Report to Congress

in accordance with the

Residential Lead-Based Paint Hazard Reduction Act of 1992

Section 1061(a), Annual Report

U.S. Department of Housing and Urban Development

August 2020

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Introduction

The Residential Lead-Based Paint Hazard Reduction Act of 1992[1] is known as "Title X" ("ten") because it was enacted as Title X of the Housing and Community Development Act of 1992.[2] Based on the Congress' final finding for that title that:

> the Federal Government must take a leadership role in building the infrastructure--including an informed public, State and local delivery systems, certified inspectors, contractors, and laboratories, trained workers, and available financing and insurance--necessary to ensure that the national goal of eliminating lead-based paint hazards in housing can be achieved as expeditiously as possible,[3]

the Department of Housing and Urban Development (HUD) has been taking a leadership role in, as stated in the first purpose for this title:

> develop[ing] a national strategy to build the infrastructure necessary to eliminate lead-based paint hazards in all housing as expeditiously as possible;[4]

and implementing the national strategy as described in the remaining purposes listed.[5]

The Department has, since enactment of Title X, made over 400,000 housing units lead safe, that is, controlling lead-based paint hazards of residential paint, dust, or soil,[6] through its more than 1,200 lead hazard control grants to state and local governments, and its regulatory implementation and enforcement programs; sponsored research through its lead technical studies grants and contracts that have evaluated lead safety methods and programs, developed new methods, and provided the basis for developing state of the art guidance for evaluating and controlling lead-based paint hazards in housing; and aligned the lead safety activities of the HUD Offices and programs that provide assistance to older housing that may contain lead-based paint.

In addition, HUD has collaborated on lead safety issues with federal partner agencies, especially the U.S. Environmental Protection Agency (EPA) and the Centers for Disease Control and Prevention (CDC), based in part on Title X's identifying those agencies by name for consultation on lead-based paint hazard reduction,[7] as well as their longstanding and ongoing expertise in this field. The collaboration has been on per-project and ongoing bases, the latter through, initially, the

[1] Amending 42 U.S.C. ch. 63, § 4822, and creating ch. 63A, to include §§ 4851-4856.
[2] Public Law 102-550.
[3] 42 U.S.C. § 4851(8).
[4] 42 U.S.C. § 4851a(1).
[5] 42 U.S.C. §§ 4851a(2)-(7).
[6] These include deteriorated lead-based paint, dust lead levels at or above EPA dust-lead hazard standards, and soil lead levels at or above EPA soil-lead hazard standards. *See* HUD's Lead Safe Housing Rule, *at* 24 CFR §§ 35.110, Definitions, and 35.1320, Lead-based paint inspections, paint testing, risk assessments, lead-hazard screens, and reevaluations; and the U.S. Environmental Protection Agency's Lead-based paint activities rule, *at* 40 CFR 745.65, Lead-based paint hazards.
[7] 42 U.S.C. § 4852b.

Federal Lead Based Paint Task Force and, more recently, the Children's Environmental Health Task Force of 17 Executive Branch departments and agencies.[8]

HUD activities, along with its federal, state, local, non-profit, and for-profit partners and stakeholders, have contributed to the substantial decrease in blood lead levels among children under age 6, Title X's focal population,[9] as seen in Figure 1, based on findings of CDC's National Health and Nutrition Examination Survey (NHANES).[10]

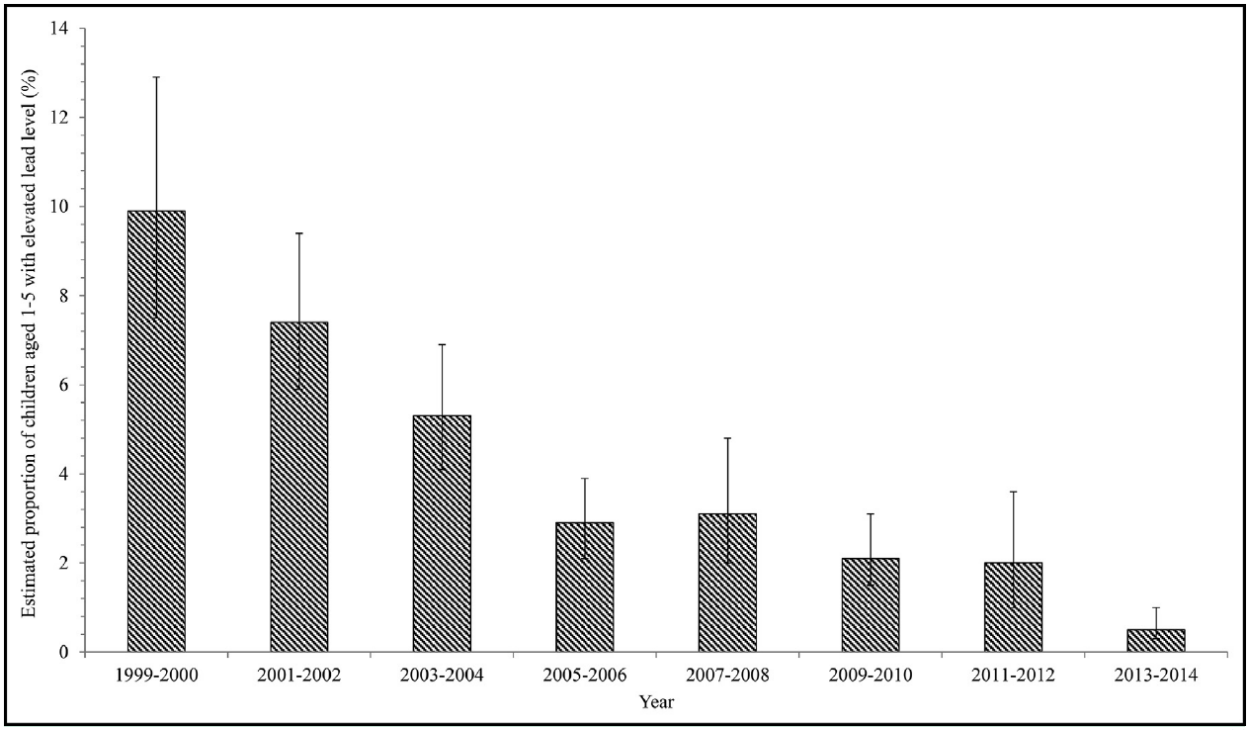

Fig. 1. Estimated proportion of children aged 1 to 5 years with elevated lead level in 1999-2014.[11]

Section 1061 of Title X, Reports of the Secretary of Housing and Urban Development,[12] includes subsection 1061(a), Annual report, to which this report is responsive. The subsection, shown here, provides the outline for this report.

[8] Executive Order 13045 of April 21, 1997. Protection of Children From Environmental Health Risks and Safety Risks, sec.3, Task Force on Environmental Health Risks and Safety Risks to Children. 62 Federal Register (FR) 19885 – 19888. April 23, 1997. www.federalregister.gov/d/97-10695.
[9] 42 U.S.C. §§ 4851(1), Findings; 4851b(25), Risk assessment; 4851b(27), Target housing; and 4852c, Guidelines for lead based paint hazard evaluation and reduction activities.
[10] CDC. NHANES Questionnaires, Datasets, and Related Documentation. wwwn.cdc.gov/nchs/nhanes/Default.aspx.
[11] Tsoi M-F, Cheung C-L, Cheung TT, Cheung BMY. Continual Decrease in Blood Lead Level in Americans: United States National Health Nutrition and Examination Survey 1999-2014. American Journal of Medicine 129(11):1213-1218. November 2016. https://doi.org/10.1016/j.amjmed.2016.05.042.
[12] 42 U.S.C. § 4856.

§ 1061. REPORTS OF THE SECRETARY OF HOUSING AND URBAN DEVELOPMENT

(a) Annual report. The Secretary shall an annual report that

(1) sets forth the Secretary's assessment of the progress made in implementing the various programs authorized by this title;

(2) summarizes the most current health and environmental studies on childhood lead poisoning, including studies that analyze the relationship between interim control and abatement activities and the incidence of lead poisoning in resident children;

(3) recommends legislative and administrative initiatives that may improve the performance by the Department of Housing and Urban Development in combating lead hazards through the expansion of lead hazard evaluation and reduction activities;

(4) describes the results of research carried out in accordance with subtitle D;[13] and

(5) estimates the amount of Federal assistance annually expended on lead hazard evaluation and reduction activities.

In 1998, after submitting the previous, 1997, annual report, HUD was advised that its reporting on the production of housing units made lead safe through its grant, assistance and enforcement programs would suffice, so it has been providing that information subsequently in its Performance and Accountability Reports and, more recently, its Annual Performance Reports.[14] HUD is submitting this Annual Report for Fiscal Year (FY) 2019 to conform explicitly to section 1061(a).

[13] 42 U.S.C. §§ 4854 - 4854b.

[14] *See*, *e.g.*, HUD. Fiscal Year (FY) 2021 Annual Performance Plan and FY 2019 Annual Performance Report. February 10, 2020. www.hud.gov/sites/dfiles/CFO/documents/HUD_FY2021_APP_FY2019_APR_Final_2-10-20.pdf. *See*, *esp.*, Strategic Goal I, Advance Economic Opportunity, Strategic Objective 3, Remove Lead-Based Paint Hazards and Other Health Risks from Homes pp. 36 – 40.

Title X Accomplishments in FY 2019

This report is sequenced by paragraph within the Reports section of Title X.

Title X, § 1061. Reports of Secretary of Housing and Urban Development[15]

(a) Annual report

The Secretary shall transmit to the Congress an annual report that—

(1) **sets forth the Secretary's assessment of the progress made in implementing the various programs authorized by this chapter;[16]**

§ 4822. Requirements for housing receiving Federal assistance

- (a) General requirements
  - (1) Elimination of hazards

The Secretary of Housing and Urban Development (hereafter in this section referred to as the "Secretary") shall establish procedures to eliminate as far as practicable the hazards of lead based paint poisoning with respect to any existing housing which may present such hazards and which is covered by an application for mortgage insurance or housing assistance payments under a program administered by the Secretary or otherwise receives more than $5,000 in project-based assistance under a Federal housing program. Beginning on January 1, 1995, such procedures shall apply to all such housing that constitutes target housing, as defined in section 4851b of this title, and shall provide for appropriate measures to conduct risk assessments, inspections, interim controls, and abatement of lead-based paint hazards. ….

- In 1999, HUD published the Lead Safe Housing Rule (24 CFR 35, subparts B – R).[17] The rule applies to all target housing that is federally owned and to target housing receiving Federal assistance.
  - Target housing is, in general, housing built before 1978, the year when the Consumer Product Safety Commission ban on using lead-containing paint in housing (16 CFR 1303) went into effect.[18]

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[15] 42 U.S.C. 4856(a).

[16] 42 U.S.C. ch. 63A, Residential Lead-Based Paint Hazard Reduction, comprising §§ 4851 – 4856. Because of the programmatic importance of § 4822, Requirements for housing receiving Federal assistance, and because that section was extensively amended by the Residential Lead-Based Paint Hazard Reduction Act of 1992 (*see* fn. 1), it is also covered in this report.

[17] 24 CFR 35 regulates Lead-Based Paint Poisoning Prevention in Certain Residential Structures (https://www.ecfr.gov/cgi-bin/retrieveECFR?n=pt24.1.35); The Lead Safe Housing Rule, formally titled Requirements for Notification, Evaluation and Reduction of Lead-Based Paint Hazards in Federally Owned Residential Property and Housing Receiving Federal Assistance, 24 CFR 35, subparts B – R, was published at 64 FR 50139-50231, September 15, 1999. https://federalregister.gov/a/99-23016.

[18] Consumer Product Safety Commission. Ban of Lead-Containing Paint and Certain Consumer Products Bearing Lead-Containing Paint. 16 CFR 1303. When published at 42 FR 44193-44201, September 1, 1977 (www.loc.gov/item/fr042170/), the ban on lead-containing paint, defined then as being "in excess of 0.06 percent of the weight of the total nonvolatile content of the paint or the weight of the dried paint film", applied to paint

    - Formally, target housing is defined as "any housing constructed prior to 1978, except housing for the elderly or persons with disabilities or any 0-bedroom dwelling (unless any child who is less than 6 years of age resides or is expected to reside in such housing)."[19]
- Specific lead safety requirements depend on whether the housing is being disposed of or assisted by the federal government, and also on the type and amount of financial assistance, the age of the structure, and whether the dwelling is rental or owner-occupied. An overview table is provided as Appendix 1, below.
- The Office of Community Planning and Development, which uses its Integrated Disbursement Information System to track project that Office funds, has created a reporting process within that system under which the Office of Lead Hazard Control and Healthy Homes can download the list of housing rehabilitation and maintenance projects in pre-1978 housing and identify the number of housing units made lead-safe (i.e., controlling lead-based paint hazards) under those projects through lead-based paint hazard abatement, interim controls, or standard practices.[20]
- In FY 2019, CPD's Community Development Block Grants, HOME Investment Partnerships, Housing Trust Fund, and Housing Opportunities for Persons with AIDS programs made 8,596 housing units lead safe in conjunction with rehabilitation or maintenance work in those units:

FY 2019	Abatement	Interim Controls or Standard Practices	Total
CDBG	1,367	4,622	5,989
HOME	1,417	1,034	2,451
HTF	21	0	21
HOPWA	0	135	135
Totals	2,805	5,791	8,596

- As part of its responsibility to oversee compliance with, and enforcement of, the Lead Safe Housing Rule, the Office of Lead Hazard Control and Healthy Homes (OLHCHH) coordinates with program offices including the Offices of Housing, Public and Indian Housing, Community Planning and Development, General Counsel and the latter Office's Departmental Enforcement Center.
- During FY 2019, OLHCHH evaluated Public Housing and Multifamily Housing compliance following Public and Indian Housing's Real Estate Assessment Center (REAC) inspections where peeling paint was identified in pre-1978

"manufactured after February 27, 1978" (p. 44199); amendments to the rule, including changing the threshold percentage, changed the manufactured-after date.

[19] 42 U.S.C. § 4851b(27).

[20] The terms are defined in the Lead Safe Housing Rule at 24 CFR 35.110.

housing covered by the Uniform Physical Condition Standards,[21] including public housing, project-based rental assisted housing, housing for the elderly, housing for persons with disabilities, among others.[22] As part of the REAC site inspection process, their inspectors request records of lead safety compliance, and REAC reports on the presence or absence of lead-based paint evaluations and lead disclosure forms. OLHCHH then determines if missing records were required to be present.

- REAC inspected more than 1000 Multifamily Housing-assisted properties and compared the field-collected information with information available in the program databases to determine if additional review was warranted. Of those properties, 35 were identified as being at higher risk of having lead-based paint hazards or not having performed lead disclosure (see the discussion of § 4852d, below), and were further reviewed based on owners' responses to document request letters issued by the Office of Multifamily Housing, the Departmental Enforcement Center, or OLHCHH. In almost all cases, reports received in response to those letters determined the properties were either lead-based paint (LBP) free or had very little lead and were in general compliance with the rules, requiring only minor adjustments to the owners' lead safety and disclosure procedures.
- REAC inspected 650 public housing properties. Of those properties, several hundred were identified as being at higher risk of having lead-based paint hazards or not having performed lead disclosure, however many of the properties are designated as housing for the elderly or persons with disabilities, and, therefore, statutorily exempt from HUD's lead safety rules because they are not target housing. OLHCHH initiated a review of the applicability of the rules to the reported properties and compared information available in the different program data bases to determine if additional review was warranted; the review is ongoing.

- For public housing properties that are target housing, the Office of Public and Indian Housing works with Housing Authority owners to address missing lead evaluations or disclosure forms, and that Office requests submission of documentation when warranted.
- OLHCHH assists REAC with the multifamily housing or public housing review when requested and conducts several independent reviews when also in a city for disclosure evaluation.
- OLHCHH worked with the Offices of Public and Indian Housing and General Counsel, as well as with the Department of Justice's U.S Attorney for the Southern District of New York in developing the case against the New York City Housing Authority (NYCHA) related, primarily, to violations of the Lead Safe

[21] HUD. Physical Condition Standards and Inspection Requirements 24 CFR 5, subpart G, www.ecfr.gov/cgi-bin/retrieveECFR?n=sp24.1.5.g, especially § 5.703, Physical condition standards for HUD housing that is decent, safe, sanitary and in good repair, https://www.ecfr.gov/cgi-bin/retrieveECFR?n=se24.1.5_1703.

[22] HUD. 24 CFR 5.701, Applicability, for the Uniform Physical Condition Standards, citing §200.853, Applicability, for Office of Housing Programs, and citing the public housing programs

Housing Rule as well as health and safety issues regarding mold, pests, heating, and elevators.

- In FY 2019, the Secretary and the Mayor of New York City signed av/ settlement agreement[23] that established specific requirements and milestones to address lead hazards. The City committed at least $2.2 billion in funding for this work through 2029. HUD agreed to continue to provide funding to NYCHA in accordance with its rules, regulations and formulas (approximately $1.5 billion in FY 2019), and agreed not to offset or reduce the formula grants by the amount of funds the City provided to NYCHA. New York State committed an additional $450 million for paying capital costs under the NYCHA State Capital Revitalization Plan.[24]
- The agreement also established a federal Monitor selected by HUD and the Southern District of New York with input from the City of New York, and funded by the City of New York. In FY 2019, the Monitor began submitting quarterly reports to HUD and the Southern District, which were made publicly available.[25]
    - In its last quarterly report for FY 2019,[26] the monitor noted that, NYCHA had "significantly increased the pace of progress in the effort to create effective Action Plans which become the blueprint for how NYCHA will meet performance-specific deadlines in the Agreement." The monitor also noted that, "NYCHA [had] redesign[ed] its Compliance Department, as well as the Environmental Health & Safety Department and the Quality Assurance Unit, each mandated by the Agreement. These are now operational." On the other hand, the monitor noted that, "NYCHA frankly acknowledged that it was not in compliance with lead-based paint regulations and many required lead-safe work practices."
    - The monitor and his staff provided direction and technical and programmatic assistance to NYCHA's leadership and management to address these problems.
    - HUD, through its OLHCHH, and Offices of Public and Indian Housing and General Counsel, provided technical and programmatic information and guidance, in addition to reviewing reports from NYCHA and from the monitor, and regularly weekly, biweekly, and ad hoc meetings to review NYCHA's efforts to

[23] In addition to HUD and the City signing the agreement, the U.S. Attorney and the NYCHA Chair and Chief Executive Officer signed it. www.hud.gov/sites/dfiles/PA/documents/HUD-NYCHA-Agreement013119.pdf.
[24] Dormitory Authority of the State of New York and the New York City Housing Authority. Funding Agreement. September 5, 2019. https://nychamonitor.com/wp-content/uploads/2019/10/DASNY-State-Capital-Revitalization-Plan-Funding-Agreement-Executed-9-5-19.pdf.
[25] New York City Housing Authority Monitor. https://NYCHAMonitor.com/, with individual quarterly reports linked through the Quarterly Reports tab.
[26] New York City Housing Authority Monitor. Second Quarterly Report July - September 2019. November 1, 2019. https://nychamonitor.com/wp-content/uploads/2019/11/NYCHA-Monitor-Second-Quarterly-Report-11.1.19-FINAL.pdf.

come into compliance with the Lead Safe Housing Rule and lead-specific provisions of the settlement and make recommendations on expediting NYCHA's progress. HUD similarly pressed met with NYCHA, reviewed its progress with regard to the other safety and health issues under the agreement, and made recommendations on expediting NYCHA's progress..

