trade groups (Gypsum Association, 2004). When applied directly to a surface, the drywall is generally glued in place with construction adhesives and then mechanically fastened to the studs or structure behind the plaster. The screws must be long enough to go through the drywall, the plaster, and the wire mesh or lath and extend an inch into the stud or structure. To avoid having dust escape from the screw hole as the drilled screw displaces plaster, a dab of shaving cream can be applied to the area to be drilled.

Moisture-resistant greenboard should be installed in damp areas. It is difficult to completely control the long-term damaging effects of a severe moisture problem without invasive waterproofing and/or water diversion from the exterior of the property. Any type of enclosure is potentially vulnerable to water damage.

Table 12.3 Steps To Install Drywall and Fiberboard on Interior Walls.

- Check to make sure the depth of the trim will accommodate the thickness of the drywall (minimum of 3/8 inch preferred). If it does not, this method may not be suitable.
- Set up the plastic containment of the work area (see Chapter 8).
- Remove any trim being disposed of, and install the drywall over any cavity left by the removed moldings, except large cavities over 16 inches in any direction. Repair any structural deficiencies.
- Repair or remove any “soft” wall areas. Removal of painted plaster generates a great deal of leaded-dust.
- Use construction adhesive to glue the drywall directly to the surface being enclosed.
- Screw the drywall to the studs behind the existing wall. Caulk all seams that meet molding.
- Use extension rings to bring out electrical devices flush with the new gypsum based drywall and retrofit any HVAC registers. Caulk all seams.
- Tape and finish the drywall.
- Prime and paint the finished area, as well as the unenclosed surfaces in the same room so that all walls match the new installation. (See specifications and recommendations from the Gypsum Association.)

Quarter-inch thick drywall tends to conform to the contours and imperfections of the original substrate or wall, compromising the appearance of the finished product. To avoid this, use of 3/8-inch thick (minimum) drywall is recommended. The enclosed wall may in fact look much improved over the original wall. If the original wall surface is highly irregular, it may be necessary to install furring strips 12 inches apart and use 1/2-inch thick drywall to improve the appearance. If 1/4-inch thick drywall is used, it must be applied in accordance with the manufacturer's specifications (Gypsum Association, 2004).

D. Interior Building Components Suitable for Enclosures

All joints between drywall pieces should be taped and spackled with joint compound. Wherever the drywall meets wood framing or any other finish material (including electrical devices and HVAC registers), the seams should be sealed with a caulk or other sealant that has at least a 20 year warranty. Similarly, where sealed pipes penetrate an enclosure, the opening around the pipe must be sealed. Drywall is painted when installation is complete. Fastening schedules are available from industry trade groups (Gypsum Association, 2004).

1. Wood Trim and Drywall

The profile of the wood trim on windows and doors must be evaluated before overlaying an adjacent wall with drywall; the wall finish should protrude past the depth of the moldings. In homes built before 1960, this problem is less frequent because the trim tended to be more ornate and generally of thicker wood. Regardless of age, the problem is more likely to occur in multi-family public housing and institutional settings where the construction is basic and trim is thin.

If the drywall overlay is too thick, it may be possible to remove the baseboard and run the drywall to the floor. The baseboard can then be reinstalled over the new drywall (unless the baseboard itself presents a lead hazard, in which case it should be replaced). Obviously, care must be taken to avoid breaking the original baseboard during its removal. The seam at the bottom of the drywall should be sealed with caulk prior to the installation of the baseboard or cove base.

2. Electrical Outlets and Vents

All electrical devices, including switches and outlets, will need extension rings to bring those fixtures out flush with the new drywall overlay. A sealant or caulk should be used at cutouts for electrical boxes. Similarly, all grillwork at openings for heat vents and cold air returns should be retrofitted. These are minor but necessary steps in the drywall enclosure process.

3. Ceilings

Ceilings are more difficult to enclose than walls. Drywall applied directly to the ceiling will frequently result in an uneven appearance because there may not be a smooth transition from one board edge to the next. The solution is to draw a chalk line, usually every 16 inches on center, so that metal hat channels (or metal furring channels) or wood furring strips can be screwed into each ceiling joist. Three- to four-inch screws should be used to ensure that the screw penetrates the hat channel, plaster (or other substrate), and the wire mesh holding the plaster enough to bite firmly into the joist. The hat channel may be shimmed to get a perfectly level finished surface.

Next, the drywall should be affixed to the hat channel for an excellent finished product. An extension ring will be needed for ceiling light fixtures. Prior to lowering the ceiling slightly, the contractor should be confident that there is no interference with the top of ornate, oversized window frames, pipes, vent covers, or crown moldings. The overall height of the lowered ceiling should conform to building code clearances.

All screws for furring channels or strips must penetrate into the ceiling joists prior to installation of the drywall. On occasion, some multi-family housing or commercial buildings converted to residential use may have cast-in-place, reinforced concrete ceilings. Anchoring supports for the new ceiling may not be practical in these instances. Though this construction is generally very strong, a structural engineer should be consulted about attaching a drywall system to the concrete. On-site architectural or engineering advice is needed on a case-by-case basis to determine if this approach is appropriate.

Acoustical lay-in panels (drop-in ceilings) do not constitute lead-based paint enclosures; they will not adequately guard against the escape of leaded-dust into the living space and cannot be sealed.

4. Floors

Lead-based painted floors should be enclosed with 1/2-inch or thicker plywood or other underlayment (see Figure 12.10). The joints in underlayment should be flash patched. Shoe molding running along the baseboard should be removed before plywood installation and reinstalled when the finished floor is completely in place. If the shoe molding contains lead-based paint, new shoe molding should be installed since new molding is inexpensive and more cost effective than removing the paint from the old shoe molding. This will ensure that all floor covering runs tight to the baseboard and the joints at vertical surfaces are covered by the quarter-round molding. The plywood should be covered with vinyl tile or sheet goods to provide a cleanable surface. Covering the plywood with wall-to-wall carpeting is generally not recommended because the carpet does not provide a sealed top cover and is harder to clean. Vinyl floor coverings should be finished off with a metal threshold at all doorways or at any access to an uncovered open floor to protect the exposed edge. When placing tile over old flooring, a row of nails (preferably screws) should be run a few inches apart in a straight line over each joist before the plywood is put down. Old floor nails often lose much of their grip, which results in squeaky floorboards. This movement can in turn cause the edges of floor tile to lift in spite of the plywood underlayment that was installed. It is most important to remember that all the plywood sheets must be installed flush with each other. Gaps must be filled with flash patching cement. Also, a bead of caulk should be run at the edge of every board before it is set in place. All nails must be hammered flush and all dirt vacuumed thoroughly; otherwise small lumps will eventually appear in the soft vinyl finish goods.

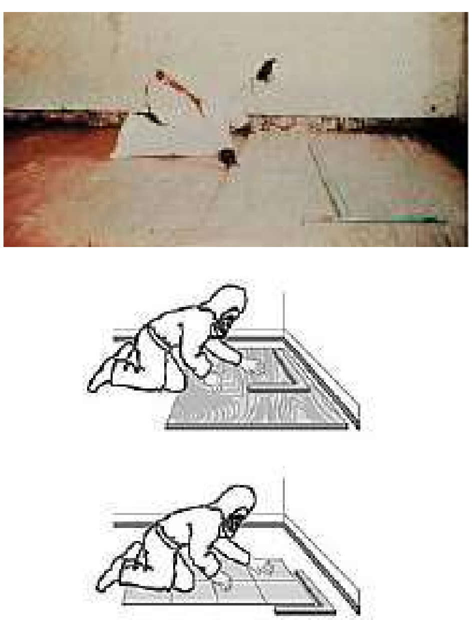


FIGURE 12.10 Install underlayment and new flooring as a suitable LBP enclosure method. The personal protective equipment is for a high-dust project.

If the floor to be enclosed is poured slab or cast-in-place concrete, the surface will have to be predrilled to accept each screw that anchors the plywood enclosure. A structural engineer should be consulted for situations other than slab-on-grade construction. Floor adhesive can offer an added measure of reinforcement and sealant. Each screwhead should be just below the level of the underlayment top surface and, along with the seams, should be covered with a smooth coat of flash patching cement to prevent dimples in the vinyl top cover.

5. Stairs

Dirt and loose paint should be removed prior to enclosure. Defective paint should be wet scraped and vacuumed; protective gear should be worn by the workers; and the work area should be contained with 6-mil plastic (or equivalent). In multi-family housing, common stairways must be accessible to residents and workers during the construction work to avoid a fire code violation.

FIGURE 12.11 Enclosed stairs.

Wooden steps with lead-based paint should be completely covered with vinyl or rubber treads and risers. These materials should have a minimum specification that would qualify for Federal Housing Administration (FHA) product approval or should be commercial grade. The vinyl should be stapled as well as glued with floor adhesive to avoid sagging. Long staples are preferred to reinforce the tread cover at this critical point and prevent the vinyl from being pulled up by the toe of a shoe. Metal bull nosing can also be used at this wear point.

In addition, long staples or metal bull nosing should be used at the end of the vinyl that butts up tight to the wood riser of the next step.

Plywood can be used to cover step risers and squared-off treads. Plywood is also useful as additional protection, supplementing the vinyl covers mentioned above. Precast concrete steps will have to be drilled, screwed, and glued to anchor the covers in place.

6. Pipes

Painted pipes can be enclosed with the same tape used to make plaster casts, which provides a hard-finished end product. Loose paint and dirt should be safely removed first. The wrapped tape should overlap itself so that it is not dependent on adhering to the painted surface.

Pipes can also be enclosed with drywall. However, this type of enclosure will insulate and limit the ability of radiator pipes carrying steam or hot water to contribute to household heating.

7. Door Frames

Preformed metal door buck or frame covers come in standard sizes to accommodate most components, and as such they can be used to enclose both wood and metal door frames, either interior or exterior. All seams must be caulked. Primers on such bucks should be lead-free.

8. Plywood Enclosures

Knee walls, painted structural supports, and trim such as baseboards, skirt boards, and stringers can be enclosed with plywood that is cut to fit tightly. These items should be sealed with adhesive and nailed. All joints should be caulked.

E. Exterior Enclosure Systems

1. Siding

Vinyl or aluminum siding may be used to enclose painted exterior surfaces. In addition, porch columns (both square and round) and porch ceilings can be enclosed with these materials. Aluminum coil stock can be used on soffits, fascia, bargeboard, decorative crown moldings (though original detailing will be lost), door and window frames, parapets, and other moldings. All seams need to be caulked and back-caulked. Soffit coverings under roof areas often need to be vented to prevent dry rot (see Figure 12.12). However, as old paint degrades behind this covering, a small amount may migrate through the vents. Breathable cloth materials such as Tyvek™ or an equivalent are available in rolls for this purpose and can be installed before the aluminum covering is put in place. The breathable cloth materials will help prevent leaded-dust from escaping through gaps in the new siding, although it will be necessary to leave attic vents uncovered to permit adequate ventilation. Vent openings should not be covered with Tyvek™ or other similar covering. Because siding may not provide an airtight enclosure, rigid or flexible dust barriers like Tyvek™ should be installed before broad surface enclosure. Perforated metal stock should not be used to enclose soffits, fascia, or eaves as the enclosure is not dust

Create a dust-tight seal

Paint deteriorates more quickly behind an enclosure. All edges of an enclosure—especially the bottom—must be sealed well.

Seal the bottom edge

- Caulk the enclosure material at the bottom
- Back-caulk the nail and baseboard in place.
- Back-caulk, bottom-caulk, and nail the shoe molding in place.

Seal the seams and other edges

- Back-caulk all the seams that aren't taped and spackled. Use a high quality adhesive caulk.
- Use a "J-channel" where drywall meets a finished surface. A J-channel is a final strip attached to the rough edge of drywall to make a finished edge. It's called a "J-channel" because of its shape. Caulk the outside edge so it seals with the finished surface. Screw the drywall in place.

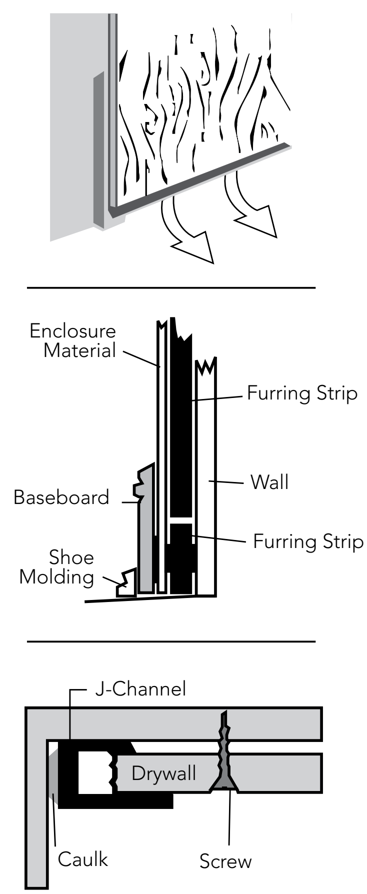


FIGURE 12.12 Seal All Seams for Enclosure.

tight. Rotten or loose wood and any other defective substrate must be repaired or replaced to provide a sturdy foundation for the siding installation and edges.

2. Windows

For standard sized windows, snap-in replaceable aluminum and vinyl tracks are available. These devices help eliminate the painted friction point (and thus the generation of leaded-dust) where the moving sash abrades the painted surface. The track covers should be pressed into a bead of caulk at each joint. Painted sashes should be planed to remove lead-based paint and then reinstalled (see Chapter 11, Section IV). Friction surfaces on windows should not be painted.

Window troughs should be covered with fitted metal and screwed into place. Again, the metal should be pressed into a bead of caulk at the joints and edges.

3. Exterior Walls

Board products made of various materials (e.g., synthetic fiberboard, wood byproduct composites, and cementitious materials) are commonly used in the construction industry for exterior purposes. These heavy, sometimes brittle coverings often have resins, fiberglass, or other durable ingredients that make them resistant to weathering and may require little maintenance, including painting. An added benefit of using these products is that they may have thermal insulation value. The products are best installed over flat surfaces that are not soft, crumbling, unstable, or otherwise defective. A defective substrate must be repaired prior to enclosure. All joints need to be sealed after installation.

Properly installed, natural or synthetic brick and stone veneers can be used to enclose exterior walls. In addition, stucco can be used as a covering material using wire mesh to physically anchor the cement to solid building components. A defective, weak surface needs to be stabilized before covering. Vinyl and aluminum siding are usually the least expensive options.

F. Summary

Enclosures are solid materials that are physically anchored to building components and that cover lead-based paint. Enclosure usually involves common construction techniques and has a 20-year design life. The enclosure abatement option is an effective, stable remedy for minimizing the danger of lead-based paint exposure. Because any barrier can be breached, annual monitoring by the owner and reevaluation by a certified risk assessor or inspector technician are necessary.

Enclosure may be less hazardous and cheaper than paint and building component removal. There is less dust generated and little hazardous waste disposal. Unlike encapsulation, the enclosure is not dependent on the adhesion of the underlying coats of paint on the substrate surface for its durability, nor does it require deteriorated paint removal or surface cleaning and deglossing before installation.

Drywall is often a cost-effective interior finish, and aluminum or vinyl siding provides an acceptable exterior barrier. Aluminum coil stock is effective for enclosing outside trim. Floors require underlayment and vinyl or other sheet finish goods. Vinyl or rubber tread and riser coverings are recommended for steps.