§ 4852. Grants for lead-based paint hazard reduction in target housing.

- Lead paint in housing presents one of the largest threats to the health, safety, and future productivity of America's children, with over 22 million homes (34 percent of the homes built before 1978) having significant lead-based paint hazards.[27]
- The Office of Lead Hazard Control and Healthy Homes' (OLHCHH's) lead hazard control grants are awarded to local governments and to states and tribes that are authorized by the U.S. Environmental Protection Agency (EPA) to manage lead-based paint abatement certification programs.[28]
- HUD has rigorously evaluated the effectiveness of the programs, determining them effective in both the pure outcome measure (i.e., reducing children's blood lead levels)[29] and the long-term effectiveness of the hazard controls.[30] The programs offer high returns for children's reduced healthcare costs and later increased work productivity, i.e., $17–$221 per dollar invested in controlling lead paint hazards.[31]
- In FY 2019, the grants were offered under the OLHCHH's Lead-Based Paint Hazard Reduction Grant Program,[32] using funds under the Lead Hazard Control, Lead Hazard Reduction Demonstration, and High Impact Neighborhoods funding lines within the Lead Hazard Control segment of the Department of Housing and Urban Development Appropriations Act, 2020 title of the Further Consolidated Appropriations Act, 2020.[33] The three funding lines have the same goal of making privately owned low-income

[27] As determined by OLHCHH's American Healthy Homes Survey I (Dewalt FG, Cox DC, O'Haver R, Salatino B, Holmes D, Ashley PJ, Pinzer EA, Friedman W, Marker D, Viet SM, and Fraser A. Prevalence of Lead Hazards and Soil Arsenic in U.S. Housing. J. Env. Health. 78(5):22-29 (2015). www.neha.org/node/6429).
[28] Title X, § 1011(n), Relationship to other law (42 U.S.C. § 4852(n)); *see also*, EPA. Lead-Based Paint Activities Professionals website, www.epa.gov/lead/lead-based-paint-activities-professionals, Lead-Paint Abatement Programs Authorized by EPA.
[29] Clark S, Galke W, Succop P, Grote J, McLaine P, Wilson J, Dixon S, Menrath W, Roda S, Chen M, Bornschein R, Jacobs D. Effects of HUD-supported lead hazard control interventions in housing on children's blood lead. Environmental Research 111(2):301–311, 2011. https://doi.org/10.1016/j.envres.2010.11.003
[30] Dixon, S. L., Jacobs, D. E., Wilson, J. W., Akoto, J. Y., and Clark, C. S. (2012, February). Window replacement and residential lead paint hazard control 12 years later. Environmental Research, 113, 14-20. Retrieved August 18, 2014, from http://doi.org/10.1016/j.envres.2012.01.005.
[31] Gould E., Childhood Lead Poisoning: Conservative Estimates of the Social and Economic Benefits of Lead Hazard Control. Env. Health Perspectives. 117(7):1162-7 (2009)
[32] Office of Lead Hazard Control and Healthy Homes. Lead Hazard Reduction Grant Program. Funding Opportunity No. FR-6300-N-13. www.hud.gov/sites/dfiles/SPM/documents/FY19_LeadHazardReductionGrantProgram.pdf.
[33] Public Law 116-94, www.congress.gov/bill/116th-congress/house-bill/1865/text?format=txt.

older housing[34] lead-safe, i.e., not having lead-based paint hazards;[35] the main distinction among the three programs is in the communities targeted by each:

- The Lead Hazard Reduction Demonstration grant program (begun in 2003, and called, under the Lead-Based Paint Hazard Reduction program, the Highest Lead-Based Paint Abatement Needs grants category) focuses communities with the most pre-1940 rental housing (which has the highest rates of lead-based paint hazards[36]) and highest rates of childhood lead poisoning cases.
- The High Impact Neighborhoods grants category of the Lead-Based Paint Hazard Reduction grant program focuses on communities with contiguous census tracts with high concentrations housing stock built before 1940, in which low-income families with children make up a significantly higher proportion of the population as compared to the State average, and that are located in jurisdictions in which instances of elevated blood lead levels reported to the State are significantly higher than the State average.
- The original Lead-Based Paint Hazard Control grant program (begun in 1993, and called, under the Lead-Based Paint Hazard Reduction program, the Other Jurisdictions grants category) is open to a broader range of communities and states.[37]
- In 2019, the OLHCHH continued to improve the Notices of Funding Availability for state and local jurisdictions seeking to improve their housing stock and improve the present and future health of their children, including:
    - Continuing to align and harmonize disparate program requirements among the three grant categories;
    - Continuing to streamline and simplify the Notice of Funding Availability Rating Factors;
    - Refining the number and scope of applicant qualification categories; and
    - Reducing overly burdensome and unnecessary threshold requirements.
- As a result of these efforts in FY 2019, the pattern of a decreasing number of applications from jurisdictions was halted, in fact, all but one of the Office's grant programs were oversubscribed; i.e., more eligible jurisdictions applied and received a score making them eligible for being funded than the OLHCHH had funding available. By making the program application process more

[34] Generally, housing built before 1978 (Title X, § 4852, Grants for lead-based paint hazard reduction in target housing; that housing is defined as certain "housing constructed prior to 1978" (§ 4851b(27)), when the Consumer Product Safety Commission ban on using lead-containing paint in housing (16 CFR 1303) went into effect.

[35] These include deteriorated lead-based paint, dust lead levels at or above EPA dust-lead hazard standards, and soil lead levels at or above EPA soil-lead hazard standards. *See* 24 CFR §§ 35.110, Definitions, and 35.1320, Lead-based paint inspections, paint testing, risk assessments, lead-hazard screens, and reevaluations; and 40 CFR § 745.65 Lead-based paint hazards.

[36] The lead results of HUD's American Healthy Homes Survey I (AHHS I) were published in Dewalt FG et al. Prevalence of Lead Hazards and Soil Arsenic in U.S. Housing. *Op. cit.*

[37] In addition to the Lead-Based Paint Hazard Reduction grant program, operated by the OLHCHH under Title X, § 1011, the Office of Public and Indian Housing operates its Lead-Based Paint Capital Fund grant program (www.hud.gov/sites/dfiles/SPM/documents/LeadBasePaintCapitalFundProgramNOFATechnicalCorrection.pdf) to treat public housing under separate authority, namely, Section 9 of the United States Housing Act of 1937 (42 U.S.C. § 1437g). Title X's subsection 1011(a) prohibits grants under the section from treating public housing.

attractive, the OLHCHH had nearly twice the number of jurisdictions apply for its funding than in the past 4 years.

- With these grants' duration ranging from 42 to 60 months, with the FY 2019 appropriation enacted on February 15, 2019, and with the process of drafting by the OLHCHH, review within HUD and by the Office of Management and Budget, followed by availability of the Notice of Funding Availability to eligible jurisdictions for 45 days to apply, and the period for HUD's reviewing applications and selecting those to whom offers of award would be made under the FY 2019 notice, those award offers were announced on September 30, 2019.[38]
- Accordingly, the production of lead-safe housing units in FY 2019 was the result of grants awarded under these programs in previous years. Grantees produced 4,489 lead-safe housing units in FY 2019 under those grants, protecting the health of approximately 6,300 children under age 6 residing in those units.
- In FY 2019, the OLHCHH expanded a pilot initiative begun in late FY 2018, of hosting "Building a Lead-Safe and Healthy Neighborhood" local events ("Build Events") nationwide in partnership with lead hazard control grantees, that:
  - Highlighted the work of OLHCHH lead hazard control grantees and local partners to build awareness of the need to create lead safe, healthy and affordable homes and neighborhoods,
  - Highlighted the partnerships needed to create lead safe and healthy homes, including increasing public-private partnerships to bring additional investments into these neighborhoods,
  - Highlighted community capacity building efforts to identify homes that need lead abatement, and children who should be tested for lead, and
  - Highlighted the health outcomes of the OLHCHH's work, and the improvement in the quality of life for residents in homes remediated by its lead hazard control grantees.
- The Build Events initiative has become a national effort to engage the OLHCHH grantees and their local partners in building capacity, creating lead safe and healthy homes, as well as expanding efforts to address problems of entire neighborhoods in a holistic fashion.
  - The OLHCHH expanded its public-private partnership with Lowe's Companies' hardware stores in FY2019; Lowe's participated in nearly all of the Office's local grantee events, donating supplies, landscaping, and appliances for the Build events and less-structured events.
  - In FY 2019, Build events were held in Phoenix, AZ, Worchester, MA, Minneapolis, MN, Las Vegas, NV, and Baytown and Houston, TX.
  - As a result of these local events, lead hazard control grantees saw a 10-20 percent increase in the number applications.
  - Lowe's developed a program for lead hazard control grantees beyond the Build Event that provided grantees across the country with discounts on supplies needed to remediate lead-based paint hazards and other housing related health hazards. The relationship had a positive effect on the amount of leveraged resources gained to further HUD's lead hazard control efforts across the country.

[38] Office of Public Affairs. HUD Awards Record $319 Million to Protect Families from Lead and Other Home Health Hazards. September 30, 2019. www.hud.gov/press/press_releases_media_advisories/HUD_No_19_145.

§ 4852a. Task force on lead-based paint hazard reduction and financing.

- The Task Force on Lead-Based Paint Hazard Reduction and Financing created by this section was "comprised of 39 men and women representing a diversity of constituencies, opinions, professions, training, and experiences," as its 1995 report noted.[39] The task force dealt with the widespread prevalence of lead-based paint hazards in housing, setting priorities in developing 59 recommendations to ensure continued availability of affordable housing and address constraints faced by the private sector in making and keeping such housing lead safe. The task force ended its operation shortly after issuing its report.
- The approaches and recommendations developed by the task force were considered during the contemporaneous development and publication of the first edition of the Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing ("HUD Guidelines")[40] by HUD and its external (federal and non-federal) drafting partners, and by HUD in drafting the Lead Safe Housing Rule in 1999.[41]

§ 4852b. National consultation on lead-based paint hazard reduction.

- The Federal Interagency Lead-Based Paint Task Force created after enactment of Title X included HUD, the Environmental Protection Agency (EPA), Centers for Disease Control and Prevention (CDC), Department of Justice, Department of Commerce's National Institute of Standards and Technology, U.S. Department of Agriculture, and other agencies concerned with lead poisoning prevention.
- In 2011, the Federal Interagency Lead-Based Paint Task Force task force merged itself into the Children's Environmental Health Task Force,[42] which plays a critical role in the coordination of federal agencies' efforts to identify research needs and priorities that impact children's environmental health, as well as to maximize the productivity of research resources to benefit children.[43]
    - Specifically, the Federal Interagency Lead-Based Paint Task Force was reconstituted as the Lead Exposures Subcommittee of the Children's Environmental Health Task Force. The subcommittee "facilitate[s] interagency coordination around childhood lead exposures and related effects, including research activities and sharing of information with the public, in order to better understand and prevent disease and disabilities in children from lead."[44]
    - HUD co-chairs the Lead Exposures Subcommittee with EPA and CDC.

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[39] Task Force on Lead-Based Paint Hazard Reduction and Financing. Putting the Pieces Together: Controlling Lead Hazards in the Nation's Housing. HUD-1547-LBP. July 1995.
[40] Office of Lead-Based Paint Abatement and Poisoning Prevention. Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing. www.hud.gov/program_offices/healthy_homes/lbp/hudguidelines1995,
[41] Office of Lead Hazard Control. Requirements for Notification, Evaluation and Reduction of Lead-Based Paint Hazards in Federally Owned Residential Property and Housing Receiving Federal Assistance. 24 CFR 35, subparts B – R, etc. 64 FR 50139-50231 *at* 50142. September 15, 1999. https://federalregister.gov/a/99-23016.
[42] Executive Order 13045 of April 21, 1997. Protection of Children From Environmental Health Risks and Safety Risks, sec. 3, Task Force on Environmental Health Risks and Safety Risks to Children. 62 FR 19885 – 19888. April 23, 1997. www.federalregister.gov/d/97-10695.
[43] President's Task Force on Environmental Health Risks and Safety Risks to Children. https://ptfceh.niehs.nih.gov/. *See* https://ptfceh.niehs.nih.gov/about/index.htm.
[44] _____. Lead Exposures. https://ptfceh.niehs.nih.gov/activities/lead-exposures/index.htm.

        - In FY 2019, the task force published, based on work headed by the subcommittee, the Federal Action Plan to Reduce Childhood Lead Exposures and Associated Health Impacts.[45] The action plan documents the task force member agencies' commitment to reducing lead exposure through collaboration among themselves and with such stakeholders as states, tribes, local communities, businesses, property owners and parents.
        - The Lead Action Plan will help federal agencies work strategically and collaboratively to reduce exposure to lead and improve children's health. EPA and members of the Task Force will continue to engage with and reach out to community stakeholders such as non-governmental organizations.
        - The four Lead Action Plan goals that identify 61 actions the task force agencies have committed to accomplish, are:
            - Goal 1: Reduce Children's Exposure to Lead Sources.
            - Goal 2: Identify Lead-Exposed Children and Improve their Health Outcomes.
            - Goal 3: Communicate More Effectively with Stakeholders.
            - Goal 4: Support and Conduct Critical Research to Inform Efforts to Reduce Lead Exposures and Related Health Risks.
- HUD provided consultative information to EPA for the Agency's development of its Dust Lead Hazard Standards final rule.[46]
    - Using information from its Lead Hazard Control Grant Program and the implementation of its Lead Safe Housing Rule, HUD provided comments to EPA on technical and programmatic feasibility and consistency of provisions of the draft final rule.
    - For example, OLHCHH-sponsored research demonstrating the feasibility of attaining low dust lead levels after grantees' lead hazard control activities[47] was used in setting the Office's dust lead clearance levels for its lead hazard control grants,[48] and then, in FY 2019, providing information and programmatic recommendations to EPA for the Agency's development of its revised Dust Lead Hazard Standards final rule.[49]
- HUD provided consultative information to CDC on their considering revising their blood lead reference value. In 2012, CDC introduced the concept of a blood lead

[45] _____. Federal Action Plan to Reduce Childhood Lead Exposures and Associated Health Impacts. December 19, 2018. https://ptfceh.niehs.nih.gov/resources/lead_action_plan_508.pdf.
[46] EPA. Review of the Dust-Lead Hazard Standards and the Definition of Lead-Based Paint. 84 FR 32632 – 32648. July 9, 2019. www.federalregister.gov/d/2019-14024.
[47] Cox D and Dewalt G. Lead Hazard Control Clearance Survey. Lead Hazard Control Clearance Survey Final Report. October 2015. https://www.hud.gov/sites/documents/ClearanceSurvey_24Oct15.pdf.
[48] Revised Dust-Lead Action Levels for Risk Assessment and Clearance; Clearance of Porch Floors. Policy Guidance 2017-01 Rev 1. February 16, 2017. www.hud.gov/sites/documents/LEADDUSTLEVELS_REV1.pdf.
[49] EPA. Review of the Dust-Lead Hazard Standards and the Definition of Lead-Based Paint. 84 FR 32632-32648, July 9, 2019. www.federalregister.gov/d/2019-14024,

reference value to identify children exposed to more lead than most, based on the 97.5th percentile of the blood lead distribution in U.S. children ages 1–5 years.[50]

- This reference value is based on data from two consecutive cycles of CDC's National Health and Nutrition Examination Survey, and updated periodically to ensure that changes in the population are adequately assessed.
- Based on the trend of this continuous survey's results over time,[51] this reference value would be likely to decrease. Such a change, would affect CDC's guidance to physicians, and, depending on CDC's implementing decisions, might affect CDC's guidance regarding environmental investigations in response to children's blood lead levels at lower levels than is currently the case. If CDC's guidance regarding such investigations were to change, that change would be considered by HUD in its implementing the elevated blood lead level definition under its Lead Safe Housing Rule, which refers to such CDC environmental investigations guidance.[52]

- HUD provided consultative information to CDC's Community Preventive Services Task Force[53] for the task force's Lead Prevention Evidence Assessment Project, specifically, providing strategic information for the Project's determining the current state of literature on lead prevention interventions.
- HUD coordinated with CDC on encouraging CDC's childhood lead poisoning prevention grantees[54] to use their blood lead level testing data to identify apartment buildings (or owners) associated with multiple elevated children's blood lead level (EBL) cases, or neighborhoods with high EBL prevalences and conveying that information to HUD's lead hazard control grantees for the HUD grantees to be able to target a portion of their lead hazard evaluation and control efforts to such housing.
- HUD coordinated with CDC on using the National Report on Human Exposure to Environmental Chemicals' Fourth Report's Updated Tables,[55] specifically, on geometric mean and selected percentiles of blood concentrations, for use in the targeting strategy for HUD's FY 2019 Lead-Based Paint Hazard Reduction Notice of Funding Availability.

§ 4852c. Guidelines for lead-based paint hazard evaluation and reduction activities.

- As noted above in the discussion of the implementation of § 4852a, Task force on lead-based paint hazard reduction and financing, HUD published the first edition of the

[50] CDC. CDC Response to Advisory Committee on Childhood Lead Poisoning Prevention Recommendations in "Low Level Lead Exposure Harms Children: A Renewed Call of Primary Prevention". June 7, 2012. www.cdc.gov/nceh/lead/acclpp/CDC_Response_Lead_Exposure_Recs.pdf.
[51] Tsoi M-F et al. Continual Decrease in Blood Lead Level in Americans. *Op cit.*
[52] Office of Lead Hazard Control and Healthy Homes. Lead Safe Housing Rule. Definitions. 24 CFR 35.110, Elevated Blood Lead Level.
[53] Department of Health and Human Services Community Preventive Services Task Force. What is the CPSTF? www.thecommunityguide.org/task-force/what-task-force.
[54] CDC. Childhood Lead Poisoning Prevention. State and Local Programs. www.cdc.gov/nceh/lead/programs/default.htm.
[55] CDC. Updated Tables, January 2019. National Report on Human Exposure to Environmental Chemicals. January 2019. www.cdc.gov/exposurereport/index.html, especially, Volume 1, www.cdc.gov/exposurereport/pdf/FourthReport_UpdatedTables_Volume1_Jan2019-508.pdf.

Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing ("HUD Guidelines") in 1995.

- HUD developed the second edition to reflect scientific, technical, regulatory, and policy changes since the first edition, and published the second edition in 2012.[56]
- In FY 2019, as in previous years, the HUD Guidelines were used by residential (especially multifamily) property owners and managers, individuals certified in the lead-based paint disciplines (including lead-based paint inspectors, risk assessors, renovators, abatement supervisors, abatement workers), the accredited training providers who train them, and the certified lead-based paint firms for whom they work,[57] for providing authoritative information and guidance on approaches and procedures for prioritizing lead hazard evaluation and control activities and conducting them. The HUD Guidelines are cited ten times by the EPA's residential lead-based paint poisoning prevention rules, as being one of the "Documented methodologies" that are appropriate for the work practice standards for certified persons to conduct lead-based paint activities.[58]

§ 4852d. Disclosure of information concerning lead upon transfer of residential property.

- Congress directed HUD and EPA, under this section, to require the disclosure of known information on lead-based paint and lead-based paint hazards before the sale or lease of most housing built before 1978. The two agencies issued their respective regulations under this section with identical wording,[59] known as the Lead Disclosure Rule, in 1996.
- Before ratification of a contract for sale or lease of most pre-1978 housing (except for properties being leased having been found to be lead-based paint free), sellers and landlords must, in short:
    - Give the prospective buyer or renter an EPA-approved information pamphlet on identifying and controlling lead-based paint hazards.[60]
    - Disclose any known information concerning lead-based paint or lead-based paint hazards.
    - Provide available records and reports on lead-based paint and/or lead-based paint hazards.
    - Provide the Rule's Lead Warning Statement.
    - Confirm that the seller or landlord has complied with all notification requirements.
    - Provide, to sellers, a 10-day period (adjustable or waivable by agreement) to conduct a paint inspection or risk assessment for lead-based paint or lead-based paint hazards.

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[56] Office of Lead Hazard Control and Healthy Homes. Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing. Second Edition. July 2012. www.hud.gov/program_offices/healthy_homes/lbp/hudguidelines.

[57] EPA. Lead-Based Paint Poisoning Prevention in Certain Residential Structures. 40 CFR 745.

[58] EPA. 40 CFR 745.227(a), Lead-based paint activities rule's work practices terms subsection, specifically, ¶ 745.227(a)(3), Documented methodologies, first item listed.

[59] HUD. Disclosure of Known Lead-Based Paint Hazards Upon Sale or Lease of Residential Property. 24 CFR 35, subpart A. EPA. {Same title}. 40 CFR 745, subpart F.

[60] EPA, HUD, Consumer Product Safety Commission. Protect Your Family From Lead In Your Home. www.epa.gov/lead/protect-your-family-lead-your-home-real-estate-disclosure.

- In FY 2019, HUD conducted local onsite reviews for Lead Disclosure Rule compliance in New York, New Jersey, Pennsylvania, and North Carolina, reviewing a total of 14 residential landlords and property management firms.
    - The larger firms, each managing a total portfolio of about200 housing units in apartment complexes, were found to be complying with the rule.
    - HUD continues to evaluate the compliance record of several medium sized firms, those with about 50 to about 200 housing units.
    - Smaller landlords and firms, managing fewer than about 50 units of single-family housing, typically were found to be violating the rule although many of these violations were technical in nature; HUD provided the landlords and firms with information and guidance on coming into compliance. Several small management firms had sufficiently significant violations for HUD to propose consent agreements to these firms. Two small firms have entered into agreements, which will result in 52 housing units being made lead safe, in addition to the firms' paying a fine lower than the maximum fine.

§ 4853. Worker protection.

- In response to this section, the Secretary of Labor issued an interim final regulation regulating occupational exposure to lead in the construction industry on May 5, 1993.[61]
- In FY 2019, the Occupational Safety and Health Administration cited a construction company for violating the Lead in Construction regulation, above, by exposing workers to lead and other workplace hazards as the company renovated and remodeled a worksite, and proposed $104,637 in penalties.[62]

§ 4853a. Coordination between Environmental Protection Agency and Department of Labor.

- The initial coordination between EPA and Department of Labor was completed upon issuance of the Occupational Safety and Health Administration's Lead in Construction rule May 4, 1993, as noted above.
- The Department of Labor, through its Occupational Safety and Health Administration, was a member, along with EPA, of the Federal Lead-Based Paint Task Force, and continues its collaboration with EPA as a member of the successor task force, the Children's Environmental Health Task Force (*see* the discussion of § 4852b, above).

HUD Research

- HUD conducts lead safety research through grants (formally, cooperative agreements, in which there is substantial HUD involvement in carrying out the activities[63]) under its

[61] Occupational Safety and Health Administration. Lead. 29 CFR 1926.62. 58 FR 26590 – 26649, May 4, 1993. https://cdn.loc.gov/service/ll/fedreg/fr058/fr058084/fr058084.pdf.
[62] Occupational Safety and Health Administration. U.S. Department of Labor Investigation Finds New Jersey Contractor Exposed Employees to Lead and Other Hazards at Pennsylvania Worksite. July 24, 2019. www.osha.gov/news/newsreleases/region2/07242019,
[63] 2 CFR § 200.24.

lead technical studies grant program[64] and contracts (including those with the private sector and interagency agreements with other federal agencies, most notably EPA).

- Since FY 1995, HUD has requested funding for the lead technical studies grant program and Congress has provided such funding, allowing the OLHCHH to issue a lead technical studies notice of funding availability and to issue contracts.
    - Each year, the OLHCHH updates the notice to, in part, identify the Office's research topics of greatest interest at that time, soliciting, primarily, technical proposals on those subjects, while also allowing proposals on other subjects within the overall scope of the grant program.
    - In recent years, HUD has issued a combined Lead and Healthy Homes Technical Studies notice of funding availability to harmonize the procedural provisions of the two programs notices, which benefits researchers who may be considering applying under either or both programs, and also simplifies for HUD staff the development of one notice rather than two. Funding and awards continue to be separate, in accordance with the respective appropriations.
    - HUD has further streamlined the technical studies notices by having all applicants submit a short "pre-application," with just the applicants that submitted the highest rated pre-applications invited to submit a full application. This reduces the burden on most of the initial applicants, and provides more time for the smaller number of applicants invited to submit full applications to develop their thinking about the proposal. This approach also reduces the overall workload on the members of the application review panel.
- The OLHCHH began FY 2019 by awarding the FY 2018 lead technical studies grants on October 2, 2018,[65] for which grantees began doing their work in the first quarter of the fiscal year. The priority research topics in the FY 2018 notice of funding availability[66] and the abstracts of the grants awarded[67] are listed in Appendix 3.
- During FY 2019, the OLHCHH designed that year's technical studies grant program and drafted and published the notice of funding availability,[68] the priority research topics for which are listed in Appendix 4. (The FY 2019 lead technical studies grant awards were made at the start of FY 2020, specifically, on October 10, 2019.[69])

[64] The OLHCHH uses "technical studies" to describe its research grants programs to avoid confusion with the name of HUD's Policy Development and Research, and that Office's research grant programs.
[65] Office of Public Affairs. HUD Awards $6.7 Million in Research Grants to Reduce Lead and Other Housing-Related Health Hazards. HUD No. 18-112. October 2, 2018. https://archives.hud.gov/news/2018/pr18-112.cfm.
[66] Office of Lead Hazard Control and Healthy Homes. Lead and Healthy Homes Technical Studies Grant Program Pre- and Full Application. FR-6200-N-15. April 2018. www.hud.gov/sites/documents/2017lhhtsnofa.pdf.
[67] J. Kofi Berko, Jr., FY 2018 Lead Technical Studies NOFA Pre- and Full Application Review Panel Final Report. September 27, 2018.
[68] Office of Lead Hazard Control and Healthy Homes. Lead and Healthy Homes Technical Studies Grant Program Pre- and Full Application. FR-6300-N-15. June 11, 2019. www.hud.gov/sites/dfiles/SPM/documents/FR-6300-N-15_TechStudiesNOFA.pdf.
[69] Office of Public Affairs. HUD Awards $8.4 Million to Study Lead and Other Health Hazards. HUD No, 19-153. October 10, 2019. www.hud.gov/press/press_releases_media_advisories/HUD_No_19_153.

§ 4854. Research on lead exposure from other sources.

- This section provides that HUD, in cooperation with other Federal agencies, shall conduct research on strategies to reduce the risk of lead exposure from other sources, including exterior soil and interior lead dust in carpets, furniture, and forced air ducts.
- See Appendix 2, Summary of Results of Lead Research Carried Out under Title X, summarizing publications of research conducted by the OLHCHH in previous years, which includes research on exterior soil and interior lead dust in carpets, furniture, and forced air ducts. HUD has collaborated with the EPA and with CDC on developing the scopes of work for several years' notices of funding availability for lead technical studies on a range of lead exposure sources. Scientists with those agencies have served on application review panels for lead technical studies grants. HUD funded EPA research on a variety of lead exposure reduction topics; HUD collaborated with the National Survey of Lead and Allergens in Housing;[70] EPA and with the Department of Health and Human Services' National Institute of Environmental Health Sciences on the American Healthy Homes Survey,[71] with EPA and the Consumer Product Safety Commission on the First National Environmental Health Survey of Child Care Centers,[72] and began collaborating with EPA on the American Healthy Homes Survey II[73] in 2017 on a project for which statistical design and methodology, and the field work, have been completed.
- Among the FY 2018 grants awarded at the start of FY 2019 was an award to the National Center for Healthy Housing, Inc., partnering with the Michigan Department of Health and Human Services, for $596,830 to analyze data collected by the State of Michigan's lead poisoning prevention program to characterize and assess recent lead levels in dust, soil, paint, and drinking water, while controlling for a large number of potentially confounding variables. These levels will be modeled to predict exposures using robust structural equation modeling, which has been used previously in the evaluation of HUD's Lead Hazard Control Grant program and other research. The study will provide updated information on the relative contributions of various residential lead exposure sources to children's blood-lead levels.
- As noted above, the American Healthy Homes Survey II, conducted by HUD in collaboration with EPA in FY 2018 – 2021, including FY 2019, is finding out how much lead is in paint, dust, soil and water; how much pesticides and mold, in dust; and formaldehyde, in air, as well as safety hazards in homes nationwide. Because homes are randomly selected for the survey, some will not have any lead-based; however, it is important that these homes be included in the study. This is the third survey of its kind, following the first AHHS, which HUD conducted in 2005-2006 and the National Survey of Lead and Allergens in Housing (NSLAH), which HUD conducted in 1998-2001. The

[70] Jacobs DE, Clickner RP, Zhou JY, Viet SM, Marker DA, Rogers JW, Zeldin DC, Broene P, and Friedman W. The Prevalence of Lead-Based Paint Hazards in U.S. Housing. Environmental Health Perspectives 110(10), October 2002: A599-A606. http://doi.org/10.1289/ehp.021100599.

[71] Dewalt FG et al. Prevalence of Lead Hazards and Soil Arsenic in U.S. Housing. *Op cit.*

[72] Zhou JY, Friedman W, Jacobs DE, Tulve NS, Jones PA, Croghan CW, Cave CJ, Rogers J, Viet SM, Marker D, Fraser A. First National Environmental Health Survey of Child Care Centers. 2005. www.cdc.gov/nceh/lead/ACCLPP/March%202006/presentations/presentation.%20acclpp%20march%202006.fnehsccc.friedman.23mar2005.pdf.

[73] Office of Lead Hazard Control and Healthy Homes. American Healthy Homes Survey II Project Description. www.hud.gov/program_offices/healthy_homes/ahhs_ii_pd.

information obtained from these surveys is important for tracking national progress in reducing the number of homes with lead-based paint and other potential health hazards. Findings from the previous surveys have been published in scientific journals, as noted above.

§ 4854a. Testing technologies.

This statutory section requires the HUD Secretary, in cooperation with other Federal agencies, to conduct lead safety research in 10 subject areas. As noted in the HUD Research preamble above, research topics are addressed through grants and contracts, with key results summarized in Appendix 2 below.

The specific research topics vary by year; within the finite funding available, not all subject areas are researched each year. Below are listed activities in FY 2019 from lead technical study grants and contracts either starting out that year, ongoing from having been started previously, or concluding in that year.

- (1) develop improved methods for evaluating lead-based paint hazards in housing;
  - National Center for Healthy Housing, Inc. The MI CHILD Study (MIchigan CHIldren's Lead Determination Study). FY 2018 Lead Technical Study (LTS) grant underway in FY 2019. The absence of recent data characterizing lead exposures in paint, dust, soil, and water while controlling for other key variables made it difficult to understand the relative importance of different sources. This evaluation is helping to fill this evidence gap by analyzing data collected by Michigan Department of Health and Human Services' lead poisoning prevention.
  - Sinai Health System. Primary Prevention of Lead Poisoning through Targeted Deployment of Community Health Workers. FY 2017 grant underway in FY 2019. This study is working towards the long-term goal of reducing lead poisoning among children living in economically highly challenged communities. It is generating evidence on the feasibility, effectiveness and cost-effectiveness of utilizing Community Health Workers to conduct proactive visual inspections in homes for lead-based paint hazards before a child is exposed.
- (2) develop improved methods for reducing lead-based paint hazards in housing;
  - University of Texas at El Paso. Lowering Children's Blood Lead Levels by Mitigating Household Lead Paint in Central El Paso, TX. FY 2018 grant underway in FY 2019. This study is using a holistic approach strategy, integrating community neighborhood-level education on child lead exposure solutions, with household-level lead hazard detection and mitigation.
- (3) develop improved methods for measuring lead in paint films, dust, and soil samples;
  - QuanTech showed, in a contract report issued in 2019,[74] that the color-changing spot test kit based on the reaction of lead in paint with sodium sulfide can, using a new solid dilution technique, be used for detection of LBP at the regulatory level. The test results, run on HUD's XRF Archive of Materials used for characterizing X-ray fluorescence (XRF) analyzers' performance when

[74] Dewalt FG, Cox D, Enhancing the Performance of Spot Test Kits for Lead Based Paint Using Solid-Phase Dilution. Final Report on OLHCHH grant MDLTS0003-14. June 2019.

developing Performance Characteristic Sheets, are comparable to the criteria applied to XRF analyzers . The research found that the two-sided EPA criteria for spot test kits[75] are too stringent for any test kit or XRF analyzer. It also suggests that the same solid dilution technology applied to the reaction of rhodizonate with lead in paint can be applied for on-site clearance testing of dust wipe samples, which would expedite reoccupancy of housing undergoing interim controls or abatement for which clearance is required.

- Healthy Housing Solutions, under a FY 2018 contract underway in FY 2019, performed a literature review and evaluated impacts of potential lowered HUD lead-based paint definitions as part of the OLHCHH's determining its strategy for addressing that issue, in support of HUD's reviewing the current definition and reducing it to the extent that reliable technology makes feasible the detection of a lower level and medical evidence supports the imposition of a lower level.[76] The study found that evidence was lacking that would support such a lowering.[77]
- QuanTech, under a FY 2017 contract underway in FY 2019 to maintain the XRF Archive of testing materials used for developing Performance Characteristic Sheets[78] specifying the ability of makes and models of portable X-ray fluorescence analyzers to measure lead in paint with respect to the current 1.0 milligram per square centimeter (mg/cm^2) loading of lead in paint that defines lead-based paint[79] on a set of common housing construction substrates, tested several analyzers (by agreement with the manufacturers) that had Performance Characteristic Sheets that showed that they were most successful (i.e., determined the presence or absence of lead-based paint with no inconclusive range) with respect to paint at 0.5 mg/cm^2. Unfortunately, none of the analyzers were able to perform successfully at that lower level.[80]

- (4) establish performance standards for various detection methods, including spot test kits;
  - Healthy Housing Solutions. Review Literature and Potential Impacts of Alternative HUD Lead-Based Paint Definitions. FY 2017 contract underway in FY 2019. This two-year project provided an extensive statistical analyses and modeling on the relationship of lead-based paint to dust lead levels and certain other variables using the American Healthy Housing Survey data, and assessed the feasibility of lowering the lead-based paint definition, including the extent to which X-ray fluorescence analyzers, the most common lead-based paint inspection instrument, and the one that is nondestructive, could be readily reprogrammed or redesigned to attain a lower threshold level for reporting the presence of lead-based paint.

[75] 40 CFR § 745.88(c).
[76] 42 U.S.C. § 4822(c).
[77] Healthy Housing Solutions. Review Literature and Potential Impacts of Alternative HUD Lead-Based Paint Definitions: Perform a Focused Literature Review to Update Applicable Information. January 2019.
[78] HUD. Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing, Chapter 7, Lead-Based Paint Inspection, and Chapter 7, Addendum 3: XRF Performance Characteristic Sheets. 2012. www.hud.gov/program_offices/healthy_homes/lbp/hudguidelines.
[79] 42 U.S.C. § 4822(c).
[80] QuanTech. Maintain the XRF Archive of Testing Materials. Contract: 2017. Reports: FY2019.

- (5) establish performance standards for lead-based paint hazard reduction methods, including the use of encapsulants;
    - While research on this topic was not conducted in FY 2019, prior-year research results are reflected throughout the HUD Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing, in EPA's Lead-Based Paint Activities Rule's work practices section, and HUD's Lead Safe Housing Rule's subpart on methods and standards for lead-paint hazard evaluation and hazard reduction activities.
- (6) establish appropriate cleanup standards;
    - While research on this topic was not conducted in FY 2019, prior-year research results were used in FY 2019 to provide information and programmatic recommendations to EPA for the Agency's development of its revised Dust Lead Hazard Standards final rule. (See the discussion of § 4852b.)
- (7) evaluate the efficacy of interim controls in various hazard situations;
    - Healthy Housing Solutions. National Evaluation of the Housing and Neighborhood Impact of the HUD Lead-Based Paint Hazard Control Program, 1993-2016. FY 2017 grant underway in FY 2019. The main aim of this study is to use existing secondary data to conduct a large-scale national evaluation of the localized benefits of lead-based paint hazard interventions, specifically on property values, neighborhood health, and economic outcomes. The study also analyzes the determinants of effective lead hazard control grant programs as measured by improvements in housing and neighborhood quality.
    - Michigan Technological University. A Novel Phytoremediation Method to Cleanup Lead-Based Paint Contaminated Soils: Phase III – Demonstration Study. FY 2017 grant underway in FY 2019. This investigation is designed to demonstrate whether phytoremediation is efficacious via longer-term, in situ studies in six residential properties in two geographically distant U.S. areas characterized by very different climate pattern and soil types. The secondary objective is to develop a guidance manual for implementation of catalyzed vetiver (a tall perennial grass) phytoremediation technology, which will be made available for free to affected home owners.
- (8) evaluate the relative performance of various abatement techniques;
    - National Center for Healthy Housing, Analysis of Benefits of Abatement Techniques and Effectiveness in the HOME Study (the ABATE HOME Study). FY 2018 LTS grant underway in FY 2019. The three main objectives of this study are: (1) to determine the efficacy of the type and intensity of lead hazard control interventions used in the HOME Study (2003-2006) on blood lead levels and neurobehavioral factors; (2) to identify which housing interventions are capable of routinely achieving compliance with low dust lead levels in the most cost-effective manner; and (3) to determine if residential dust lead loadings are related to neurobehavioral outcomes in children.
- (9) evaluate the long-term cost-effectiveness of interim control and abatement strategies;
    - The National Center for Healthy Housing, partnering with Cincinnati Children's Hospital. FY 2018 LTS grant underway in FY 2019. A retrospective data analysis of the effectiveness of lead hazard control abatement techniques that were used in the HOME Study (previously funded by HUD and the NIH). This

study looked at whether aggressive lead hazard control interventions, conducted in both urban and suburban households, can keep dust-lead levels sufficiently low to prevent children from developing elevated blood-lead levels. The study also provided information about the intensity of interventions needed to achieve dust-lead clearance levels that are lower than the current federal standard.