IV. Paint Removal Methods

A. Introduction

Paint removal means the separation of the paint from the substrate using heat guns, chemicals, or certain contained abrasive measures, either on-site or off-site. As an abatement technique, paint removal is usually reserved for limited areas and for those surfaces where historic preservation requirements may apply.

While paint removal can be performed safely and effectively, it also demands the highest level of control and worker protection for several reasons. Paint removal usually creates the greatest hazard for the worker, either from the hazards associated with the removal process (e.g., heat, chemicals, and sharp tools) or from the lead that becomes airborne or is left as a residue on the surface after removal. On-site paint removal will usually be a high-dust job. Prepare the worksite in accordance with the guidance in Chapter 8. Lower levels are possible if the size of the area to be treated is small (see Chapter 8). Because of the lead residues left behind by all paint-removal methods, particularly on porous surfaces such as wood or masonry, more extensive cleaning is usually required to meet clearance criteria. Paint removal methods also generate a significant amount of waste and may be the most costly of all lead abatement methods (HUD, 1991).

All work involving lead-based paint should be performed in a manner that minimizes all dust production. All high-dust paint removal operations should be avoided, and all work be planned and designed to reduce all dust generation. Using work practices and procedures such as wet work practices and the use of tools with attached HEPA-vacuum exhaust will help protect children, workers and residents.

In spite of these limitations, paint removal has the benefit of a low reevaluation failure rate. If some lead-based paint is left in the dwelling, its condition will need to be monitored by the owner (see Chapter 6).

B. Prohibited Methods

Certain methods of lead-based paint removal are absolutely prohibited, either because of unacceptably high worker exposures to lead or release of lead into the environment through production of dust or fumes or both.

1. Open Flame Burning or Torching

Burning, torching, fossil fuel-powered heat plates, welding, cutting torches, and heat guns operating at temperatures greater than 1100°F are prohibited as a means of paint removal because of the high temperatures generated in the process. So-called heat plates (those using propane to heat a grid, which in turn heats the paint) are also prohibited because of the high temperatures generated. At these temperatures, lead fumes may be produced.

Lead fumes are formed when lead is heated into a gas. The gas cools when it comes into contact with the cooler surrounding air and condenses into very small particles. These particles travel easily, are readily inhaled and absorbed into the body, and are difficult to cleanup. Several researchers have found that worker exposures are extraordinarily high when doing this kind of work (NIOSH, 1992a; Jacobs, 1991b; Rekus, 1988). The fumes may also travel throughout the dwelling, contaminating all surfaces with which they come into contact. Other hazardous substances may be released from the paint film using heat.

Using cutting torches to remove fire escapes, railings, or other metal components coated with lead-based paint is also prohibited unless the paint is removed first. Similarly, welding of painted metal components (such as pre-primed structural steel) is prohibited by Occupational Safety and Health Administration (OSHA) regulations (29 CFR 1926.354(d)).

2. Machine Sanding or Grinding Without a HEPA Exhaust Tool

Machine sanding or grinding is prohibited (regardless of the grit used) because of the large volume of leaded-dust generated (see Figure 12.13). As a result of these methods, workers have been exposed to extremely high leaded-dust levels, and blood-lead levels in resident children have increased (Amitai, 1991; Farfel, 1990; Jacobs, 1991b). However, machine sanding with a HEPA abatement exhaust tool *is* permitted and is discussed further below. Extensive dry hand sanding is not recommended, but wet sanding can be done if no electrical outlets are nearby. Limited dry sanding or scraping near electrical circuits is permitted.

3. Abrasive Blasting or Sandblasting

Traditional abrasive blasting or sandblasting is prohibited in residential structures, regardless of whether the abrasive material is recycled or if the area is fully contained. These methods

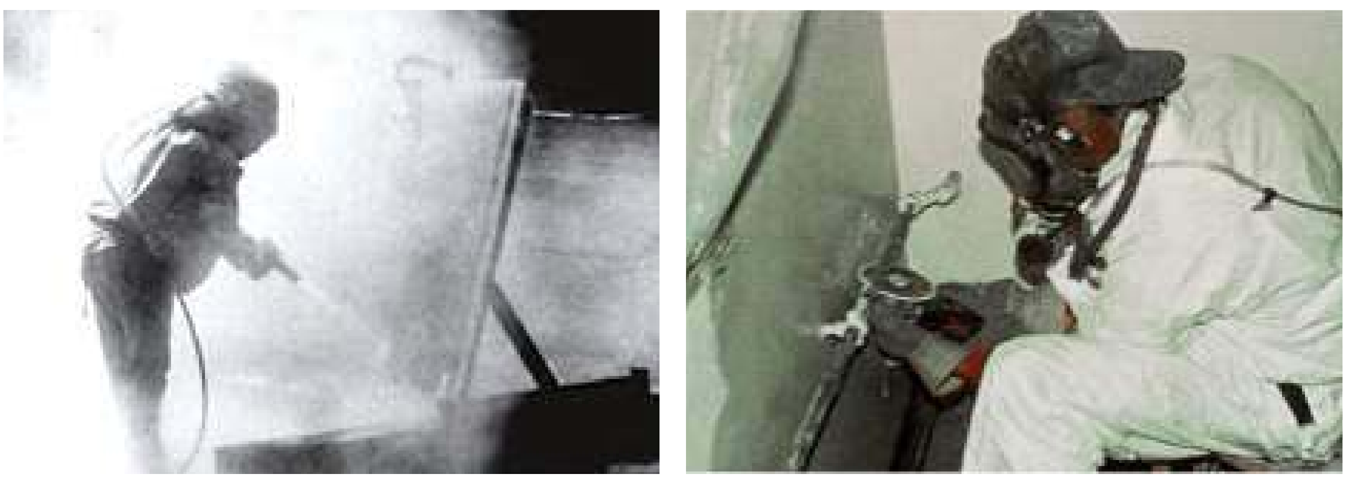


FIGURE 12.13 Prohibited work practices (traditional abrasive blasting (left) and grinding without HEPA exhaust).

produce widespread dust contamination; full containment is nearly impossible to maintain and guarantee in a residential environment. Abrasive blasting should only be done using HEPA vacuum local exhaust equipment, discussed below.

If abrasive blasting must be done in a residential structure, the area must be sealed and placed under negative pressure with enough clean fresh air so at least 10 times the volume of air in the contained space is brought in to the space and, after filtration, exhausted from it each hour (i.e., the ventilation rate is at least 10 air changes per hour) to ensure the dust can be controlled. If the exterior must be blasted, the entire building must be covered with a tent and placed under negative pressure with at least 10 air changes per hour. In both cases, all exhaust air must be passed through a HEPA filter. Fresh air should be provided to the containment zone at a lower rate than the exhaust airflow to maintain the negative pressure zone.

4. Heat Guns Above 1100° F

Heat guns operating above 1100° F or charring the paint should not be used. See discussion of operating heat guns below 1100° F in section IV.C below.

5. Dry Scraping

Dry scraping is not recommended because of the large volume of particulate matter that is generated (including high levels of leaded-dust).

The two situations where dry scraping is appropriate are scraping surfaces near electrical outlets, which cannot be wet scraped because of the obvious electrocution hazard, and scraping when using a heat gun as this cannot be done wet. For both of these cases, dry scraping is only appropriate for limited surface areas.

6. Chemical Paint Stripping in a Poorly Ventilated Space

Workers should not remove paint in poorly ventilated space when using a volatile stripper that is a hazardous substance in accordance with regulations of the Consumer Product Safety Commission (CPSC) at 16 CFR 1500.3 and/or a hazardous chemical in accordance with the OSHA regulations at 29 CFR 1910.1200 or 1926.59, as applicable to the work. (This practice is prohibited by HUD regulations but not explicitly by EPA regulations as of the publication of the second edition of these *Guidelines*.)