- (10) assess the effectiveness of hazard evaluation and reduction activities funded by this chapter.
    - The OLHCHH began designing its Assessment of HUD Lead Hazard Control Grant Program Evaluation and Control Procedures, which will be a current evaluation of the effectiveness of OLHCHH grantees in producing lead-safe housing, and repairing or eliminating lead-based paint hazards. It will build on the National Evaluation of the US Department of Housing and Urban Development Lead-Based Paint Hazard Control Grant Program that showed that it is feasible to include local governments in the design and data collection activities, making it possible to study many housing units across numerous jurisdictions,[81] and that, among other findings, blood lead levels in children under age 6 in housing treated under the program declined up to three-years post-intervention.[82] While the OLHCHH's current Lead Hazard Control Grant Programs reflect the findings of the National Evaluation (see the list of peer-reviewed papers[83]), in FY 2019, the Office deemed it timely to determine whether and if so, how the current program is as effective in hazard evaluation and reduction activities as it was at the time of the National Evaluation. The Office projects that, subject to information collection request approval by the Office of Management and Budget and other conditions, it will begin this assessment in late FY 2020 or early FY 2021.

§ 4854b. Authorization.

- This section authorized lead safety research appropriations for FY 1993 and 1994, and is no longer an active part of Title X.

§ 4855. Federal implementation and insurance study

This section required the Government Accountability Office to conduct two studies shortly after enactment of Title X. The three resulting reports are listed here; they were discussed in HUD's 1997 Title X annual report.

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[81] Galke W, Clark S, McLaine P, Bornschein R, Wilson J, Succop P, Roda S, Breysse J, Jacobs D, Grote J, Menrath W, Dixon S, Chen M, Buncher R. National Evaluation of the HUD Lead-Based Paint Hazard Control Grant Program: Study Methods, *Environmental Research* 98(3):315-328, 2005. http://doi.org/10.1016/j.envres.2004.12.011

[82] Clark S, Galke W, Succop P, Grote J, McLaine P, Wilson J, Dixon S, Menrath W, Roda S, Chen M, Bornschein R, Jacobs D. Effects of HUD-supported lead hazard control interventions in housing on children's blood lead Environmental Research 111 (2011) 301–311. https://doi.org/10.1016/j.envres.2010.11.003.

[83] *See* Peer reviewed published papers on the Evaluation of the Department of Housing and Urban Development Lead Based Paint Hazard Control Program. www.hud.gov/sites/dfiles/HH/documents/Papers_on_Evaluation_of_HUD_LBP_Hazard_Control_Program.pdf.

- **§ 4855(a) Federal implementation study**
  - Lead-Based Paint Poisoning: Children in Public Housing Are Not Adequately Protected[84]
    - GAO reviewed HUD's efforts to protect children in public housing from lead-based paint hazards.
  - Lead-Based Paint Poisoning: Children in Section 8 Tenant-Based Housing Are Not Adequately Protected[85]
    - GAO reviewed HUD's enforcement of and compliance with federal lead safety laws and regulations as they apply to section 8 tenant-based housing.
- **§ 4855(b) Insurance study**
  - Lead-Based Paint Hazards: Abatement Standards Are Needed to Ensure Availability of Insurance[86]
    - GAO reviewed: (1) property owners' risks due to the limited availability of insurance for lead hazards and the reasons insurance companies exclude this coverage; (2) contractors' experiences in obtaining liability insurance for their lead abatement activities; and (3) state and federal government efforts to increase the availability of liability insurance for lead-based paint hazards.

[84] GAO. Lead-Based Paint Poisoning: Children in Public Housing Are Not Adequately Protected. RCED-93-138. September 17, 1993. www.gao.gov/products/RCED-93-138.
[85] GAO. Lead-Based Paint Poisoning: Children in Section 8 Tenant-Based Housing Are Not Adequately Protected. RCED-94-137. May 13, 1994. www.gao.gov/products/RCED-94-137.
[86] GAO. Lead-Based Paint Hazards: Abatement Standards Are Needed to Ensure Availability of Insurance. RCED-94-231. July 15, 1994. https://www.gao.gov/products/RCED-94-231.

Title X, § 1061. Reports of Secretary of Housing and Urban Development[87]

(a) Annual report

The Secretary shall transmit to the Congress an annual report that—

…

(2) summarizes the most current health and environmental studies on childhood lead poisoning, including studies that analyze the relationship between interim control and abatement activities and the incidence of lead poisoning in resident children;

- **Summarizes the most current health and environmental studies on childhood lead poisoning**
  - The most current major health and environmental studies on childhood lead poisoning are the:
    - National Institute of Environmental Health Sciences' National Toxicology Program's NTP Monograph on Health Effects of Low-Level Lead;[88] and the
    - Environmental Protection Agency's most recent Integrated Science Assessment for Lead.[89]
  - In EPA rulemaking as recently as June 2019,[90,91] the Agency characterized those studies as "authoritative reviews," and HUD accepts that assessment.
  - The National Toxicology Program:
    - Within the Department of Health and Human Services' National Institute of Environmental Health Sciences is the Division of the National Toxicology Program. The Division's mission includes improving public health through data and knowledge development, particularly relating to environmental factors.[92] Much of the Division's work is in support of the National Toxicology Program, an interagency partnership of the Food and Drug Administration, National Institute for Occupational Safety and Health, and National Institute of Environmental Health Sciences. Among the Division's activities supporting the Program are developing literature-based assessments. In June 2012, the Division issued one of these, the NTP Monograph on Health Effects of Low-Level Lead.

[87] 42 U.S.C. 4856(a).
[88] National Toxicology Program. NTP Monograph on Health Effects of Low-Level Lead. ("NTP Monograph") June 13, 2012. https://ntp.niehs.nih.gov/ntp/ohat/lead/final/monographhealtheffectslowlevellead_newissn_508.pdf.
[89] EPA. Integrated Science Assessment for Lead. EPA/600/R-10/075F. May 2014 corrected reposting with errata sheet. https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=255721.
[90] EPA. Economic Analysis of the Final Rule to Revise the TSCA Dust-Lead Hazard Standards, e.g., p. 138. June 2019. www.regulations.gov/document?D=EPA-HQ-OPPT-2018-0166-0573.
[91] EPA. Technical Support Document for Residential Dust-Lead Hazard Standards Rulemaking, p. 15. June 2019. www.regulations.gov/document?D=EPA-HQ-OPPT-2018-0166-0574).
[92] NTP. National Toxicology Program (NTP) Division. www.niehs.nih.gov/research/atniehs/dntp/index.cfm.

- NTP Monograph:
    - The Division developed the NTP Monograph using its staff, and external technical advisors, and an external peer reviewer panel.[93]
    - As described in the NTP Monograph, its conclusions were derived by evaluating data from studies of the incidence and distribution of human physical and behavioral health, and from studies of lead exposures, with a focus on blood lead levels less than 10 micrograms of lead per deciliter (tenth of a liter) of blood (µg/dL). The evaluation reviewed the original research literature for evidence of whether low-level lead is associated with five effects: neurological, immunological, cardiovascular, renal, and/or reproductive and developmental. These health effect areas were selected because a relatively large database of human studies was available in each area. The Division considered four possible conclusions for specific health effects within each area:
        - Sufficient Evidence of an Association: An association is observed between the exposure and health outcome in studies in which chance, bias, and confounding could be ruled out with reasonable confidence.
        - Limited Evidence of an Association: An association is observed between the exposure and health outcome in studies in which chance, bias, and confounding could not be ruled out with reasonable confidence.
        - Inadequate Evidence of an Association: The available studies are insufficient in quality, consistency, or statistical power to permit a conclusion regarding the presence or absence of an association between exposure and health outcome, or no data in humans are available.
        - Evidence of No Association: Several adequate studies covering the full range of levels of exposure that humans are known to encounter (in this case limited to blood Pb levels less than 10 µg/dL) are mutually consistent in not showing an association between exposure to the agent and any studied endpoint. [94]
    - In the five potential effects studied (neurological, immunological, cardiovascular, renal, and/or reproductive and developmental), the evidence was found to be sufficient that low-level lead is associated with two effects, namely, neurological, and reproductive and developmental; the evidence was found to be limited for the immunological effect, and inadequate to demonstrate cardiovascular or renal effect associations. In sum, in the five potential effects studied, sufficient or limited, or inadequate evidence of an association was found, while in none

[93] NTP. NTP Monograph. *Op cit.* pages ix – x.
[94] *Ibid.* Section 1.2.2, Approach to Develop Health Effects Conclusions, pp. xv – xvi.

of the potential effects was affirmative evidence found of there not being an association.

- The Division concluded that there is sufficient evidence of adverse health effects in children and adults at blood lead levels below 10, and below 5 µg/dL.[95] A major strength of the evidence supporting effects of low-level lead comes from the consistency demonstrated by adverse effects associated with blood lead below 10 µg/dL across a wide range of health outcomes, across major physiological systems from reproductive to renal, among multiple groups, from studies using substantially different methods and techniques, and for health effects in both children and adults.[96]
  - In children, there is sufficient evidence that blood lead levels below 5 µg/dL are associated with increased diagnosis of attention-related behavioral problems, greater incidence of problem behaviors, and decreased cognitive performance as indicated by (1) lower academic achievement, (2) decreased intelligence quotient, and (3) reductions in specific cognitive measures. There is also limited evidence that blood lead below 5 µg/dL is associated with delayed puberty and decreased kidney function in children at least 12 years of age.
  - There is sufficient evidence that blood lead levels below 10 µg/dL in children are associated with delayed puberty and reduced postnatal growth.
  - There is limited evidence that blood lead levels below 10 µg/dL are associated with elevated serum immunoglobulin E, which is a principal mediator of hypersensitivity; consistent with this effect, there is limited evidence that blood lead levels less than 10 µg/dL are associated with changes to an immunoglobulin E-related health effect, allergy diagnosed by skin prick test to common allergens.
  - There is inadequate evidence of an association between blood lead below 10 µg/dL in children and other allergic diseases, such as eczema or asthma.
  - There is also inadequate evidence of an association between blood lead below 10 µg/dL and cardiovascular effects in children of any age, or renal function in children less than 12 years of age.

- Environmental Protection Agency
  - The Office of Research and Development is EPA's research arm. Its research informs Agency decisions and supports the emerging needs of EPA stakeholders, including the Agency's state, tribal, and community partners.

[95] *Ibid.* Table 1.1: NTP conclusions on health effects of low-level lead by life stage, pp. xix – xx.
[96] *Ibid.* Section 1.4, Health Effects Evidence, section 1.4.1, NTP Conclusions. p. xviii; the following paragraph is reformatted here for visibility into five bullets, corresponding to the five health effects reviewed, and abbreviations other than for blood lead concentrations are spelled out here for convenience.)

- Under the Clean Air Act as amended,[97] EPA has set National Ambient Air Quality Standards[98] for six principal criteria air pollutants, lead among them,[99] and reviews and revises the criteria and standards, as appropriate. Since 2008, EPA's Integrated Science Assessments have formed the scientific foundation for the Agency's review of the standards by providing the primary (human health-based) and secondary (welfare-based, e.g. ecology, visibility, materials) science assessments. The assessments, conducted as part of the Agency's general process for reviewing the standards,[100] are a comprehensive review, synthesis, and evaluation of the most policy-relevant science, including key science judgments that are important to inform the development of the risk and exposure assessments, as well as other aspects of the review of the standards.[101]
- EPA Integrated Science Assessment for Lead.
    - Health Effects of Lead.[102] The major conclusions regarding health effects from lead exposure in children and adults are presented in Table ES-1[103] of the assessment and summarized as follows.
    - Effects of Lead Exposure in Children[104]
      Multiple studies on the incidence and distribution of health conditions conducted in diverse populations of children consistently demonstrate the harmful effects of lead exposure on cognitive function (as measured by intelligence quotient decrements, decreased academic performance and poorer performance on tests of executive function). Blood lead-associated effects on cognitive function were found in populations of children (ages 4-10) with mean or group blood lead levels measured concurrently or earlier in the range of 2-8 µg/dL[105]. Evidence suggests that some lead-related cognitive effects may be irreversible and that the neurodevelopmental effects of lead exposure may persist into adulthood.[106] Epidemiologic studies also demonstrate that lead exposure is associated with decreased attention, and increased impulsivity and hyperactivity in children (externalizing behaviors). This is supported by findings in animal studies demonstrating both

[97] July 14, 1955, ch. 360, 69 Stat. 322 (42 U.S.C. § 7401 et seq.)
[98] 42 U.S.C. §§ 7409 and 7409.
[99] 40 CFR §§ 50.12 and 50.16.
[100] EPA. Process of Reviewing the National Ambient Air Quality Standards. www.epa.gov/criteria-air-pollutants/process-reviewing-national-ambient-air-quality-standards.
[101] EPA. www.epa.gov/criteria-air-pollutants/process-reviewing-national-ambient-air-quality-standards. The process is further detailed in the Integrated Science Assessment for Lead's Preamble section on Process of ISA Development, pp. xliv – l.
[102] EPA. Integrated Science Assessment. *Op. cit.* Executive Summary. p. lxxxii.
[103] *Ibid.* Executive Summary. Table ES-1 Summary of causal determinations for the relationship between exposure to Pb and health effects. p. lxxxiii – lxxxvii.
[104] *Ibid.* Executive Summary, pp. lxxxvii-lxxxviii.
[105] Fn. 1 on ISA p. lxxxvii: "The age range and blood Pb levels are based on studies described in detail in Section 4.3.2" (Cognitive Function, pp. 4-59 – 4-150).
[106] *Ibid.* Section 1.9.4. Pb Exposure and Neurodevelopmental Deficits in Children, pp. 1-75 – 1-76.

analogous effects and biological plausibility at relevant exposure levels. Lead exposure can also exert harmful effects on blood cells and blood producing organs, and is likely to cause an increased risk of symptoms of depression and anxiety and withdrawn behavior (internalizing behaviors), decreases in auditory and motor function, asthma and allergy, as well as conduct disorders in children and young adults. There is some uncertainty about the lead exposures contributing to the effects and blood lead levels observed in studies on the incidence and distribution of health conditions; however, these uncertainties are greater in studies of older children and adults than in studies of young children.[107] Despite these uncertainties, it is clear that lead exposure in childhood presents a risk; further, there is no evidence of a threshold below which there are no harmful effects on cognition from lead exposure.

- For infants exposed in utero, the assessment found evidence suggestive of a causal relationship between lead exposure and adverse birth outcomes.[108] Similarly, the National Toxicology Program Monograph stated that there is sufficient evidence that maternal blood lead levels below 5 µg/dL are linked to reduced fetal growth, and limited evidence that maternal blood lead levels below 10 µg/dL are associated with increased pre-term births and increased spontaneous abortion.[109]
- Both EPA's Integrated Science Assessment for Lead and subsequent research support a causal relationship between lead exposure and cognitive function decrements as measured by intelligence quotient testing in children up to age 10. Within EPA's economic analysis for its 2019 dust lead hazard standards rulemaking, the Agency discussed this relationship in its review of the literature on the relationship between lead exposure and changes in intelligence quotient testing results.[110]
- In the context of lead exposure, conceptual frameworks have long been used to describe the relationships between intelligence quotient testing results, education, labor participation, and earnings.[111,112]
- However, it is important to note that some studies have found that non-cognitive personality traits (and measures strongly affected by them, such as school achievement test scores and grades), are at least as predictive of life outcomes as intelligence quotient testing

[107] *Ibid.* Section 1.9.5. Reversibility and Persistence of Neurotoxic Effects of Pb, pp. 1-76 – 1-78.
[108] *Ibid.* Section 4.8, Reproductive and Developmental Effects, esp. sections 4.8.1, Effects on Development, and 4.8.2, Effects on Birth Outcomes, pp. 4-589 – 4-655.
[109] NTP Monograph. *Op. cit.* Section 1.4.6 Reproduction and Developmental Effects, pp. xxiii – xxiv.
[110] EPA. Economic Analysis. *Op cit.* Section 5.4.1, Literature Review. Pp. 5-25 – 5-32.
[111] Salkever DS. Updated estimates of earnings benefits from reduced exposure of children to environmental lead. Environmental Research 70(1):1-6. 1995. https://doi.org/10.1006/enrs.1995.1038.
[112] Schwartz J. Societal benefits of reducing lead exposure, Environmental Research 66(1):105-24 (July 1994), https://doi.org/10.1006/enrs.1994.1048.

results;[113,114, and (in 2016) 115] and, as an environmental justice concern, there is also potential for racial or gender bias in cognitive testing.[116]
    - Of particular concern regarding a neurotoxin like lead is that it affects both cognitive and non-cognitive traits, including attention-related behaviors, per the NTP Monograph and the Integrated Science Assessment, which can affect performance on intelligence quotient examinations.
    - Thus, intelligence quotient testing results should be seen as one of many variables for predicting important life outcomes, and its importance not overstated.

- **summarizes …Summarizes … studies that analyze the relationship between interim control and abatement activities ….**

    - HUD's National Evaluation data yielded two studies comparing the effects of abatement and interim controls on dust-lead loading (amount of lead per area of surface, such as, as used by EPA in its dust lead hazard standards and clearance levels, micrograms of lead per square foot of surface) after lead hazard control work in the older housing treated under the first two rounds of the Department's lead hazard control grants.
        - Dixon, Wilson, et al.[117] looked at dust-lead loadings on floors and window sills at 12 months and 36 months after a range of lead hazard control work, including abatement and interim lead hazard controls of lead-based paint hazards.
            - This study examined dust lead levels on floors and window sills after using one of six standardized lead hazard control methods in homes treated under the lead hazard control grant program: "strategy 2,"[118] low-intensity professional cleaning, 3, paint stabilization, 4, window treatments including some component replacement and some stripping or capping of

[113] Heckman JJ and Kautz T. Hard evidence on soft skills. Labour Economics. 2012 Aug 1; 19(4):451–464. https://doi.org.10.1016/j.labeco.2012.05.014.
[114] Borghans, L, Golsteyn BH, Heckman JJ, Humphries JE. What grades and achievement tests measure. Proceedings of the National Academy of Sciences 113(47):13354-13359. November 2016. https://doi.org/10.1073/pnas.1601135113.
[115] Lin D, Lutter R, Ruhm, CJ. Cognitive Performance and Labor Market Outcomes. Labour Economics 51:121-135. July 2016. http://hdl.handle.net/10419/145209.
[116] Walton GM and Spencer SJ. Latent ability: Grades and test scores systematically underestimate the intellectual ability of negatively stereotyped students. Psychological Science 20(9):1132-1139. September 2009. https://doi.org/10.1111/j.1467-9280.2009.02417.
[117] Dixon SL, Wilson JW, Scott SC, Galke WA, Succop PA, Chen M. Effectiveness of lead-hazard control interventions on dust lead loadings: findings from the evaluation of the HUD Lead-Based Paint Hazard Control Grant Program. Environmental Research 98(3):303-314. 2005. http://doi.org/10.1016/j.envres.2005.02.002.
[118] Strategy 1, no action, was specified for statistical analysis purposes, but not used under these lead hazard control grants, for which some action was undertaken in each housing unit because enrollment in the Lead Hazard Control Grant Program required that one or more lead-based paint hazards be identified and then controlled.

components (sills and/or troughs), 5, stabilization of deteriorated lead-based paint, 6, lead-based paint abatement by enclosure, encapsulation, or removal, or 7, full lead removal.
    - Floor and sill lead-dust levels for full lead removal (strategy 7) were reduced from 16 μg/ft^2 before treatment to 5 μg/ft^2 on floors and from 182 to 88 μg/ft^2 on sills; for window abatement plus other treatments (strategy 4), the reductions were from 27 to 8 μg/ft^2 on floors and from 570 to 124 μg/ft^2 on sills).
    - Full abatement (strategy 6) reduced windowsill and floor loadings from baseline to 12 months post-intervention from 95 to 6 μg/ft^2 on floors and from 518 to 30 μg/ft^2 on sills (data were not available for this strategy at 36 months).
    - Window lead-hazard abatement was the most effective measure to reduce dust lead loadings on windows, but this treatment would need to be performed in conjunction with treatments to floors as well as exterior and soil treatments for the most effective control of dust lead on floors.
- Dixon, Jacobs, et al.[119] looked at dust-lead loadings on floors and window sills at 12 years after treating housing units, comparing those in which all windows were either replaced (abatement) or some windows were replaced, other windows having been repaired using interim lead hazard controls.
    - Homes treated under the lead hazard control grant program with all windows having been replaced had 41% lower floor dust lead 12 years after the lead hazard control work, than did homes with no windows replaced (1.4 vs. 2.4 μg/ft^2), with window sill dust lead being 51% lower (25 versus 52 μg/ft^2) in homes in which all windows were replaced.
    - Homes that had some windows replaced (but not all) had interior floor and window sill dust lead loadings that were 28% (1.7 versus 2.4 μg/ft^2) and 37% (33 versus 52 μg/ft^2) lower, respectively, 12 years after the lead hazard control work, than homes that had no windows replaced.
- With window replacement abatement costing more than interim control of lead-based paint hazards at windows, there is the programmatic trade-off within a finite funding amount for the lead hazard control grant program of the abatement being more effective in homes in which it occurs, being balanced against the smaller number of homes that would have such abatement and the consequently larger number of homes that would not be treated at all and whose lead-based paint hazards would remain.

- **Summarizes … studies that analyze … the incidence of lead poisoning in resident children.**
    - Another study based on the National Evaluation studied the effectiveness of the housing intervention performed in reducing the blood lead of children at four post-intervention times (6 months, 1 year, 2 years, and 3 years). The children's

[119] Dixon SL, Jacobs DE, Wilson JW, Akoto JY, Nevin R, Clark CS, Window replacement and residential lead paint hazard control 12 years later, Environmental Research 113 (2012) 14–20. http://doi.org/10.1016/j.envres.2012.01.005.

blood lead levels declined up to three-years after completion of the lead hazard control work in a housing unit.

- The results at each successive collection time were significantly lower than at the previous post-intervention time except for the difference between the levels at two and three years, for which they were statistically the same.
- At 2 years post-intervention, geometric mean blood lead levels[120] were approximately 37% lower than at pre-intervention levels. Children with pre-intervention blood lead levels as low as 10 μg/dL experienced substantial declines in blood lead levels. Previous studies had found substantial improvements only if a child's pre-intervention blood lead level was above 20 μg/dL.
- Individual interior lead hazard control treatments as grouped by interior lead hazard control strategy (discussed above) were not a significant predictor of post-intervention blood lead levels, indicating that they were all effective in lowering children's blood lead levels.
- However, children living in dwellings where exterior lead hazard control interventions were done on paint that had very high lead loadings (at least 7.0 mg/cm^2, found in only a tenth of the units treated) had lower blood lead levels at one-year post-intervention than those living in dwellings without the exterior interventions (all other factors being equal).

- Regarding the incidence of elevated blood lead levels in children under age 6 (for whom the term is defined, in accordance with Title X) living in HUD-assisted housing (rather than the HUD lead hazard control grant-treated housing discussed above):
  - Based on the size of the HUD-assisted housing stock and research results described below, an expected 12,009 children under age 6 would have elevated blood lead levels in that housing if it had the same frequency of lead-based paint hazards as does the national housing stock.
  - However, based on the findings of the American Healthy Homes Survey that government-supported housing is less likely to have lead-based paint hazards than unassisted housing,[121] the number of HUD-assisted housing units with a child under age 6 with an elevated blood lead level is estimated to be 6,745, i.e., 56% as many.
  - The calculations used to derive the incidence of elevated blood lead levels in children under age 6 in HUD-assisted housing are found in Appendix 5.

[120] While an arithmetic mean of n numbers is the sum of those numbers divided by n, the geometric mean of those numbers is calculated by finding their product, and taking the n^{th} root of it (e.g., the arithmetic mean of 2 and 4 is $(2 + 4) /2 = 3$, and their geometric mean is $(2 * 4)^{1/2} = 8^{1/2} = \sqrt{8} = 2.828$). While the arithmetic mean is useful for a set of numbers that are distributed with about as many below the average as above it, the geometric mean is useful for a set of positive numbers in which most values are below the average but with some well above the average; this is typical of blood lead levels.

[121] Cox D, Dewalt FG. Prevalence of Lead-Based Paint Hazards. *Op. cit.*

Title X, § 1061. Reports of Secretary of Housing and Urban Development[122]

(a) Annual report

The Secretary shall transmit to the Congress an annual report that—

…

(3) recommends legislative and administrative initiatives that may improve the performance by the Department of Housing and Urban Development in combating lead hazards through the expansion of lead hazard evaluation and reduction activities;

- HUD is proposing the following legislative initiatives:
  - Increasing the threshold for requiring lead abatement under the Lead Safe Housing section 1012(a)(1)(E) of Title X[123] to reflect inflation since the 1992 enactment of that statute, and tying the threshold in future years to inflation.
    - The lead abatement threshold is met when federal rehabilitation assistance (excluding lead hazard control work) is greater than the fixed amount of $25,000 per housing unit. Inflation since the 1992 enactment of Title X (when the dollar threshold was established) means that a rehabilitation project of $13,800 at the time of enactment would now cost over $25,000.[124]
    - As a result, the abatement of units is required for projects with much less real-dollar rehabilitation assistance than Congress intended. This can induce local funding agencies to avoid rehabilitating many of the housing units they would have improved in previous years, leaving them to continue exposing young children to avoidable health risk.
    - To restore the real-dollar meaning of the abatement threshold, adjusting the threshold for inflation is necessary. The proposed statutory amendment would authorize the Secretary to, annually, use a publicly available inflation index to determine the abatement threshold.
  - Authorizing HUD to issue a subpoena for enforcement of the Lead Disclosure section of Title X.[125]
    - Under current law, HUD and the Environmental Protection Agency (EPA) have joint authority for enforcing compliance with the Lead-Based Paint Disclosure Statute ("Disclosure Statute") in (almost all) pre-1978 housing being sold or leased. However, while EPA has the authority to issue subpoenas for enforcing under a separate statute,[126] HUD does not have Disclosure Statute subpoena authority under Section 1018 nor elsewhere in or outside of Title X.
    - Currently, in cases where HUD is the primary or sole investigator, HUD must rely solely on EPA's availability and agreement to issue a

[122] 42 U.S.C. 4856(a).
[123] 42 U.S.C. § 4822(a)(1)(E).
[124] U.S. Bureau of Labor Statistics. CPI Inflation Calculator. www.bls.gov/data/inflation_calculator.htm.
[125] 42 U.S.C. § 4852d.
[126] 15 U.S.C. § 2610(c), Subpoenas, enacted under the Toxic Substances Control Act (Pub. L. 94–469, §11, Inspections and Subpoenas).

subpoena. However, EPA lacks the staffing resources to accommodate HUD's requests for adding to its enforcement workload.

- This section will provide HUD with the subpoena authority. Even after enactment, HUD will continue to request initially that a residential property owner and/or manager provide documents or permit entry to HUD staff in order to view and copy the documents, on a voluntary basis. HUD will use the subpoena authority provided by this section only when the owner and/or manager does not provide the documents. This section will not affect EPA's ability to exercise its existing authorities under the Toxic Substances Control Act nor the Lead Disclosure section of Title X.

- HUD is proposing the following administrative initiatives:
  - To address inadequate assessment and reporting of lead-based paint hazards and lead safety program deficiencies by program offices, which exposes HUD to ongoing programmatic liability for elevated blood lead levels in residents:
    - Request and justify additional travel and staff resources to allow for the level of monitoring and technical assistance needed to protect and promote effective use of funds towards lead safe homes in compliance with appropriations.
  - To address the technical, programmatic, and financial complexity of having six types of lead safety examination methods (lead-based paint inspection, risk assessment, lead hazard screen, clearance examination, re-evaluation, and visual assessment for deteriorated paint):
    - Research the feasibility of developing a smaller set of examination methods that perform at least as well as the current set. If successful, propose regulatory and, if needed, statutory changes to allow implementing the streamlined set.
  - To address the complexity of multiple deadlines for identifying and responding to lead-based paint hazards in housing and elevated worker lead exposures during a health-related national emergency:
    - Convene a panel of the regulatory and technical agencies involved, i.e., HUD, EPA, CDC, and Occupational Safety and Health Administration, and partner agencies, to identify proposed harmonized approaches, evaluate them, and if any appear promising, consult with the Office of Management and Budget on the most efficient way of implementing the approach.
  - To reduce a significant procedural barrier to enrolling poor families in assisted housing when the families and/or the housing are covered by more than one form of federal assistance, get the families into such assisted housing more quickly, and lower the operating costs of assisted housing for the housing owners and the assisting agencies:
    - Implement income eligibility harmonization across HUD assistance and grant programs, and with other departments that provide housing assistance or its equivalents, e.g., the Departments of Energy, Agriculture, and Veterans Affairs.

- Note that the OLHCHH already allows its lead hazard control grant programs to recognize Public and Indian Housing's housing choice voucher income eligibility determinations and eliminate a replicate determination for lead hazard control grant program enrollment.[127]

[127] Office of Lead Hazard Control and Healthy Homes. Income Verification Guidance. Policy Guidance 2017-05. December 13, 2017. www.hud.gov/sites/dfiles/HH/documents/PG%202017_05%20Income%20Verification%20Guidance%20Revision%20Finalrv.pdf.

Title X, § 1061. Reports of Secretary of Housing and Urban Development[128]

(a) Annual report

The Secretary shall transmit to the Congress an annual report that—

…

(4) describes the results of research carried out in accordance with subchapter III of this chapter;

- See Appendix 2 for a summary of results of lead research carried out under Title X[129] that has been published in the peer-reviewed literature. The 64 papers are categorized as:
  - I. Sampling and Analysis of Lead in Paint and Dust
  - II. Sources of Lead
  - III. Abatement and Interim Controls
  - IV. Lead Cleaning and Clearance Sampling
  - V. Effects of Interventions on Children's Blood Lead Levels
- Many of these research results have been used in revising the HUD Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing ("Guidelines"), in developing the Lead Safe Housing Rule and its elevated blood lead level amendment, and developing policy guidance for the OLHCHH's lead hazard control grant programs.

[128] 42 U.S.C. 4856(a).
[129] 42 U.S.C. 4854 – 4854a.

Title X, § 1061. Reports of Secretary of Housing and Urban Development[130]

(a) Annual report

The Secretary shall transmit to the Congress an annual report that—

…

(5) estimates the amount of Federal assistance annually expended on lead hazard evaluation and reduction activities.

- The amount of Federal assistance annually expended on lead hazard evaluation and reduction activities can be categorized as incremental costs under the Lead Safe Housing Rule for rehabilitation or other projects associated with the rule that would not have been incurred if the paint in the housing was not lead-based paint, and costs for lead hazard reduction under that grant program of the OLHCHH.
- For the OLHCHH's Lead-Based Paint Hazard Reduction grants:
  - The work performed by these grants involves conducting construction activities just for the sake of lead hazard control, in contrast to the housing assistance programs, which conduct lead hazard control work in conjunction with rehabilitation or maintenance activities that would be conducted even without lead-based paint being present. Accordingly, there is a range of activities attributable to the lead hazard control grants that are not so attributable to lead hazard control for housing assistance programs; these include outreach, housing owner recruitment, housing unit enrollment, and similar costs. In addition, the housing treated under the lead hazard control grants is older than the assisted housing stock and in poorer condition, so more lead hazard control work is needed, on average, than is needed for the assisted housing covered by the Lead Safe Housing Rule.
  - The OLHCHH's Healthy Homes Grants Management System[131] reported that $88.14 million was disbursed to lead hazard control grantees in FY 2019. For the 4,489 units made lead safe in FY 2019, the average unit cost was $19,600.
- For the Community Planning and Development programs listed in the discussion of § 4822, above:
  - The numbers of housing units which had abatement conducted and had interim controls or standard practices conducted are multiplied by the respective unit costs of the risk assessment and the interim controls (per the regulatory impact assessment for the elevated blood lead level amendment to the Lead Safe Housing Rule,[132] increased by inflation since the January 2017 date of the amendment[133]), and the same costs plus the cost of incremental interior abatement per the regulatory impact assessment for the original Lead Safe

[130] 42 U.S.C. 4856(a).
[131] Office of Business Transformation. Optimizing the Healthy Homes Grants Management System. 2019. www.hud.gov/sites/dfiles/SPM/documents/Optimizing_The_Healthy_Homes_Grants_Management_System.pdf.
[132] Office of Lead Hazard Control and Healthy Homes. Economic Analysis of the Final Rule on Lead-Based Paint: Requirements for Notification, Evaluation and Reduction of Lead-Based Paint Hazards in Federally Owned Residential Property and Housing Receiving Federal Assistance; Response to Elevated Blood Lead Levels. January 3, 2017. www.hud.gov/sites/documents/LSHR_EBL_Amendment_RIA17.pdf.
[133] U.S. Bureau of Labor Statistics. CPI Inflation Calculator. *Op. cit*.

Housing Rule,[134] increased by inflation since the September 1999 date of the rule.
    - For the 5,791 housing units that had interim controls or standard practices conducted, the inflation-adjusted unit cost of $1,562 yields an expenditure of $9.04 million; for the 2,805 units that had abatement conducted, the inflation-adjusted unit cost of $2,237 yields an expenditure of $6.27 million, for a (rounded) total of $15.32 million.
- Thus, the total lead hazard control expenditure by the Offices above in FY 2019 was approximately $84.5 million.
- For the Office of Public and Indian Housing, the project tracking system, the Public and Inventory Management / Indian Housing Information Center[135] does not track lead hazard control activities in housing assisted by that Office, so its expenditures for such activities are not tracked.
- For the Office of Multifamily Housing, the project tracking system, Integrated Real Estate Management System [136] does not track lead hazard control activities in housing assisted by that Office, so its expenditures for such activities are not tracked.

[134] Office of Lead Hazard Control and Healthy Homes. Economic Analysis of the Final Rule on Lead-Based Paint: Requirements for Notification, Evaluation and Reduction of Lead-Based Paint Hazards in Federally-Owned Residential Property and Housing Receiving Federal Assistance. September 7, 1999. www.hud.gov/sites/documents/DOC_25478.pdf.
[135] Office of Public and Indian Housing. Inventory Management (IMS) /Public Housing Information Center (PIC). www.hud.gov/program_offices/public_indian_housing/systems/pic.
[136] Office of Manufactured Housing. Integrated Real Estate Management System (iREMS). www.hud.gov/program_offices/housing/mfh/rems/rems.

Appendix 1: Lead Disclosure Rule and Lead Safe Housing Rule Overview

Subpart of rule in title 24 CFR / Type Program		Year Built	Owner/Landlord Requirements[1, 2, 3]	Participant Monitoring Requirements	HUD Program Monitoring Requirements[4]
A	**Lead Disclosure Rule**	Pre-1978	Disclose knowledge, records, reports about LBP and LBP hazards to potential buyers or lessees. Provide lead warning statement Allow buyer to conduct evaluation.	Have system in place that documents that participants ensure owner / landlord complies with Lead Disclosure Rule.	OHHLHC and EPA are responsible to ensure compliance with Lead Disclosure Rule.
B	**General Requirements and Definitions**	Pre-1978	Definitions. Exemptions.[5] Notice of acceptable evaluation and hazard reduction activities. Pamphlet.		
C	**Disposition by Federal Agency Other Than HUD**	Pre-1960	LBP inspection and risk assessment. Abatement of LBP hazards. Notice to occupants.	Agency, or its agent, must document compliance with the Lead Safe Housing Rule unless waived due to insufficient resources.	OHHLHC is responsible to ensure compliance with Lead Safe Housing Rule and Lead Disclosure Rule.
		1960-1977	LBP inspection and risk assessment. Notice to occupants of results.		
D	**Project-Based Assistance by Federal Agency Other Than HUD**	Pre-1978	Provision of pamphlet. Risk assessment. Interim controls. Notice to occupants. Response to child < 6 years with elevated blood lead level (EBLL).[6]	Have system in place that documents that participants ensure owner / landlord complies with Lead Safe Housing Rule and Lead Disclosure Rule.	OHHLHC is responsible to ensure compliance with Lead Safe Housing Rule and Lead Disclosure Rule.
F	**HUD-Owned Single Family Sold With a HUD-Insured Mortgage**	Pre-1978	Visual assessment. Paint stabilization. Notice to occupants of clearance.		HUD, or its agent, must document compliance with the Lead Safe Housing Rule and Lead Disclosure Rule.