Paint strippers with methylene chloride should be avoided. OSHA has found that adults exposed to methylene chloride "are at increased risk of developing cancer, adverse effects on the heart, central nervous system and liver, and skin or eye irritation. Exposure may occur through inhalation, by absorption through the skin, or through contact with the skin." (62 FR 1493, January 10, 1997). OSHA's permissible exposure limit for methylene chloride in air was reduced in 1997 from 500 to 25 parts per million (29 CFR 1910.1052 for general industry, and the identical 29 CFR 1926.1152 for construction). Methylene chloride cannot be detected by odor at the permissible exposure limit, and organic vapor cartridge negative-pressure respirators are generally ineffective for personal protection against it.

Alternative paint strippers may be safer, but have their own safety and/or health concerns, so all paint strippers must be used carefully. Always follow precautions provided by the manufacturer. It is especially important that people who use paint strippers frequently not use such chemicals in a poorly ventilated area. If good ventilation is not possible, professionals equipped with protective equipment should perform the work in accordance with CPSC regulations (16 CFR 1500.3) and/or OSHA's hazard communications standards (29 CFR 1910.1200 or 29 CFR 1926.59, which are identical) and with any substance-specific standards applicable to the work.

CPSC and EPA recommend that people who strip paint provide ventilation by opening all doors and windows and making sure there is fresh air movement throughout the room ("What You Should Know About Using Paint Strippers," CPSC Document 4423, and EPA Document EPA 747-F-95-002). (***www.cpsc.gov/CPSCPUB/PUBS/423.html***)

C. Recommended Methods of Paint Removal

1. Heat Guns

Open flame burning is prohibited, so removal methods using heat are limited to electric powered flameless heat guns (see Figure 12.14).

FIGURE 12.14 Using a heat gun to remove paint is labor-intensive.

Before beginning work, fuses and an adequate electrical supply should be verified. Larger fuses should not be installed because of the possibility of creating a fire hazard. A portable electric generator may be needed, especially if several heat guns will be required. Care should be exercised around wallpaper, insulation, and other flammable materials. An accessible garden hose with a pressure-release spray nozzle, a crowbar to remove smoldering wood, and a long-handled sledgehammer to open up walls exposed to smoldering insulation should be readily available. Under OSHA regulations (29 CFR 1926.150), a fully charged ABC-type 20-pound (minimum) fire extinguisher must be available within 100 feet of the work area. Work should be conducted only in well-ventilated spaces. Other hazardous materials may be released when old painted surfaces are heated (NIOSH, 1992a).

While there is little risk that dangerous levels of lead fumes will be produced at temperatures below 1100°F, significant airborne particulate lead is generated by the accompanying scraping of the paint. Also, significant amounts of potentially harmful organic vapors can be released from the action of the heat upon the paint, even at temperatures below 1100 °F. For this reason, air-purifying respirators should be outfitted with both a HEPA-filtered cartridge and an organic vapor cartridge. Organic vapor cartridges may not be available for some powered air-purifying respirators.

Depending on the size of the area and the substrate, paint removal by heat gun can be a slow, labor-intensive process and may result in a high final clearance failure rate if used extensively and without proper cleanup. Removing paint completely, particularly from crevices, requires attention to detail. Significant leaded residue may remain on surfaces unless cleanup is thorough. Heat guns do not appear to be particularly effective on metal or masonry substrates, which are too porous to be scraped effectively; the heat may cause small particles to fly up and hit the worker, causing burns or eye damage. Although heat guns work well on wood, they will usually damage drywall and plaster.

Workers may tend to place the nozzle of the heat gun too close to the surface, burning out the heating elements prematurely, sometimes inadvertently even if they have been trained not to do so. One way to prevent this is to attach a small metal wire cage or extension tube to the end of the heat gun to prevent it from being placed too close. For most heat guns, the optimal distance from the surface is 3 to 6 inches. The heat gun is recommended only for limited surface areas in well-ventilated spaces. Other problems with heat guns include additional fire hazards from dry rot, insulation, and dust, especially in window troughs, roof areas, and hollow porch columns. Scraping often leaves the substrate very rough and may singe adjacent wallpaper. Telephone wires mounted on baseboards can melt, and heat can crack glass with a cold exterior or dry glazing.

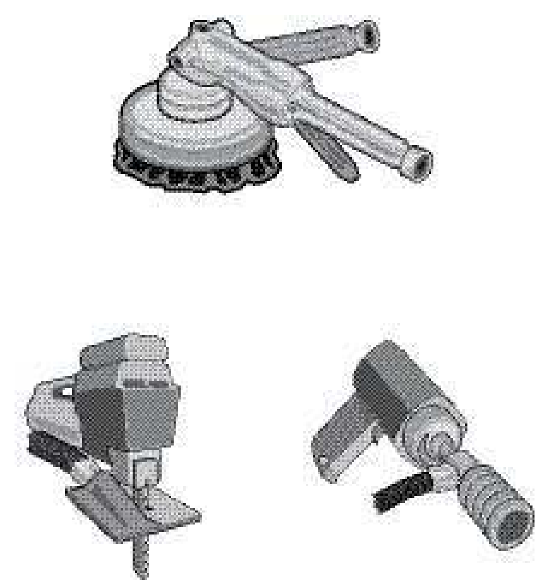
To use heat guns properly, allow the heat stream leaving the gun to merely soften the paint. Do not allow the paint film to scorch or smoke. Scrape the loose paint off the surface at the very first sign of paint softening, blistering, or bubbling.

2. Mechanical Removal Methods

HEPA Sanding

HEPA sanders are valuable for surface preparation prior to repainting. As chemical stripping sometimes raises the grain of the wood and some removal methods are not effective at removing all visible traces of paint, some sanding prior to repainting may be needed. Manual sanding can generate significant levels of airborne and settled lead-dust; airborne levels more than 10 times OSHA's permissible exposure limit, have been observed (Zhu, 2012). Therefore, HEPA-assisted sanders are recommended whenever sanding must be done. HEPA sanders do not work well on detailed moldings. In such situations, chemical stripping, use of a heat gun or offsite removal may be suggested.

HEPA sanding uses traditional electric sanders, such as disc sanders or orbital or vibrating sanders, equipped with specially designed shrouds or containment systems that are placed under a partial vacuum (also known as local exhaust ventilation). All exhaust air is passed through a HEPA filter (often using an ordinary HEPA vacuum) to reduce the amount of airborne particulate lead (see Figure 12.15). The HEPA vacuum must be correctly sized to provide adequate airflow to permit the system to operate properly. If hoses are longer than normal, a larger HEPA vacuum may be needed to handle the increased pressure drop.



HEPA Saw HEPA Drill

FIGURE 12.15 HEPA-filtered power tools.

There are two main types of HEPA sanders. The first uses a flexible shroud to surround the sanding head, with the HEPA vacuum hose attached to the shroud. The shroud must be in constant contact with the surface to be effective. If the shroud extends beyond the surface being sanded, large amounts of particulate lead will be released into the air. In addition, this configuration makes it impossible to sand to the edge of protruding surfaces, such as baseboards or window and door casings.

The second type of HEPA sander pierces the sandpaper with holes through which the vacuum draws the dust. This allows the instrument to be used to the edge of protruding surfaces. However, care must be exercised to keep the sandpaper flat on the surface. Neither one of these methods is completely effective; respirators are always recommended. Worker fatigue can also prevent the worker from holding the tool flush with the surface, making it necessary to provide frequent breaks or rotate workers.

Wet Scraping

FIGURE 12.16 Wet scraping (left)
FIGURE 12.17 Scraping tools (right).

Wet scraping is feasible on most surfaces and results in lower lead exposures than dry scraping. Since surfaces near electrical outlets should never be moistened (due to the electrocution hazard), these areas should be dry scraped.

Wet scraping can be performed by using a spray bottle or sponge attached to a paint scraper (see Figure 12.16 and 12.17). Wet scraping is often used to remove loose and flaking paint before paint film stabilization or encapsulation. If wet scraping is employed as an abatement technique, a more durable covering than new paint is needed. Working a few square feet at a time, the worker should mist the surface lightly using a garden sprayer or plant mister. Loose material should be scraped from the surface and deposited on the containment plastic with a paint scraper. Damp paint chips should be cleaned up as soon as possible so that they are not tracked throughout the work area or crushed beneath the feet of workers.