Lead Disclosure Rule and Lead Safe Housing Rule Overview

G	**Multifamily Mortgage Insurance:**				
	1. For properties that are currently residential	Pre-1960	Provision of pamphlet. Risk assessment. Interim controls. Notice to occupants. Ongoing LBP maintenance.	Have system in place that documents that participants ensure owner / landlord complies with Lead Safe Housing Rule and Lead Disclosure Rule.	Program must ensure Participant can document proper performance under agreement with respect to Lead Safe Housing Rule and Lead Disclosure Rule.
		1960-1977	Provision of pamphlet. Ongoing LBP maintenance.		
	2. For conversions and major renovations.	Pre-1978	Provision of pamphlet. LBP inspection. Abatement of LBP. Notice to occupants.		
H	**HUD Project-Based Assistance:**				
	For all Multifamily properties		Provision of pamphlet. Notice to occupants. Ongoing LBP maintenance. Response to child < 6 years with EBLL.[6]	If no bilateral agreement with owner / landlord, have system in place that documents that participants or subrecipients ensure owner / landlord complies with Lead Safe Housing Rule and Lead Disclosure Rule.	Program must ensure Participant can document proper performance under agreement with respect to Lead Safe Housing Rule and Lead Disclosure Rule.
	1. Property receiving more than $5,000 per unit per year	Pre-1978	Risk assessment. Interim controls.		
	2. Property receiving less than or equal to $5,000 per unit per year, and single family properties	Pre-1978	Visual assessment. Paint stabilization. Reevaluation every two years		
I	**HUD-Owned Multifamily Property**	Pre-1978	Provision of pamphlet. LBP inspection and risk assessment. Interim controls. Notice to occupants. Ongoing LBP maintenance and reevaluation. Response to child < 6 years with EBLL.[6]		HUD, or its agent, must document compliance with the Lead Safe Housing Rule and Lead Disclosure Rule.

Lead Disclosure Rule and Lead Safe Housing Rule Overview

J	**Rehabilitation Assistance:**				
	For all Properties		Provision of pamphlet. Paint testing of surfaces to be disturbed, or presume LBP. Notice to occupants. Ongoing LBP maintenance if HOME.	Have system in place that documents that participants or the subrecipients ensure owner / landlord complies with Lead Safe Housing Rule and Lead Disclosure Rule.	Program must ensure Participant can document proper performance under agreement with respect to Lead Safe Housing Rule and Lead Disclosure Rule.
	1. Property receiving less than or equal to $5,000 per unit	Pre-1978	Safe work practices in rehab. Repair disturbed paint. Clearance of the worksite.		
	2. Property receiving over $5,000 and up to $25,000 per unit	Pre-1978	Risk assessment. Interim controls.		
	3. Property receiving more than $25,000 per unit	Pre-1978	Risk assessment. Abatement of LBP hazards.		
K	**Acquisition, Leasing, Support Services, or Operation**	Pre-1978	Provision of pamphlet. Visual assessment. Paint stabilization. Notice to occupants. Ongoing LBP maintenance.	Have system in place that documents that participants ensure owner / landlord complies with Lead Safe Housing Rule and Lead Disclosure Rule.	Program must ensure Participant can document proper performance under agreement with respect to Lead Safe Housing Rule and Lead Disclosure Rule.
L	**Public Housing**	Pre-1978	Provision of pamphlet. LBP inspection. Risk assessment if LBP not yet abated. Interim controls if LBP not yet abated. Abatement of LBP. Notice to occupants. Ongoing LBP maintenance and evaluation. Response to child < 6 years with EBLL.[6]	Have system in place that documents that participants ensure owner / landlord complies with Lead Safe Housing Rule and Lead Disclosure Rule.	Program must ensure Participant can document proper performance under agreement with respect to Lead Safe Housing Rule and Lead Disclosure Rule.
M	**Tenant-Based Rental Assistance for units to be occupied by children under 6 years of age**	Pre-1978	Provision of pamphlet. Visual assessment. Paint stabilization. Notice to occupants. Ongoing LBP maintenance. Response to child < 6 years with EBLL.[6]	Have system in place that documents that participants ensure owner / landlord complies with Lead Safe Housing Rule and Lead Disclosure Rule.	Program must ensure Participant can document proper performance under agreement with respect to Lead Safe Housing Rule and Lead Disclosure Rule.

Footnotes to Appendix 1:

1. Lead safe work practices, occupant protection, and clearance are always required after abatement, interim controls, paint stabilization, or standard treatments, except when the amount of deteriorated paint is at or below the de minimis amounts specified in Subpart R of the rule – see 24 CFR 35.1350(d)) for threshold amounts.
2. Notice to occupants must include results of evaluations (paint testing, inspection, and risk assessment) and clearance, where applicable.
3. Training requirements (see www.hud.gov/program_offices/healthy_homes/enforcement/regulations for program information; see www.epa.gov/lead about certification for individuals and firms:
   Evaluation:
   Visual assessment: Web-based HUD visual assessment course or risk assessment certification.
   Inspection: Lead-based paint (LBP) inspection certification.
   Risk assessment, or re-evaluation: Risk assessment certification.
   Clearance: LBP inspection or risk assessment certification, or sampling technician course.
   Hazard Control (other than small ("de minimis") amounts of paint disturbance – see 24 CFR 35.1350(d)) for threshold amounts:
   Repair of paint, paint stabilization, or interim control: Renovation, repair, and painting "renovator" certification for supervisor and workers.
   Abatement: Abatement certification for workers and supervisors.
4. Field Office monitoring areas of interest: Covered program responsibility, partnerships, information management (monitoring, data processing, tracking), reporting and responding, and resources.
5. See 24 CFR 35.115 for exemptions.
6. Elevated Blood Lead Level: At least 5 micrograms of lead per deciliter (μg/dL) in a child under 6 years old residing in the housing unit (as of the date of this report).

Appendix 2: Summary of Results of Lead Research Carried Out under Title X

Focus Area	Year Published	Title	Results	Reference
I. Sampling and Analysis of Lead in Paint and Dust				
Spot Test Kits	2019	Enhancing the Performance of Spot Test Kits for Lead Based Paint Using Solid-Phase Dilution	Spot test kits based on the reaction with sodium sulfide using the solid dilution technique can be used for detection of LBP, comparably to the criteria applied to XRF instruments when developing Performance Characteristic Sheets. The same technology applied to the reaction with rhodizonate can potentially be applied for on-site clearance testing of dust wipe samples.	Dewalt FG, Cox D, Final Report on OLHCHH grant MDLTS0003-14. June 2019. Paper in preparation.
Comparison of XRF and FAAS for Lead in Dust Wipes	2012	Statistical Comparison of Analysis Results for Lead on Dust Wipe Samples by X-ray Fluorescence Analysis and Flame Atomic Absorption Spectrometry	The correlations between FAAS and XRF measurements exceeded 0.80 ($p<0.0001$). The XRF method could be used to quantify dust lead loadings in compliance with EPA dust lead hazard standards. Significant differences were found between floor or sill and quality control sample types. The use of 95% prediction intervals could allow for rapid screening of clearance samples in the field. Additional work is needed for differences among XRF instruments.	Rogers J, Viet S, Roda S, Fraser A, Friedman W, Zhou J, Jacobs D. *Journal of ASTM International,* Vol. 9, No. 6 (2012)
Lead in composite Dust Wipes	2011	Development of Two Sample Preparation Methods for Determination of Lead in Composite Dust Wipe Samples.	Both methods are capable of meeting NLLAP LQSR requirements for MDLs, MQLs, and recovery for four-wipe composites. The sonication method proved superior in all areas, with lower individual laboratory MDLs and superior accuracy and precision compared to the hot-plate method.	White KT, Dewalt FG, Cox DC, Schmehl R, Friedman W, Pinzer EA. (2011). Development of two sample preparation methods for determination of lead in composite dust wipe samples. *Journal of ASTM International*, 8, 3.)
Evaluation of XRF Analyzer Performance	2011	Pilot Evaluation for Lead-Based Paint Proficiency Testing of Field Portable XRF Instruments	All XRF instruments tested in this pilot performed within two standard deviations from the mean of like brands evaluated in the baseline study. Therefore, the XRF instruments in the pilot have performed no differently than those previously evaluated.	White KT, Dewalt FG, Cox DC, Schmehl R, Friedman W, Pinzer, EA. (2011). Pilot evaluation for lead-based paint proficiency testing of field portable XRF instruments. *Journal of ASTM International* 8, 3.
Spot Test Kits	2011	Improving the Performance of Existing Spot Test Kits for Accurate Assessments	A method was developed for any test kit to measure the presence and absence of LBP with a transition from negative to positive occurring at 1.0 mg/cm². Validation testing using 2 operators	Final Report; QuanTech VALTT0001-11; David Cox,

Summary of Results of Lead Research Carried Out under Title X

Focus Area	Year Published	Title	Results	Reference
		of the Presence and Absence of Lead Based Paint	showed that the QT Method is successful near 1.0 mg/cm². This method can shift a test kit response curve for determination of LBP needed to meet the EPA RRP Rule requirements.	F. Gary Dewalt, February 26, 2016
Lead in Soil Sampling	2006	Potential lead on play surfaces: Evaluation of the "PLOPS" sampler as a new tool for primary lead prevention	Potential lead on play surfaces: Evaluation of the "PLOPS" sampler as a new tool for primary lead prevention	Mielke HW, Powell ET, Gonzales CR, Mielke P W. (2007). Potential lead on play surfaces: Evaluation of the "PLOPS" sampler as a new tool for primary lead prevention. *Environmental Research*, 103(2), 154-159. doi:10.1016/j.envres.2006.08.007
UE/ASV Analysis of Lead in Dust Wipes	2005	Ultrasonic Extraction/Anodic Stripping Voltammetry for Determining Lead in Dust: Analyses of Field-Sampled Wipes	Ultrasonic Extraction/Anodic Stripping Voltammetry procedures were tested as a potential on-site analysis for lead in dust wipes. More work was needed to increase the efficacy of the UE/ASV protocol. , particularly to improve lead extraction.	NIST Publication Number: NISTIR 7109. NTIS Accession Number: PB2005-100339 January 13, 2005
UE/ASV Analysis of Lead in Dust Wipes	2004	Ultrasonic Extraction/ Anodic Stripping Voltammetry for Determining Lead in Dust: A Laboratory Evaluation	Lead recoveries were variable and not quantitative. Extraction of the lead was found to be a major problem, and the wipe type has an effect on the lead recovery.	NIST Interagency/Internal Report NISTIR 6998 September 2004
Extraction of Lead from Household Paint Films	2003	Factors Affecting Ultrasonic Extraction of Lead from Household Paint Films: Further Investigations	If a ground specimen appears to have adequately small particle size when compared against that of a reference powder, then extraction during a UE/ASV analysis may be performed at 45 °C and 30 min, as is presently carried out in common practice.	NIST Interagency/Internal Report NISTIR 6948, March 01, 2003
Extraction of Lead from Lab-prepared paint films	2002	Factors Affecting of Lead from Laboratory-Prepared Household Paint Films Ultrasonic Extraction	A key contributor to low lead recoveries appeared to be incomplete lead solubilization during paint specimen sonication. Overlayer of the paint was another factor affecting the recovery.	NIST Interagency/Internal Report NISTIR 6834 - May 01, 2002
Spot Test Kits	2000	Spot Test Kits for Detecting Lead in Household Paint: A Laboratory Evaluation	Eight Test Kits were evaluated, 4 of the sulfide and 4 of the rhodizonate type. The study showed that the spot test kits gave positive results at lead levels less than 1 mg/cm². The type of lead pigment had a significant effect on the spot test kit response.	NIST Interagency/Internal Report (NISTIR) – 6398; Report Number: 6398 May 01, 2000

Summary of Results of Lead Research Carried Out under Title X

Focus Area	Year Published	Title	Results	Reference
II. Sources of Lead				
LBP and Lead Hazards in U.S. Housing	2015	Prevalence of Lead Hazards and Soil Arsenic in U.S. Housing	This is the report of the American Healthy Homes Survey with prevalence of LBP and lead hazards in a representative sample of U.S. homes.	Dewalt FG, Cox DC, O'Haver R, Salatino B, Holmes D, Ashley PJ, Pinzer EA, Friedman W, Marker D, Viet SM, Fraser A. *Journal of Environmental Health*, 78 (5), 22-29 (2015)
Preventing Lead Poisoning State Laws	2014	Primary prevention of lead poisoning in children: a cross-sectional study to evaluate state specific lead-based paint risk reduction laws in preventing lead poisoning in children	The states with lead laws, MA and OH, were 79% less likely than MS without legislation, to have residences with lead poisoning cases among children younger than 72 months, adjusted OR = 0.21, 95% CI (0.08-0.54). The evidence suggests that lead laws such as those studied reduced primary exposure to lead among young children living in residences that may have had lead contaminants.	Kennedy C, Lordo R, Sucosky MS, Boehm R and Brown MJ. *Environmental Health* 2014, 13:93
LBP and Lead Hazards in Child Care Centers	2013	Lead, Allergen, and Pesticide Levels in Licensed Child Care Centers in the United States	Reports the LBP and lead dust hazards in Child Care Centers in the U.S. Fourteen percent of centers had lead hazards, suggesting that an estimated 470,000 children under age six (approximately 10% of all children in licensed centers) attend centers with significant lead hazards.	Viet SM, Rogers J, Marker D, Fraser A, Friedman W, Jacobs D, Zhou J, Tulve N. *Journal of Environmental Health*, 76 (5), 8-14 (2013)
Soil Sample Locations to Predict Child Lead Exposure	2013	Determining the relative importance of soil sample locations to predict risk of child lead exposure	Residential street soils account for 39.7% of between-neighborhood variation, followed by busy street soils (21.97%), open space soils (20.25%), and home foundation soils (18.71%). As the age of housing stock is used as a statistical shortcut for child risk of exposure to lead-based paint, one can shortcut the characterization of child risk of exposure to neighborhood soil Pb by concentrating sampling efforts within 1 m and adjacent to residential and busy streets, while significantly reducing the total costs of collection and analysis.	Zahran S, Mielke HW, McElmurry SP, Filippelli GM, Laidlaw MAS, Taylor MP. *Environment International 60 (2013) 7–14*
Lead in Varnished Floors	2012	Lead Exposures from Varnished Floor Refinishing	Compared with federal standards, no lead in varnish samples exceeded 1.0 mg/cm^2, but 52% exceeded 5000 ppm (i.e., half the 10,000 ppm standard) and 70% of settled dust samples after refinishing exceeded 40 μg/ft^2. Refinishing pre-1930 dwellings or stairs predicted high lead dust on floors.	Schirmer J, Havlena J, Jacobs DE, Dixon S, Ikens R. *Journal of Occupational and Environmental Hygiene*, 9: 280–287 (April 2012)
Lead from gasoline	2011	The continuing impact of lead dust on children's blood lead: Comparison of	This study presents evidence that 5-10 times more Pb dust is accounted for by Pb additives to gasoline compared to the worst case scenario for Pb dust from Pb-based paint; The large input of Pb dust from vehicle traffic was concentrated within high traffic	Mielke HW, Gonzales CR, Mielke PW. (2011) The continuing impact of lead dust on children's blood lead:

Summary of Results of Lead Research Carried Out under Title X

Focus Area	Year Published	Title	Results	Reference
		public and private properties in New Orleans	flow areas of the inner-city compared with outlying lower traffic areas of the city.	Comparison of public and private properties in New Orleans. *Environmental Research*, 111(8), 1164-1172. doi:10.1016/j.envres.2011.06.010
Lead after Hurricane Katrina	2011	Environmental Lead after Hurricane Katrina: Implications for Future Populations	The high prevalence (61%) of lead above recommended levels in soil and dust samples in and around residences raises concern about potential health risk to the New Orleans population, most notably children. Steps should be taken to mitigate the risk of exposure to lead-contaminated soil and dust. Further research is needed to quantify the possible contribution of reconstruction activities to environmental lead levels.	Rabito FA, Iqbal S, Perry S, Arroyave W, Rice JC, 2011 Environmental Lead after Hurricane Katrina: Implications for Future Populations. *Environ Health Perspectives* 120:180–184 (2012). doi:10.1289/ehp.1103774
Lead Dust Exposure	2009	Exposure of U.S. Children to Residential Dust Lead,1990-2004: Housing and Demographic Factors	Most houses with children have lead dust (PbD) levels that comply with federal standards but may still put children at risk. Factors associated with PbD in the population-based models are primarily the same as factors identified in smaller at-risk cohorts. Income, race/ethnicity, floor surface/condition, windowsill PbD, year of construction, recent renovation, smoking, and survey year were significant predictors of floor PbD.	Gaitens JM, Dixon SL, Jacobs DE, Nagaraja J, Strauss W, Wilson JW, Ashley, PJ (2009). Exposure of U.S. Children to Residential Dust Lead, 1999--2004: I. Housing and Demographic Factors. *Environmental Health Perspectives*, 117(3), 461-467.
Lead Availability from LBP	2009	Nitrogen Dioxide and Ozone as Factors in the Availability of Lead from Lead-Based Paints	Both ozone and nitrogen dioxide were shown to increase surface lead released from low gloss solvent based paint, as well as have systematic effects both on color and surface morphology.	Edwards RD, Lam NL, Zhang LL, Johnson MA, Kleinman MT (2009). Nitrogen Dioxide and Ozone as Factors in the Availability of Lead from Lead-Based Paints. *Environmental Science & Technology*, 43(22), 8516-8521.
LBP Degradation from Air Quality	2009	Potential for Atmospheric-Driven Lead Paint Degradation in the South Coast Air Basin of California	This study uses photochemical air quality modeling to map areas susceptible to increased lead paint degradation as a result of photochemical atmospheric pollutants to prioritize areas of concern.	Cohan AJ, Edwards RD, Kleinman MT, Dabdub D (2009). Potential for Atmospheric-Driven Lead Paint Degradation in the South Coast Air Basin of

Summary of Results of Lead Research Carried Out under Title X

Focus Area	Year Published	Title	Results	Reference
				California. *Environmental Science & Technology*, 43(23), 8881-8887.
LBP and LBP Hazards in U.S. Housing	2002	The Prevalence of Lead-Based Paint Hazards in U.S. Housing	This paper summarizes major findings from the National Survey of Lead and Allergens in Housing	Jacobs DE, Clickner RP, Zhou HY, Viet SM, Marker DA, Rogers JW, Zeldin DC, Broene P, Friedman W. *Environ Health Perspectives* 110:A599–A606 (2002)
III. Abatement and Interim Controls				
Window Replacement Dust Lead Levels	2016	Replacing Windows Reduces Childhood Lead Exposure: Results From a State-Funded Program	Reduced dust lead loadings after window replacement by the Illinois window replacement program were sustained, showing that children would benefit from the program. With economic benefits of reduced blood lead levels far outweighing costs, investment in window replacement would be a wise use of funds.	Jacobs DE, Tobin M, Targos L, Clarkson D, Dixon SL, Breysse J, Pratap P, Cali S, (2016) Replacing Windows Reduces Childhood Lead Exposure: Results From a State-Funded Program J Public Health Management Practice, 2016, 22(5) 482-491.
Porch Dust Lead Levels	2015	An investigation into porch dust lead levels	Baseline GM porch floor dust lead loading (PbPD) was 68 μg/ft^2, almost four times more than interior floor dust lead (18 μg/ft^2). Immediate post-work PbPD declined 55% after porch floor replacement and 53% after porch floor paint stabilization. When no porch floor work was conducted but lead hazard control was conducted elsewhere, immediate post-work PbPD increased 97%.	Wilson J, Dixon SL, Jacobs DE, Akoto J, Korfmacher KS, Breysse J, An investigation into porch dust lead levels, *Environmental* Research 137 (2015) 129–135.
Window Replacement	2012 *	Window replacement and residential lead paint hazard control 12 years later	Twelve years after intervention, homes with all replacement windows had 41% lower floor dust lead, compared to non-replacement homes (1.4 vs. 2.4 μg/ft^2), and window sill dust lead was 51% lower (25 vs. 52 μg/ft^2). Homes with some windows replaced had interior floor and window sill dust lead loadings that were 28% (1.7 vs. 2.4 μg/ft^2) and 37% (33 vs. 52 μg/ft^2) lower, respectively. The economic benefit of window replacement compared to window repair (non-replacement) is $1700–$2000 per housing unit.	Dixon SL, Jacobs DE, Wilson JW, Akoto JY, Nevin R, Clark CS, Window replacement and residential lead paint hazard control 12 years later, *Environmental Research* 113 (2012) 14–20.

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Focus Area	Year Published	Title	Results	Reference
Phyto-Remediation of Soil Lead	2011	Predicting potentially plant-available lead in contaminated residential sites	The limiting factor in successful soil phytoremediation is the availability of Pb for plant uptake. 20 sites from two different locations (San Antonio, Texas and Baltimore, Maryland) with varying soil properties and total soil Pb concentrations ranging between 256 and 4,182 mg kg^{-1} were tested. The plant-available Pb fraction is controlled by soil pH in the case of acidic Baltimore soils, while soil organic matter plays a major role in alkaline San Antonio soils. Models suggest that Pb is more available for plant uptake in Baltimore soils and a Chelan-assisted phytoextraction strategy will be necessary for San Antonio soils in mobilizing Pb to be plant-available.	Andra SS, Sarkar D, Saminathan SKM, Datta R. Predicting potentially plant-available lead in contaminated residential sites (2011) *Env. Monitoring Assessment* 175(1-4) 661-676
Primary Prevention of Lead Exposure	2011	Primary Prevention of Lead Exposure: The Philadelphia Lead Safe Homes Study	There were no significant differences in initial BLLs (one year of age) between study children and a matched comparison group of children, nor any significant difference in BLLs of children in the Standard Education Group vs. the Maintenance Education Group. Most study homes had lead hazards at baseline, with some decrease in lead dust levels for floors (non-significant) and windowsills (significant) by the end of the study. At baseline, 36.9% of homes were above the U.S. EPA's lead dust standard, compared with 26.9% at 12 months, mainly due to a drop in windowsill dust levels. Parental acquisition of knowledge about lead exposure prevention was retained during the year-long study.	Campbell C, Tran M, Gracely E, Starkey N, Kersten H, Palermo P, Rothman N, Line L, Hansen-Turton T. Primary Prevention of Lead Exposure: The Philadelphia Lead Safe Homes Study *Public Health Reports* 126.1_suppl (2011): 76-88.
MD Lead Law Effective-ness	2007	Immediate and one-year post-intervention effectiveness of Maryland's lead law treatments	Dust lead loadings declined significantly immediately after Maryland Law EA 6-8 prescribed lead hazard reduction treatments were implemented in the study units. One-year loadings remained below pre-intervention for floors but not for window sills or troughs.	Breysse J, Anderson J, Dixon S, Galke W, Wilson J (2007). Immediate and one-year post-intervention effectiveness of Maryland's lead law treatments. *Environmental Research*, 105(2), 267-275. doi:10.1016/j.envres.2007.04.002
Lead Hazard Control Effectiveness after 6 Years	2006	Evaluation of HUD-funded lead hazard control treatments at 6 years post-intervention	This study showed that both lower and higher intensity interim control measures were effective at maintaining lower dust lead loadings on floors and window sills in both rural and urban housing. Dust-lead levels on floors and window sills were 11% and 23% lower, respectively, at 6 years post-intervention. Window trough dust-lead levels were still over 75% lower than before intervention.	Wilson J, Pivetz T, Ashley P, Jacobs D, Strauss W, Menkedick J, Dixon S, Tsai HS, Brown V, Friedman W, Galke W, Clark S (2006). Evaluation of HUD-funded lead hazard control treatments at 6 years post-intervention. *Environmental Research*, 102(2), 237-248.

Summary of Results of Lead Research Carried Out under Title X

Focus Area	Year Published	Title	Results	Reference
				doi:10.1016/j.envres.2006.04.007
Lead in Soil Treatment Effectiveness	2006	The effectiveness of low-cost soil treatments to reduce soil and dust lead hazards: The Boston lead safe yards low cost lead in soil treatment, demonstration and evaluation.	Soil lead levels and exterior and main/common entry dust lead levels at 1 year were measured for treatment effectiveness. In the absence of children's blood lead data, these environmental measures were used to project whether these non-abatement soil treatments would protect children's BLL. Soil lead levels at the building dripline dropped from 2021 ppm at baseline to 206 ppm at 1-yr follow-up.	Dixon SL, McLaine P, Kawecki C, Maxfield R, Duran S, Hynes P, Plant T (2006). The effectiveness of low-cost soil treatments to reduce soil and dust lead hazards: The Boston lead safe yards low cost lead in soil treatment, demonstration and evaluation. *Environmental Research*, 102(1), 113-124. doi:10.1016/j.envres.2006.01.006
LHC and Dust Lead	2005 *	Effectiveness of lead-hazard control interventions on dust lead loadings: findings from the evaluation of the HUD Lead-Based Paint Hazard Control Grant Program	Strategies ranging from complete repainting to window abatement plus other treatments reduced preintervention windowsill and floor dust lead loadings up to 36 months post-intervention (reductions for complete repainting, from 16 to 5 μg/ft^2 on floors and 182 to 88 μg/ft^2 on sills; for window abatement plus other treatments, 27–8 μg/ft^2 on floors and 570–124 μg/ft^2 on sills). Full abatement reduced windowsill and floor loadings from baseline to 12 months post-intervention [95–6 μg/ft^2 on floors and 518–30 μg/ft^2 on sills. Window lead-hazard abatement was the most effective measure to reduce dust lead loadings on windows, but would need to be performed with treatments to floors for the most effective control of dust lead on floors.	Dixon SL, Wilson JW, Scott SC, Galke WA, Succop PA, Chen M. (2005). Effectiveness of lead-hazard control interventions on dust lead loadings: findings from the evaluation of the HUD Lead-Based Paint Hazard Control Grant Program. *Environmental Research*, 98, 3, 303-14.
Soil Lead Cleanup	2006	New Orleans Soil Lead (Pb) Cleanup Using Mississippi River Alluvium: Need, Feasibility, and Cost	There were significant reductions in soil Pb for all 3 community groups. Six months after the completion of the soil emplacement action the blood Pb levels of children decreased from 15-20 μg Pb/dL to ~8 μg/dl The New Orleans children responded to clean soil in the same positive way as the children of Minnesota.	Howard W, M., Powell ET, Gonzales CR, Mielke Jr. PW, Ottesen R, Langedal M (2006). New Orleans Soil Lead (Pb) Cleanup Using Mississippi River Alluvium: Need, Feasibility, and Cost. *Environmental Science & Technology*, 40(8), 2784-2789.
Soil Replacement after Katrina	2006	Katrina's Impact on New Orleans soils treated with	The hypotheses that properties with new soils were severely eroded or reverted back to their initial state of contamination was rejected. After catastrophic flooding, the clean soil remained	Milke HW, Powell ET, Gonzales CR, Mielke Jr. PW (2006). Hurricane Katrina's

Summary of Results of Lead Research Carried Out under Title X

Focus Area	Year Published	Title	Results	Reference
		Low Lead Mississippi River Alluvium	relatively undisturbed; the soil Pb changes were small with increases of median Pb of 12 and 6 mg/kg for vacant lots and properties with homes, respectively.	Impact on New Orleans Soils Treated with Low Lead Mississippi River Alluvium. *Environmental Science & Technology*, 40(24), 7623-7628.
Soil Lead Amendment	2005	Biosolids compost amendment for reducing soil lead hazards: a pilot study of Orgro amendment and grass seeding in urban yards	This study confirms the viability of in situ remediation of soils in urban areas where children are at risk of high Pb exposure from lead in paint, dust, and soil. At 1-year post-treatment, grass cover was healthy and reductions in bioaccessible Pb concentrations compared to pre-tillage were 64% (from 1655 to 595 mg/kg) and 67% (from 1381 to 453 mg/kg) at the sampling lines closest to the houses.	Farfel MR, Orlova AO, Chaney RL, Lees PS, Rohde C, Ashley PJ (2005). Biosolids compost amendment for reducing soil lead hazards: a pilot study of Orgro amendment and grass seeding in urban yards. *Science of the Total Environment*, 340, 1-3.
Common Areas Lead Dust	2005	Influence of Common Area Lead Hazards & LHC on Dust Lead Loadings: Multiunit Buildings	This study demonstrates that interior common areas in multiunit buildings contain substantial amounts of deteriorated lead-based paint and dust lead.	Dixon S, Wilson JW, Clark CS, Galke WA, Succop PA, Chen M. The Influence of Common Area Lead Hazards and Lead Hazard Control on Dust Lead Loadings in Multiunit Buildings. (2005). *J. Occupational & Environmental Hygiene*, 2(12), 659-666.
National Evaluation of LHC Program	2005	National evaluation of the US Department of Housing and Urban Development Lead-Based Paint Hazard Control Grant Program	This study showed that it is feasible to include local governments in the design and data collection activities, making it possible to study many housing units across numerous jurisdictions.	Galke W, Clark S, McLaine P, Bornschein R, Wilson J, Succop P, Roda S, Buncher R. (2005). National evaluation of the US Department of Housing and Urban Development Lead-Based Paint Hazard Control Grant Program: study methods. *Environmental Research*, 98, 3, 315-28.
Exterior Dust and Interior Dust Lead Levels	2004	The Influence of Exterior Dust and Soil Lead on Interior Dust Lead Levels in Housing That Had	Post intervention exterior entry dust lead loadings were lower when a site treatment (interim soil lead control) was implemented. Statistical modeling revealed pathways from exterior entry dust lead loading to loadings on interior entryway floors, other interior	Clark S, Menrath W, Chen M, Succop P, Bornschein R, Galke W, Wilson J (2004). The Influence of Exterior

Summary of Results of Lead Research Carried Out under Title X

Focus Area	Year Published	Title	Results	Reference
		Undergone Lead-Based Paint Hazard Control	floors, and windowsills. Paint lead was found to influence exterior entry dust lead.	Dust and Soil Lead on Interior Dust Lead Levels in Housing That Had Undergone Lead-Based Paint Hazard Control. *Journal of Occupational and Environmental Hygiene*, 1, 5, 273
Dust Lead After Intervention	2004	Residential Dust Lead Loading Immediately After Intervention in the HUD Lead Hazard Control Grant Program	The experience of 14 grantees participating in the "Evaluation of the HUD Lead-Based Paint Hazard Control Grant Program" shows 80% of the 2682 dwellings achieved grantee-specific clearance standards on windowsills, window troughs (500 microg/ft2 and 800 microg/ft2, respectively), and floors (80, 100, or 200 microg/ft2 depending on state/local regulations in the mid-1990s), with grantee success rates ranging from 63 to 100%. Dwellings that failed initial clearance required an average of 1.13 retests to clear. The most common lead hazard control intervention was window abatement.	Dixon SL, Wilson JW, Succop PA, Chen M, Galke WA, Menrath W, Clark C (2004). Residential Dust Lead Loading Immediately After Intervention in the HUD Lead Hazard Control Grant Program. *Journal Occupational & Environmental Hygiene*, 1 (11), 716-724. doi:10.1080/15459620490520792.
Soil Lead Landscape Coverings	2004	Evaluation of landscape coverings to reduce soil lead hazards in urban residential yards: The Safer Yards Project	Over 1 year, the intervention groups had significantly reduced acute hazard soil lead concentration, enhanced landscape coverings, and a 50% decrease in lead tracked onto floor mats. The long-term sustainability of the method needs further examination.	Binns HJ, Gray KA, Finster ME, Peneff N, Schaefer P, Ovsey V, Fernandes J, Brown M, Dunlap B. *Environmental Research* 96, 2, 2004, 127-138
Demolition Study	2003	A study of urban housing demolitions as sources of lead in ambient dust: demolition practices and exterior dust fall.	Lead dust-fall rate increased by >40-fold during demolition to 410 µg Pb/m2/hr and by >6-fold during debris removal to 61 µg Pb/m2/hr. Lead concentrations in dust fall also increased (2,600 mg/kg) and debris removal (1,500 mg/kg) compared with baseline (950 mg/kg). We need to minimize demolition lead deposition and educate urban planners, contractors, health agencies, and the public about lead and other community concerns so that society can maximize the benefits of future demolition activities.	Farfel, MR, Orlova AO, Lees PS J, Rohde C, Ashley PJ, Chisolm JJ. A study of urban housing demolitions as sources of lead in ambient dust: demolition practices and exterior dust fall. (2003) *Env. Health Perspectives* 111 (9) 1228-1234
Use Pattern of Encapsulants	2003	A Review of Currently Available Lead-Based Paint Encapsulants and Use Patterns in the Control of	Encapsulants are not a widely used method of abating lead-based paint hazards throughout the country. There is no information on the long-term performance of encapsulants in the literature.	Pate A, Parsons A, Sanford J, Ashley P Battelle Report; A Review of Currently Available Lead-Based Paint Encapsulants and Use

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Focus Area	Year Published	Title	Results	Reference
		Residential Lead-Based Paint Hazards		Patterns in the Control of Residential Lead-Based Paint Hazards, March 28, 2003
National Evaluation Early Findings	2001	Evaluation of HUD Lead Hazard Control Grant Program: Early Overall Findings	At least 40% of the interior building components tested for lead-based paint were rated as fair or poor using a standard developed by HUD to assess paint quality. Floor and window dust lead loadings declined at least 50 and 88%, respectively, immediately post-intervention. Three years later, floor dust lead loadings remained at or below the immediate postintervention levels. Window dust lead loadings remained substantially reduced from pre-intervention levels and below clearance standards. At 1 year after intervention, age-adjusted blood lead levels declined from 11.0 to 8.2 lg/dL, a 26%decline.	Galke W, Clark S, Wilson J, Jacobs D, Succop P, Dixon S, Bornschein B, Chen M. (2001). Evaluation of the HUD Lead Hazard Control Grant Program: Early Overall Findings. *Environmental Research*, 86, 2, 149-156.
Primary Prevention	1999	Preventing Lead Poisoning: U.S. Federal Policies and Current Technologies	Primary prevention of childhood lead poisoning in the United States requires the widespread implementation of lead hazard control measures in housing and, in some circumstances, adjacent soil.	Haley BA, Ashley PJ (1999). Preventing Lead Poisoning: U.S. Federal Policies and Current Technologies. *Journal of Urban Technology*, 6(3), 37-58. doi:10.1080/10630739983579
Long-Term Effectiveness of Abatement	1994	Longer-Term Effectiveness of Residential Lead Paint Abatement	Primary prevention of childhood lead poisoning in the United States requires the widespread implementation of lead hazard control measures in housing and, in some circumstances, adjacent soil.	Farfel MR, Chisolm JJ, Rohde CA (1994). The Longer-Term Effectiveness of Residential Lead Paint Abatement. *Environmental Research*, 66, 2, 217-221.
IV. Lead Cleaning and Clearance Sampling				
Lead Clearance Improvement	2011	Improving the Confidence Level in Lead Clearance Examination Results through Modifications to Dust Sampling Protocols	(1) Floor dust-lead along the perimeters of rooms was 3x more difficult to clean than from the interiors; (2) The implementation of the EPA protocol has a significant impact on the likelihood of detecting clearance failures; (3) Clearance failure is much more likely for floor samples near the walls , so clearance sampling protocols should emphasize perimeter sampling; and (4) Composite sampling provides a very reliable method of detecting clearance failure without significantly increasing the cost.	Cox DC, Dewalt FG, White KT, Schmehl R, Friedman W, Pinzer EA, Improving the Confidence Level in Lead Clearance Examination Results through Modifications to Dust Sampling Protocols, J*ournal*

Summary of Results of Lead Research Carried Out under Title X

Focus Area	Year Published	Title	Results	Reference
				of ASTM International, 2011, Vol. 8, No. 8, 1-12.
Cleaning of HEPA Vacuum and Dry Steam on Carpet	2008	Cleaning Efficacy of High-Efficiency Particulate Air-Filtered Vacuuming and "Dry Steam" Cleaning on Carpet	Slow and steady HEPA vacuuming with the help of a dust finder indicator reduces surface and overall lead dust in carpets, from 29% to 40%, and dry steam cleaning further reduces surface lead contamination as compared with HEPA vacuuming alone.	Yiin LM, Yu CH, Ashley P, Rhoads G Cleaning Efficacy of High-Efficiency Particulate Air-Filtered Vacuuming and "Dry Steam" Cleaning on Carpet *Journal of Occupational and Environmental Hygiene*, 5: 94–99 (2008) DOI: 10.1080/15459620701805169
Clearance Study	2004	Imputation of Data Values That are Less Than a Detection Limit	Clearance standards have been lowered since this work was conducted, the clearance dust lead loading reached in this study suggest that contractors who take proper precautions can routinely achieve clearance at the current standards.	Succop PA, Clark S, Mei C, Galke W (2004). Imputation of Data Values That are Less Than a Detection Limit. *Journal Of Occupational & Environmental Hygiene*, 1(7), 436-441.
Household Vacuum Cleaners	2004	Evaluation of Household Vacuum Cleaners in the Removal of Settled Lead Dust from Hard Surface Floors	A single wet wash removes most of the lead dust from vinyl floors, with a 90% clearance rate. The canister vacuum (HVC) achieved a 76% clearance rate, followed by the upright HVC (52% clearance rate). Poorer performance was observed for both the "gold-standard" HEPA and shop vacuums (31% and 29% clearance rates, respectively). The primary predictor of HVC performance proved to be the mechanical action of the floor tool brush, which breaks the adhesion of the lead dust with the flooring. No detectable levels of lead dust from any HVCs were measured in air samples.	Lance L, Wall S, Garellick J, et.al. Evaluation of Household Vacuum Cleaners in the Removal of Settled Lead Dust from Hard Surface Floors CA Dept. of Health Services Public Health Institute, CALHR0028-97 Final Report, April 2004.
Lead Dust Sampling on Carpets	2003	Field evaluation and comparison of five methods of sampling lead dust on carpets	Wipe and vacuum methods are reliable sampling techniques for accessible lead to children from carpets and total lead contamination in carpets; The adhesive and sheets appear infeasible because of the high cost and performance limitation for carpet sampling; the hand rinse method is not practical or reliable.	Bai Z, Yiin LM, Rich DQ, Adgate JL, Ashley PJ, Lioy PJ, Rhoads GG, Zhang J. (2003). Field evaluation and comparison of five methods of sampling lead dust on carpets. *AIHA Journal* 64, 4.
Cleaning Hard Surfaces	2002	Comparison of Home Lead Dust Reduction Techniques on Hard Surfaces	The HEPA vacuum cleaner's filtering advantages over the non-HEPA vacuum cleaner did not provide any substantial benefit in cleaning on hard surfaces, and any ability to achieve larger	Rich DQ, Rhoads GG, Lih-Ming Y, Junfeng Z, Zhipeng B, Adgate JL, Lioy PJ (2002). Comparison of Home