Scraper blades should be kept sharp to minimize abrasion and gouging. Additional scraper blades should be on hand and should be selected for the type of surface being scraped. To obtain a smooth finish, it may be necessary to follow wet scraping with wet sanding. A variety of scraping tools are available from hardware and paint supply stores.

HEPA Vacuum Blasting

HEPA vacuum blasting is simply abrasive blasting with a shroud under a vacuum that is attached to the blast head. All exhaust air is passed through a HEPA filter, using a properly sized HEPA vacuum system. Vacuum blasting is appropriate for metal, brick, concrete, and other masonry surfaces. To date, attempts to use the process on wood, plaster, and other soft materials have

FIGURE 12.18 Vacuum blasting is not often used on housing.

FIGURE 12.19 Needle Gun with HEPA Exhaust Ventilation.

not been successful, as they usually cause severe substrate damage.

Various blasting media can be used (e.g., aluminum oxide, metal shot, walnut shells) depending on the type of substrate. Blast heads, usually a brush-type arrangement, come in various sizes and shapes. The blast head must remain in continuous contact with the surface to avoid dispersal of both the blast medium and particulate lead (see figure 12.18). The equipment can be outfitted with a device that separates the blast media from the paint, effectively recycling the blast material, and dramatically reducing the volume of waste. This is particularly important because the blast material should be disposed of very carefully (see Chapter 10).

Use of the equipment for long periods of time can result in worker fatigue, particularly if working with the arms above the head. Fatigue can cause a worker to momentarily lose contact with the surface, resulting in the release of leaded dust, so the goal is to minimize the degree to which workers must reach above their shoulders. Scaffolding and platforms should be constructed to minimize such stress, and frequent work breaks should be taken. Vacuum blasting is not typically used in interior residential work.

HEPA Vacuum Needle Gun

The HEPA vacuum needle gun is similar to vacuum blasting in concept but avoids the use of a blast medium (see Figure 12.19). In the vacuum needle gun, metal needles rapidly pound against the painted surface, dislodging the paint. The HEPA vacuum, which is connected to the gun head, draws paint chips and dust into the vacuum, minimizing the dispersion of the particulate.

The needle gun is appropriate for metal surfaces but may cause significant damage to masonry. Problems of worker fatigue are similar to those encountered in vacuum blasting. Losing shroud contact with the surface can cause the deposition of significant amounts of chips onto the containment surface. Chips should be cleaned up as soon as possible following the work to avoid tracking.

One way of maintaining the seal with the surface is to select the proper shroud for the shape of the surface treated. At least one manufacturer (Penntek) has developed different shrouds for corners, edges, and flat surfaces. Needle guns are not effective in capturing large paint chips, so use of plastic sheeting underneath is required.

3. Chemical Removal Methods

Chemical removal may result in less leaded dust generation than other removal methods. It is often used in situations where historic preservation requirements apply. However, it may leave leaded residues on porous surfaces, which may pose a hazard to resident children in the future.

One study has demonstrated that windows treated with chemical paint removers had high leaded-dust levels a few months after treatment, even though cleanup and clearance had been conducted properly (Farfel, 1992).

Other drawbacks to chemical removal include high cost and potential harm to workers from splashes and chemical burns if proper gloves, face shields, and clothing are not provided and used (see Figure 12.20).

FIGURE 12.20 Workers should wear protective clothing when using chemicals.

Proper ventilation is necessary when using chemical paint removal. Plastic may not be effective in protecting floors and may have to be augmented by paper or cardboard. Chemical residues can be tracked into other areas on workers' shoes if proper decontamination is not conducted. Adjacent surfaces, especially plaster, can also be damaged. High humidity may retard the chemical remover's effectiveness. If protective clothing is penetrated and becomes matted against the skin, it must be removed *immediately*. A full shower is strongly recommended.

Off-site Paint Removal

Off-site paint removal is preferred so that most of the contamination and residues are generated away from the dwelling. The general approach is as follows.

Building components to be stripped must first be removed from the building. Misting with water prior to removal will help minimize the amount of airborne lead. The painted seam between the component and the wall should first be cut with a utility razor knife to minimize damage to the adjacent plaster. If there is more than one similar component, each component should be labeled to identify exactly where the component came from, eliminating the need for changing doors or other retrofitting problems.

Potential damage to components during stripping includes damage to hardware (this should be removed before stripping), broken glass, loss of glue joints and fillers, damage to wood fibers (wood swelling), and raising of the wood grain. The component may even fall apart and have to be blocked and re-glued. Old glazing compounds on windows may also be weakened. The stripping firm should be instructed to *thoroughly* wash and neutralize the components after stripping.

Before materials are returned from the paint stripper, they should be wrapped in heavy duty plastic and sealed with tape. This will minimize contamination of those handling the materials (leaded residue may remain on the surface). Materials should remain sealed until other on-site dust-generating activities are concluded and the dust cleaned up.

Before reinstallation, the treated components should be cleaned using the standard vacuum/wet clean/vacuum cycle to remove any residues left by the paint stripper. Components must be completely dry before repainting. Always check the pH (acidity or alkalinity) after cleaning and *before* repainting.

On-site Paint Removal

Many paint removers must be allowed to remain on the surface anywhere from 1 hour to a day or more to accomplish effective stripping.

Most paint removers are efficient within a limited temperature range and may be completely ineffective in cold weather. The contractor must therefore be certain of weather conditions before outdoor application. Also, rain or snow can cause environmental contamination from the lead and the chemical remover.

Paint removers are either caustic (corrosive) or non-caustic. The non-caustic chemical removers are generally safer to use than the caustic ones (assuming they do not contain methylene chloride). Material Safety Data Sheets should always be consulted to determine potential chemical hazards.

When using chemical strippers, securing the area where the strippers are used and the areas where they are stored is important, particularly with caustics, to prevent injuries to people who may gain access to the work area. Caustic paint removers can cause severe skin burn and eye damage to workers, other adults and children who may gain access to the work area. Pain receptors in the eyes are not as sensitive to caustic substances as they are to acids, so workers may suffer damage without immediately realizing it.

Personal protective equipment should be appropriate to the chemical paint stripping work being done; see Chapter 9, Worker Protection.

FIGURE 12.21 Eye- and body-wash stations are required when working with corrosive or irritant chemicals.

An abundant source of water within the abatement area for quick drenching or flushing injurious corrosive chemicals from skin or eyes is required by OSHA regulations (29 CFR 1910.151(c)). The water can come from a tap or portable eyewash station(s) (see Figure 12.21).

If contact with the eyes occurs, a full 15-minute rinse of the eyes is necessary on-site *before the individual leaves to seek medical attention* because permanent damage to the eyes occurs quickly. While 15 minutes may seem excessive, a quick rinse is ineffective, and permanent damage usually occurs on the way to seek medical attention.

Usually, non-caustic strippers are not as effective at removing multiple layers of paint in a single application compared to the caustic products. When using non-caustic removers, small areas should be tested before full-scale treatment to determine their efficacy. For vertical surfaces, adhesion of the liquid or gel type paint removers should also be tested to determine runoff potential (particularly a problem in warm weather). Most caustic paint removers work best on nonporous surfaces such as steel. They generally should not be used on aluminum or glass surfaces.

Paint removers that contain volatile substances should be used only in areas equipped with mechanical ventilation and only when workers are properly equipped with gloves, face shields, protective clothing, and respirators, as needed.

The paint remover should be applied with a spatula, trowel, brush, or spray gun. Spray gun use should be minimized because they increase worker exposures. The time the remover must stay on the surface will depend upon the number of layers of paint, the type of paint, the temperature, and the humidity, and can range from a few hours to a day or more. The paint remover should not be allowed to dry out. Some manufacturers provide a polyethylene or paper blanket that is pressed into the surface to retard drying; others contain a film that is formed on the surface of the paint remover as it sits to prevent drying. Caution must be used when applying the paint remover overhead to avoid its dripping onto workers below.

After the appropriate period of time, the softened paint should be removed using a scraper or putty knife and the material deposited in a watertight and corrosion-proof container (usually supplied by the manufacturer). The waste should be managed and disposed of in accordance with the guidance in Chapter 10.

With wood surfaces, it is important to complete the entire neutralization and cleaning process without letting the surface dry. If the wood dries before cleanup is complete, the pores in the wood may close, locking potentially significant leaded residues inside. When repainting, some of the leaded residue may leach into the new paint.

Alkali neutralization and residue removal are accomplished as follows. Immediately after paint removal (while wood surfaces are still damp), the surface should be thoroughly scrubbed with a solution of glacial acetic acid. Use of vinegar to neutralize the alkali should be avoided because vinegar may be inadequate as a neutralizing agent and will also result in a significantly larger volume of liquid (and potentially hazardous) waste.

Glacial acetic acid is hazardous and can cause skin burns and eye damage. It should be used carefully and only with neoprene, nitrile, rubber, or PVC gloves; chemical-resistant clothing; eye shields; a NIOSH-approved acid gas cartridge; and a HEPA filter on air-purifying respirators.

The damp, stripped surface should be thoroughly scrubbed with the acetic acid solution. The solution should be monitored with pH litmus paper and discarded if the pH exceeds 6. After use, the solution should be placed in corrosion proof containers and treated as potentially hazardous waste. Sponges and other cleaning materials should not be reused but deposited in heavy duty (double 4-mil, or single 6-mil) trash bags that are sealed, labeled, and put in a secure waste storage area.

Following neutralization, the damp surface should be thoroughly scrubbed with a detergent and water. Scrubbing should continue until no residues are visible. The cleaning solution should be changed when it becomes dirty. Following the detergent scrub, a clean water wash should be performed to remove residue. The pH of the water wash should be checked after use. If the pH exceeds 8, further neutralization of the surface with the acetic acid solution is necessary prior to repainting since an alkaline surface will cause the new paint to fail in a matter of days or weeks.

Surfaces should be completely dry before repainting. For wood surfaces, this may take several days to a week. If the moisture has raised the grain and sanding of wood surfaces is required before repainting, a HEPA sander should be used.

Since porous surfaces such as wood or masonry may still have slight alkali residues, some types of oil paints should not be used after caustic paint remover application. To do so may result in saponification (a “soap-making” reaction between the paint and the substrate, leading to rapid paint failure). Therefore, latex paints are probably most appropriate. Wood surfaces (especially exterior ones) can deteriorate after paint removers have been applied, making new paint difficult to apply. Also, the new paint may not last long on deteriorated substrates. Some old plasters with a high pH (that is, highly alkaline) may require primers that are no longer manufactured, so a special sealant may be needed on such surfaces. The specific paint remover manufacturer should be contacted for further guidance on appropriate paints to use.

High-pressure water removal of caustic paint removers should be avoided because control of solid and liquid contamination is difficult. Release of solids or liquids into the soil is likely to result in costly cleanup. Care must be used when applying caustic paint removers to friction surfaces, such as window jambs. Such surfaces are often weathered, making residue removal even more difficult. If these residues are embedded in a coat of new paint, the friction caused by opening and closing the windows can lead to the release of leaded-dust.

D. Waste Disposal

Wastes produced during paint removal may be highly concentrated, but low in volume. The toxic characteristic leaching procedure (TCLP) test should be used to determine if the waste is hazardous. See Chapter 10, Housing Waste, and the EPA regulations. Many local jurisdictions pick up small amounts of hazardous waste on certain days. If off-site paint removal is performed, the waste is the responsibility of the facility performing the removal.

V. Soil and Exterior Dust Abatement

A. Introduction

Lead-contaminated soil and exterior dust have been shown to cause elevations in blood-lead levels of children in a number of studies (EPA, 1993c). Exposure to lead in soil and exterior dust can occur both outside during play and inside from soil and dust carried into houses on shoes, clothing, pets, or by other means.

Soil can become contaminated over a period of years from the shedding of lead-based paint on nearby buildings, windblown leaded-dust from adjacent areas, and fallout of leaded-dust from the atmosphere (either from a local point source or from leaded gasoline emissions in the past). Uncontrolled paint removal from nearby houses or painted steel structures can also result in contaminated soil (controlling soil lead levels should be a consideration in every exterior lead-based paint abatement project).

Soil lead hazards are determined by measuring the concentration of lead in the soil, examining the location and use of the soil, and determining the degree to which the soil is “bare” (see Chapter 5). For a yard or area to require hazard control, a total of at least 9 square feet of bare soil must be present. Any size bare area in a play area containing more than 400 µg/g of lead is a hazard. Appendix 13.3 contains details on a sampling method to measure lead in soil. When assessing the condition of the surface cover, it is important to determine why the soil is bare. Bare soil is common in the following areas and circumstances:

- Heavily used play areas.
- Pathways.
- Areas shaded by trees or buildings.
- Areas with damaged grass.
- Drought conditions.

Measuring the lead content of soil will aid in the selection of an appropriate abatement method that has a reasonable likelihood of being maintained. Soil *abatement* (as opposed to interim controls) is generally appropriate when lead is present in extraordinarily high concentrations (more than 5,000 µg/g), use patterns indicate exposures are likely, or interim controls are likely to be ineffective (e.g., planting grass in high-traffic areas). Soil interim controls are covered in Chapter 11, Section VI. This section describes soil treatments that should be effective for at least 20 years.

Pre-abatement soil samples should be collected but not necessarily analyzed until post-abatement soil samples have been collected, analyzed, and compared to clearance standards. If post-abatement soil levels are below applicable limits, the pre-abatement samples need not be analyzed (see Chapter 15).

B. Soil Abatement Methods

Soil abatement methods include:

- Soil removal and replacement followed by off-site or on-site disposal; including covering with clean soil (Mielke, 2006; Mielke, 2011).
- Soil cultivation (rototilling).
- Soil treatment (e.g., organic matter, chemical, phytoremediation) and replacement.
- Paving with concrete or asphalt.

Soil removal is discussed in detail below; however, before choosing to remove contaminated soil, other treatment options should be considered. The advantages of using soil treatment methods (as opposed to soil removal) are three-fold (Elias, 1988):

- The costs of hauling large quantities of contaminated soil are eliminated or greatly reduced.
- Disposal sites for soil are not needed except for a much smaller volume of wastes generated during the treatment process.
- The need for uncontaminated replacement soil is greatly reduced.

1. Soil Removal and Replacement

For most soil removal projects, removal of 6 inches of topsoil is adequate. The depth of soil lead contamination is usually restricted to the top of the soil, with contamination decreasing markedly below the top few inches. However, in urban areas it is not uncommon for the contamination to extend to up to 1 or 2 feet in depth. This may be because these areas were once the location of buildings contaminated with lead-based paint. Alternatively, past practices may have resulted in a gradual buildup of the elevation of the soil grade over time. In such circumstances, the removal of the top layer of soil may leave behind contaminated soil at lower depths. In mixed residential/ industrial areas, or where industry once existed, the depth of the contamination may vary widely. The desired decision on the depth of removal should also consider the depth of soil disturbance during the course of usual activities, such as gardening. If the top layer of soil will not be penetrated, then it should not be necessary to remove lead-contaminated soil at deeper levels, since there will be no exposure.

For practical purposes, properly conducted soil removal to a depth of 6 inches should suffice in urban residential areas that are restricted to grass, shrubs, or shallow gardens. However, the depth of soil contamination should be assessed at each site, and the decision regarding depth should be made based on the results of the soil sampling and anticipated use of the land. For most residential areas, the depth of removal will not exceed 6 inches (Jones, 1987; Ontario, 1987; Stokes, 1987 and 1988). Records of the soil sampling and abatement that occurs should be maintained with the permanent records of the property. These records will alert property owners who are planning excavations to depths below the abatement depth, such as for water or sewer line work, to use caution to avoid contaminating the surface soil with excavated soil. The owners should be advised to sample the soil below the abatement depth to determine the lead concentrations so that procedures can be implemented to segregate this deeper soil, if contaminated, and to use it as fill for the deeper areas of the excavation when the work is completed. With EPA's standard for the maximum allowable lead concentration in replacement soil being that it is less than 400 µg/g, the lead concentration in the replacement soil must be less than that concentration; it is advisable that, where feasible, it be half or less than that, i.e., 200 µg/g or less, to provide a precautionary safety factor.

1. **Types of Equipment** – Removal and replacement of soil in residential abatement situations may take place in both large and small sites. Some urban yards are very small, consisting of only a few square feet; others are larger, but are sometimes surrounded by buildings. Therefore, residential soil abatement will often require the use of extensive manual labor in addition to mechanical soil removal. When soil is removed by hand, it generally can be loaded into wheelbarrows and then off-loaded to other vehicles to be transported to the disposal site. Rather than off-load the wheelbarrows to dump trucks, it is usually more efficient to dump the soil directly into roll off containers, which are then loaded onto trucks for transport to the disposal site.

2. **Sod and Seeded Grass Maintenance** – All grass sod planted as part of the abatement process should be maintained until the end of the growing season. This maintenance should include initial frequent watering to establish the rooting of the sod and germination of the grass seed, followed by watering on a regular basis to keep the grass in a healthy state. Under some conditions, seeding the soil may be practical, but often it is not realistic to restrict use of the soil area for the length of time needed to establish newly seeded grass.

3. **Identify Utilities** – The owner or contractor should contact the local coordinated information source for all utilities before beginning work to obtain exact locations of all underground utility lines. If a utilities information service does not exist in the community, the individual utilities should be contacted directly. In addition, the Common Ground Alliance's (CGA's) One Call Systems International committee maintains an 811 telephone number which will notify local utility companies about the intent to dig so that, within a few days, they can "send a locator

to mark the approximate location of your underground lines, pipes and cables, so you'll know what's below – and be able to dig safely" (***http://www.call811.com/how-811-works/default.aspx***). CGA also maintains an on-line interactive map (***http://www.cga-onecall.com/map/***) and a state-by-state listing (***http://www.call811.com/state-specific.aspx***) of contact information for "one call" centers for each U.S. state and Canadian province that should be able to help with finding underground service lines.

4. **Protect Utilities** – Care should be taken to protect existing utilities during abatement to prevent any damage to existing underground and overhead utilities and to prevent any harm to human life and property. If a contractor is used, the owner should require the contractor to protect the existing utilities and to make good any damage to these utilities as quickly as possible.

5. **Existing Fences** – Care should be taken while removing existing fencing for worksite access. Such fencing should be salvaged and reinstalled (if it does not contain lead-based paint) to the satisfaction of the owner. In some cases, fencing may have to be replaced.

6. **Protection of Adjacent Areas** – When working adjacent to excluded areas, including sidewalks, fences, trees, and patios, the soil should be excavated at a slope away from the excluded areas of less than 2 percent so that contamination does not wash or roll into the excluded area.

7. **Inclement Weather** – Removal and/or replacement operations should be suspended at any time when satisfactory control of the overall operation cannot be maintained on account of rain, wind, or other unsatisfactory weather or ground conditions. Determination of such conditions should be made by the owner or project consultant. When such conditions exist, the work area should be cleaned up immediately and work suspended. High winds can disperse contaminated soil and dust to off-site areas and runoff from rain can carry contamination outside the abatement area.

8. **Vehicle Operation** – Prior to hauling contaminated soil, a vehicle operation plan should be prepared for the equipment and hauling vehicle operators, which includes but is not limited to information on the cleaning of vehicles, securing of tarps and tailgates, ticketing of trucks, unloading of material, and handling of spilled soil.

   All trucks, hauling vehicles, and containers loaded with contaminated soil should be inspected for loose material adhering to the outside of the body, chassis, or tires before departure from the worksite. Such material should be cleaned up before the vehicle leaves for the disposal site. If the truck tires made contact with the contaminated soil, they should be cleaned before the trucks leave the work area. The tires should be brushed off on a plastic sheet and the contaminated soil loaded onto the truck or returned to the lot being excavated.

   Soil should be loaded directly into dump trucks or disposal containers from the worksite. If possible, there should be no "double- handling" of contaminated material, such as shoveling the soil into a wheelbarrow, moving it to another location, dumping it, and shoveling it again into another container. This double handling not only wastes time but also increases the likelihood of spreading the contamination and tends to make site cleanup more difficult. The trucks should have secure fitting tarps and sealed tailgates to reduce leakage as much as possible.

FIGURE 12.22 Replacing resident pathway after soil removal.

9. **Soil Replacement and Cleanup** – Prior to soil replacement, all walks, driveways, lanes, and streets adjacent to the excavation area should be cleaned of all contaminated soil (see Figure 12.22). All loose soil should be scraped, washed, and swept from the above-mentioned surfaces. No clean soil should be placed down until all contamination has been removed from these areas.

   At the completion of the workday, all loose contaminated soil within the limits of the work area should be collected. The collected soil should be transferred to a dump truck or other container for subsequent disposal.

   All hard surfaces, such as sidewalks, paved driveways, and patios, should be cleaned at the completion of each workday. This daily cleanup should consist of scraping, washing, vacuuming, and wet sweeping all soil from the above-mentioned surfaces.

   Cleanup procedures should begin early enough so that they can be completed before the end of the workday.

10. **Prevention of Contamination from Underlying Soil** – Regardless of the depth of removal, the possibility of contamination of the replacement soil from the underlying unexcavated soil exists, particularly from future activities. One way to minimize this occurrence is by laying a water-permeable fabric (geotextile) or similar lining at the bottom of the excavated areas to provide a visual demarcation between replaced soil and original soil (Weitzman, 1993). This liner can serve as a warning for persons digging in the future to exercise caution so that contaminated soil beneath the liner does not become mixed with the replacement soil.

11. **Contaminated Soil Load Manifest System –** In order to keep track of the contaminated soil being hauled away from the site, a load manifest system should be used to keep an exact record of the time and location of disposal. The manifest should consist of a two-part ticket, with one ticket given to the owner at the time of truck departure and the other held by the hauler. The disposal site ticket should be presented to the site owner or inspector technician before the end of the workday on which the material was deposited in the dump site. The purpose of the manifest system is to ensure that the contaminated soil is not used as fill in other residential areas. Soil waste should be managed and disposed of carefully; it may be considered hazardous as a result of a TCLP test (see Chapter 10, Housing Waste).

12. **Final Grade** – The final grades of replaced soil should be 2 inches above existing grades to allow for settling and to ensure that all drainage is away from existing structures.

13. **Existing Vegetation** – A number of precautions are needed to protect existing vegetation, such as bushes and trees. It is advisable to tie trees and shrubs to ensure stability. Hand tools are needed to scrape soil from around roots without undermining or damaging them. Any large roots should be left undisturbed.

14. **Tool Contamination** – To minimize the cross-contamination between excavation and

replacement worksites, separate tools should be provided for the excavation and replacement activities. A less-expensive alternative is to employ an acceptable method for decontamination of tools, workers' clothing, and footwear. The decontamination should include physically removing as much soil as possible and then washing and rinsing the contaminated items with water.

All workers should clean their boots thoroughly before leaving the work area. The soil removed from boots should be disposed of either in a truck used for hauling contaminated soil or left in the worksite.

15. **Prevention of Off-site Movement of Contaminated Soil** – Contaminated soil should be removed from the site as soon as possible to prevent wind and water erosion. To prevent off-site migration and to avoid the possibility of tampering by children, piles of contaminated soil should not be left on-site overnight. Wind erosion can occur on any site. Water erosion is more likely on hilly sites or during heavy precipitation. Exposed sites can be covered with plastic and secured in place to prevent off-site migration of contaminated soil. An alternative method is to wet down the site at the end of the workday to prevent wind erosion. Similar problems will be encountered when contaminated soil is stockpiled during the day prior to disposal at the end of the day. In this case, wind and water erosion should be controlled by using a combination of plastic sheeting and silt fencing.

16. **Site Control** – The following precautions should be taken:

- To prevent the spread of contaminated soil, secure working limits should be defined for each area of excavation. Access to this area should be restricted to authorized personnel with entrances and exits controlled.
- The abatement work area should be enclosed with temporary fencing or adequate barricades to prevent unauthorized personnel or animals from entering the work area.
- Yellow caution tape should be installed across doors leading to abatement areas.
- Access routes to homes should be maintained at all times. Such routes should not require passing through the area of excavation.
- The removal of a partial grass cover in preparation for the laying of sod or grass seeding may *temporarily* increase the amount of bare contaminated soil. On-site exposure could result when children play on the exposed soil. Abatement workers can control this during the day by means of adequate site control. However, control is difficult, if not impossible, after the end of the workday. Lead hazard warning signs should be posted to warn residents.
- In order to minimize inconvenience to residents and neighbors and to minimize exposure, abatement of a particular site should be completed within 1 workday.

2. Soil Cultivation

Soil lead concentration often decreases with increasing depth, so soil mixing can be considered to be an abatement strategy. If the average lead concentration of the soil to be abated is below 1,200 µg/g, thorough mixing is an adequate abatement method. Pilot testing may be necessary to determine the type of mixing process needed. Rototilling may not be effective.

FIGURE 12.23 Preparing to pave high traffic area.

3. Paving

If contaminated soil is present in high-traffic areas, the soil can be covered by a high-quality concrete or asphalt (see Figure 12.23). In this case, contaminated soil need not be removed before paving. Normal precautions associated with thermal expansion or contraction and traffic load should be considered. Hard surfaces are not appropriate in play areas where falls are possible from slides, jungle gyms, etc. The Consumer Product Safety Commission has developed recommendations for fall surfaces in public play areas (e.g., addressing the need for impact attenuating protective surfacing under and around equipment, installation and maintenance procedures, and general hazards presented by protrusions, etc. CPSC, 2008; ***www.cpsc.gov/CPSCPUB/PUBS/325.pdf***).

4. Other Soil Treatment Methods Under Study

HUD has funded studies to investigate other potential methods to reduce soil lead hazards. Plants can reduce the soil lead level (phytoremediation) but their use has not been widely tested or applied. The use of chemical additives (e.g. phosphate) to reduce the biological availability of lead appears to be attractive, but studies are continuing.

C. Exterior Dust Control

Lead in exterior dust can be a source of exposure to children because it can be tracked inside and carried on the skin, especially the hands (Bornschein, 1986). For example, in older urban areas in Cincinnati, exterior leaded-dust concentrations are on average about four times higher than interior leaded-dust concentrations, and exterior lead surface loadings are much higher than for interior dust (Clark, 1993). Just as children can be directly exposed to leaded-soil, they can also be exposed to exterior leaded-dust. Exterior dust can also migrate by various means (children, adults, pets, or wind) to the interior of homes where there are many opportunities for exposure to children. Exterior leaded-dust concentrations up to 50,000 µg/g (equivalent to 5 percent lead in dust) have been measured in urban areas in the EPA Soil Lead Abatement Demonstration Project (EPA, 1993c).

If only an individual property is involved in the exterior dust-control activity, the type of equipment that can be used will be limited by the size of the area involved and the person responsible for the area. Owners are not required to clean streets, for example. Because of the mobility of exterior dust, the length of time that the dust cleanup remains effective will be limited by the size of the abatement area and therefore may need to be repeated periodically.

Exterior dust control consists of two components:

- ✦ Controlling sources of lead-contaminated dust.
- ✦ Removing lead-contaminated dust from paved areas.

Without adequate control of the sources of lead in exterior dust, recontamination of the exterior areas will occur. Studies of a schoolyard area indicated that leaded-dust concentrations equaled pre-abatement levels within 1 year in Winnipeg, Ontario (Stokes, 1988). Recontamination of some paved areas in Cincinnati occurred within a few days (Clark, 1991), indicating that repeated cleaning and control of the *sources* of the lead are necessary.

1. Types of Equipment

Exterior dust cleanup consists of removing as much dust and dirt as possible from all paved surfaces on the property or properties involved. Lead-contaminated dust can be found on paved surfaces such as sidewalks, patios, driveways, and parking areas. For multiple adjacent proper ties that are being abated, cleanup of streets, alleys, or other common areas should be considered, although this is normally a municipal responsibility. Brick paved areas present the biggest challenge in removing exterior dust because they contain numerous cracks. For individual properties, hosing off walkways and play areas periodically may reduce exterior leaded-dust levels.

In order to meet this cleaning challenge, it is necessary to have available the most efficient hard-surface vacuum cleaning equipment. Many commercial contract cleaning firms located in urban areas have such equipment.

There are several different types of suitable paved-surface cleaning machines:

- Hand-pushed vacuum cleaners.
- Vacuum-assisted sweepers, which are similar to the traditional broom sweeper, with the added feature of a slight vacuum that assists in controlling dust and transporting material from the broom bristles to the hopper.
- Vacuum sweepers, which lift material from paved surfaces – some are equipped with curb brushes to assist in transporting the material from the edge of the cleaning area to the vacuum head and into the hopper.
- Trucks equipped with strong vacuums and large HEPA filters for the exhaust.

EPA research has found that regenerative air machines, which depend on rapidly moving air to capture particles from the surface of the pavement, frequently remove only a small fraction of the dust and thus may not be suitable for lead abatement work (Pitt, 1985).

2. Evaluation of Equipment

A number of pavement-cleaning machines were tested as part of the Cincinnati Soil Lead Abatement Demonstration Project (Clark, 1993). The machines tested were the vacuum-assisted sweeper, the vacuum sweeper, and the regenerative air machine. Initial tests demonstrated that several machines operated above the 90 percent efficiency level. A machine performing at the 90 percent efficiency level will pick up 90 percent of the available dirt after two passes. Equipment tested involved both large machines suitable for streets and parking lots and some walk-behind, vacuum-assisted broom sweepers suitable for sidewalks and other smaller areas. Several larger machines performed at or above the 90 percent efficiency rate. Some of the smaller walk behind sweepers did not perform at an acceptable level of efficiency.

Care must be taken when emptying the collected dust from the machines. The most appropriate method to minimize dust release is to dampen the contents of the hopper using an accessible hose. If water is to be used for dust control, it will be necessary to devise a means of containing excess water. This can be achieved by placing 6-mil polyethylene plastic on the ground where the equipment is being emptied and carefully collecting the water after the hopper has been emptied. It is also necessary to perform this activity in a secure area so that children are not exposed.

3. Removal of Heavy Accumulation

The first step in cleaning an area should be the removal of heavy accumulations of dust and debris. The heavily accumulated areas can be cleaned either by manually removing the material with scrapers, shovels, or brooms, or by vacuuming the heavily accumulated areas if vacuuming proves to be adequate in removing the contamination. Just as in handling lead-contaminated soil, the heavy accumulations of exterior dust should be dampened.

4. Vacuum Cleaning

Small areas, such as sidewalks and patios that are inaccessible to larger cleaning machines, may be cleaned with an acceptable vacuum cleaner (see Chapter 14 for discussion of vacuum cleaners). Surfaces should be vacuumed continuously until no additional visible dust is being removed by further vacuuming.

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