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Focus Area	Year Published	Title	Results	Reference
			reductions on window troughs may be due to suction power or a vacuum cleaner's structural characteristics.	Lead Dust Reduction Techniques on Hard Surfaces: The New Jersey Assessment of Cleaning Techniques Trial. *Environmental Health Perspectives*, 110(9), 889.
Lead Dust on Carpet and Upholstery	2002	Comparison of Techniques to Reduce Residential Lead Dust on Carpet and Upholstery: The New Jersey Assessment of Cleaning Techniques Trial	In this study, a household vacuum cleaner without HEPA filtration performed nearly as well as a HEPA vacuum cleaner in cleaning soiled carpets. It can be used as a replacement cleaner for cleaning lead dust in carpets if a HEPA vacuum cleaner is not available.	Lih-Ming Y, Rhoads GG, Rich DQ, Junfeng Z, Zhipeng B, Adgate JL, Lioy PJ (2002). Comparison of Techniques to Reduce Residential Lead Dust on Carpet and Upholstery: The New Jersey Assessment of Cleaning Techniques Trial. *Environmental Health Perspectives*, 110(12), 1233.
Floor Mat Dust Collection	2001	Floor mat lead dust collection methods and their application in pre-1950 and new urban houses	Mats were found to be a feasible method for the collection of dust that has accumulated for a known amount of time.	Farfel MR, Orlova AO, Lees PJ, Bowen C, Elias R, Ashley PJ, Chisolm Jr. J. (2001). Comparison of Two Floor Mat Lead Dust Collection Methods and their Application in Pre-1950 and New Urban Houses *Environmental Science & Technology*, 35(10), 2078.
Filter Efficiency of Vacuum Cleaners	2001	Test Methods for Evaluating the Filtration and Particulate Emission Characteristics of Vacuum Cleaners	The chamber test method was refined and validated; it shows an overall efficiency of 100% because of the HEPA filter at the exhaust. A new test method probed the internal locations so that efficiency of the components could be determined.	Willeke K, Trakumas S, Grinshpun SA, Reponen T, Truno M, Friedman W *AIHAJ* 62:313:321 (2001)
Cleaning for Clearance	1999	Achieving Dust Lead Clearance Standards After Lead Hazard Control Projects	Dust lead surface loading on smooth and cleanable surfaces for the three-step and two-step cleaning procedures can achieve 1995 federal dust clearance levels and levels substantially lower.	Dixon S, Tohn E, Rupp R, Clark S. (1999). Achieving Dust Lead Clearance Standards After Lead Hazard Control Projects: An Evaluation of the HUD-Recommended Cleaning Procedure and an

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Focus Area	Year Published	Title	Results	Reference
				Abbreviated Alternative. *Applied Occupational and Environmental Hygiene*, 14, 5, 339-344.
Dust Collection for Clearance	1994	Comparison of a Wipe and a Vacuum Collection Method for the Determination of Lead in Residential Dusts	The use of the HUD vacuum method compared to the wipe sampling method for risk assessment is likely to underestimate lead loadings and the prevalence of lead-contaminated dust in U.S. housing.	Farfel MR, Lees PS, Rohde CA, Lim BS, Bannon D, Chisolm JJ Jr. (1994). Comparison of a Wipe and a Vacuum Collection Method for the Determination of Lead in Residential Dusts. *Environmental Research*, 65, 2, 291-301.
Lead Dust Collection using Cyclones	1994	Two cyclone-based collection devices for the evaluation of lead-containing residential dusts	The study demonstrates that two collection devices can ha19ve19 significantly different performance characteristics. This clearly demonstrates the need for evaluating devices over the range of particle size and dust loadings prior to use.	Farfel MR, Lees PS, Bannon D, Lim BS (1994). Comparison of Two Cyclone-Based Collection Devices for the Evaluation of Lead-Containing Residential Dusts. *Applied Occupational and Environmental Hygiene*, 9, 3, 212.
Lead in Dust Cyclone Collection	1994	Two cyclone-based collection devices for the evaluation of lead-containing residential dusts	Direct measurement of Pb sources and eliminating children as indicators of environmental Pb is the goal of this research.	Farfel MR, Lees PS, Bannon D, Lim BS (1994). Comparison of Two Cyclone-Based Collection Devices for the Evaluation of Lead-Containing Residential Dusts. *Applied Occupational and Environmental Hygiene*, 9, 3, 212.
V. Effects of Interventions on Children's Blood Lead Levels				
Effect of LHC on BLLs	2011 *	Effects of HUD-supported lead hazard control interventions in housing on children's blood lead	The "Evaluation of the US Department of Housing and Urban Development Lead-Based Paint Hazard Control Grant Program" studied the effectiveness in reducing the blood lead of children at four post-intervention times (6-months, 1-year, 2-years, and 3-years). Blood lead levels declined up to three-years post-intervention. At two-years, blood lead levels were 37% lower than	Clark S, Galke W, Succop P, Grote J, McLaine P, Wilson J, Dixon S, Menrath W, Roda S, Chen M, Bornschein R, Jacobs D. Effects of HUD-supported lead hazard control

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Focus Area	Year Published	Title	Results	Reference
			at pre-intervention. Exterior lead hazard control can be an important component of a lead hazard control plan.	interventions in housing on children's blood lead *Environmental Research* 111 (2011) 301–311
Impact of Lead Dust on Children's BLL	2011	The continuing impact of lead dust on children's blood lead: comparison of public and private properties in New Orleans	The pre-Katrina prevalence of children's blood Pb≥10 μg/dL was 22.9% within the inner-city compared with 9.1% in the outer areas of New Orleans. Comparing the quantities of Pb dust from paint and Pb additives to gasoline, the gasoline source is a more plausible explanation for the differences in soil Pb and children's blood Pb within public and private housing in the higher traffic congested inner-city core compared with the lower traffic congested outer areas of New Orleans.	Mielke HW, Gonzales CR, Mielke PW. (2011) The continuing impact of lead dust on children's blood lead: Comparison of public and private properties in New Orleans. *Environmental Research*, 111(8), 1164-1172. doi:10.1016/j.envres.2011.06.010
Soil Lead and Blood Lead after Hurricanes Katrina and Rita	2010	New Orleans before and after Hurricanes Katrina/Rita: A Quasi-Experiment of the Association between Soil Lead and Children's Blood Lead	Prior to Hurricanes Katrina and Rita, associations were found between soil lead and blood lead levels in New Orleans. Post hurricane soil lead decreased from 328 to 203 mg/kg. Decreases in soil lead are associated with declines in children's BLL. Individual BLL in children was predicted as a function of soil lead. The results support policies to improve soil conditions for children.	Zahran S, Mielke HW, Gonzales CR, Powell ET, Weiler S. New Orleans before and after Hurricanes Katrina/Rita: A Quasi-Experiment of the Association between Soil Lead and Children's Blood Lead *Environ. Sci. Technol.* 2010, *44*, 4433–4440 (2010)
Lead Dust and BLL	2009	The Contribution of Lead-Contaminated Dust to Children's Blood Lead Levels	Lowering the floor PbD standard below the current standard of 40 μ g/ft^2 would protect more children from elevated PbB. The population mean blood lead level (PbB) was 2.0 μg/dL. Age of child, race/ethnicity, serum cotinine concentration, poverty-to-income ratio, country of birth, year of building construction, floor lead dust (PbD) by floor surface and condition, windowsill PbD, presence of deteriorated paint, home-apartment type, smoking in the home, and recent renovation were significant predictors in either the linear model or logistic model for 10 μg/dL. At floor PbD = 12 μg/ft^2, the models predict that 4.6% of children living in homes constructed before 1978 have PbB ≥ 10 μg/dL, 27% have PbB ≥ 5 μg/dL, and the mean PbB is 3.9 μg/dL.	Dixon SL, Gaitens JM, Jacobs DE, Strauss W, Nagaraja J, Pivetz T, Ashley PJ (2009). Exposure of U.S. Children to Residential Dust Lead, 1999--2004: II. The Contribution of Lead-Contaminated Dust to Children's Blood Lead Levels. *Environmental Health Perspectives*, 117(3), 468-474.
Neonatal Lead Intoxication	2009	Neonatal lead intoxication following maternal pica: A case report and review of the literature	The majority of reported cases of lead poisoning in pregnancy are caused by the following factors: home renovation, pica, dietary supplementation, alternative medications, powder eyeliner and tagine food plates. Lead exposure in the pregnant woman may be	Vasquez MM, German VF, Scott AA, Foulds DM, Blanco CL (2009). Neonatal lead intoxication following maternal pica: A case report

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Focus Area	Year Published	Title	Results	Reference
			extremely toxic to the fetus due to unencumbered transport across the placenta.	and review of the literature. *J. Neonatal-Perinatal Medicine*, 2, 2, 123-126.
Lead Dust Sampling Locations and BLLs	2006	An Investigation of dust lead sampling locations and children's blood lead levels	The study suggest it is not necessary to collect 6-8 dust lead samples from interior floors and windowsills to determine whether a dust lead hazard is present in a home. Generally, floor samples from 1 to 3 rooms were adequate to characterize the risk from dust lead hazard.	Wilson J, Dixon S, Galke W, McLaine P (2007). An investigation of dust lead sampling locations and children's blood lead levels. *Journal of Exposure Science & Environmental Epidemiology*, 17(1), 2-12. doi:10.1038/sj.jes.7500514
LHC and BLLs	2005	Evaluation of lead hazard control treatments through analysis of blood-lead surveillance data	Analysis of the Massachusetts surveillance data revealed that average BLLs of screened children in Massachusetts have declined steadily in that state between 1993 and 2002.	Strauss W, Pivetz T, Ashley P, Menkedick J, Slone E, Cameron S. (2005). Evaluation of lead hazard control treatments in four Massachusetts communities through analysis of blood-lead surveillance data. *Environmental Research*, 99, 2, 214-23.
Contribution of Lead Dust to Children's BLL	2005	Exposure of U.S. Children to Residential Dust Lead,1990-2004: the Contribution of Lead - Contaminated Dust to Children's Blood Lead Levels	Data from the 1999-2004 NHANES showed a mean (GM) PbB of 2 µg/dL. Age of child, race/ethnicity, serum cotinine concentration, poverty-to-income ratio, country of birth, year of building construction, floor PbD by floor surface and condition, windowsill PbD, presence of deteriorated paint, home-apartment type, smoking in the home, and recent renovation were significant predictors. At floor PbD=12 µg/ft^2, the models predict that 4.6% of children living in homes constructed before 1978 have PbB> 10 microg/dL Lowering the floor PbD standard below the current standard of 40 µg/ft^2 would protect more children from elevated PbB.	Dixon SL, Gaitens JM, Jacobs DE, Strauss W, Nagaraja J, Pivetz T, Wilson JW, Ashley PJ. (2005). Exposure of U.S. Children to Residential Dust Lead,1990-2004: the Contribution of Lead - Contaminated Dust to Children's Blood Lead Levels *Environ Health Perspectives*, 2009;117(3):468-74. https://doi.org/10.1289/ehp.
Isotopic Estimation of Bone Lead and Blood Lead	2005	A Non-invasive Isotopic Approach to Estimate the Bone Lead Contribution to Blood in Children: Implications for Assessing	A noninvasive isotopic approach to estimate the bone lead contribution to blood in children following household lead remediation is presented. The release of lead from bone supported a substantial fraction of the measured blood lead level post-intervention. Results from this limited number of cases support the hypothesis that the release of bone lead into blood may	Gwiazda R, Campbell C, Smith D A Non-invasive Isotopic Approach to Estimate the Bone Lead Contribution to Blood in Children: Implications for

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Focus Area	Year Published	Title	Results	Reference
		the Efficacy of Lead Abatement	substantially buffer the decrease in blood lead levels expected from the reduction in lead intake.	Assessing the Efficacy of Lead Abatement *Environ Health Perspectives*, 113:104–110 (2005)
Blood Lead Levels Post Intervention	2003	Occurrence and determinants of increases in blood lead levels in children after LHC activities	There was an overall reduction in the blood lead levels of 869 children soon after the lead hazard controls. But 9.3% of these children had blood lead increases of 5 µg/dL or more. Analysis indicated that the amount of exterior deterioration (prior to intervention), the educational level of the mother, and the child's age were associated with the blood lead increases. Analyses also did not reveal any single interior strategy to be more or less likely than others to be associated with a blood lead increase of 5 µg/dL or more.	Clark S, Grote J, Wilson J, Succop P, Chen M, Galke W, McLaine P. (2004). Occurrence and determinants of increases in blood lead levels in children shortly after lead hazard control activities. *Environmental Research*, 96(2), 196-205. doi:10.1016/j.envres.2003.11.006
Children Mouthing Behavior and BLL	2002	Prevalence and Location of Teeth Marks Observed on Painted Surfaces in an Evaluation of the HUD Lead Hazard Control Grant Program	Children exhibiting moderate or high mouthing behavior blood lead levels were higher than in children not exhibiting such behavior. Therefore, children living in housing where teeth marks observed and children who are reported to have moderate or high mouthing behavior deserve special attention.	Clark S, Chen M, McLaine P, Galke W, Menrath W, Buncher R, Dixon S. (2002). Prevalence and Location of Teeth Marks Observed on Painted Surfaces in an Evaluation of the HUD Lead Hazard Control Grant Program. *Applied Occupational & Environmental Hygiene*, 17(9), 628-633. doi:10.1080/10473220290095952
Lead Dust and BLL	1997	Lead-Contaminated House Dust/ Residential Soil to Children's Blood Lead Levels	The results confirm that lead-contaminated house dust is the major source of lead exposure for children. Dust lead loading is more predictive of children's BLL than dust lead concentration.	Lanphear BP, Matte TD, Rogers J, Clickner RP, Dietz B, Bornschein RL, Succop P, Jacobs DE (1998). The contribution of lead-contaminated house dust and residential soil to children's blood lead levels. A pooled analysis of 12 epidemiologic studies. *Environmental Research*, 79, 1, 51-68.

Appendix 3: FY 2018 Priority Research Topics on Lead Technical Studies and Abstracts of FY 2018 Lead Technical Studies Grantees

HUD Office of Lead Hazard Control and Healthy Homes

FY 2018 Priority Research Topics on Lead Technical Studies

(1) Evaluation of the effectiveness of specific residential lead hazard control interventions. The effectiveness of lead hazard control interventions (i.e., interim controls or a combination of interim controls and abatement) over various time periods following implementation is a topic that has been primarily covered through HUD's Evaluation of the HUD Lead Hazard Control Grant Program (referred to as the National Evaluation) (see, e.g., http://nchh.org/resource-library/Early_Overall_Findings.pdf) that assessed the impact of lead hazard control interventions conducted in 2682 housing units by 14 grantees that were among the first recipients of HUD lead hazard control grants. Follow-up research on a subset of the original study participants demonstrated that dust-lead levels generally remained low (particularly on floors) six years following interventions (Wilson et al., 2006). Although this research has demonstrated that interim controls can be effective in reducing dust-lead levels over an extended period, there is still value in conducting research on the efficacy and durability of specific interventions or combinations of interventions. For example, HUD has supported research that focused on the benefits of window replacement in reducing floor dust-lead levels for up to 12 years (Dixon et al., 2012). It is notable that these durability results were achieved even through the grant programs do not require ongoing lead-based paint maintenance after the interventions, in contrast to the requirement for such maintenance under most housing assistance programs covered by HUD's Lead Safe Housing Rule and described in Chapter 6 of the HUD Guidelines. Furthermore, because there is no recognized safe level of lead exposure for children, which is reflected by the action of the U.S. Centers for Disease Control and Prevention in adopting a "reference value" for lead in children's blood based on the blood lead level distribution in the children's population, vs. their previous "level of concern" approach, the ability of interim controls to maintain low dust-lead levels in treated homes has assumed even greater importance. Research supports the need to achieve and maintain low dust-lead levels in order to keep children's lead exposure as low as is feasible, so evaluations of the effectiveness of specific interim controls, combinations of interim controls, and/or ongoing lead-based paint maintenance activities following well characterized interim controls are of particular interest to HUD with respect to their ability to sufficiently maintain low dust-lead levels over both the short and long term (e.g., 3 or more years). HUD is also interested in the ability of specific lead hazard control treatments to consistently achieve low clearance levels (i.e., at or below the clearance levels of 10 µg/ft^2 for floors and 100 µg/ft^2 for window sills that are required for HUD's Lead Hazard Control Program grantees) (HUD OLHCHH Policy Guidance Number 2017-01 Rev 1, February 16, 2017).

(2) Analysis of Available Data and Databases. HUD is interested in supporting research using existing data to address key scientific issues related to the identification and control of lead-based paint hazards. Research efforts often generate large data sets that are analyzed to address primary research objectives; however, there is often important information to be gained by conducting additional analyses of the collected data. Such analyses can generally be conducted at

low cost relative to the cost of the initial research. Applicants submitting proposals in this area should explain how the analyses would address one or more important issues and will result in improvements in lead hazard assessment and control methods. HUD is also interested in the creative use of existing databases (e.g., Census data, blood-lead screening data, etc.) to improve the efficacy of lead hazard control programs (e.g., by improved targeting of the highest risk homes and neighborhoods), assess the effectiveness of enforcement and lead hazard control activities and regulations, and other uses of these data that further the goal of improving methods for the identification and control of residential lead-based paint hazards.

(3) Other Focus Areas that are Consistent with the Overall Goals of HUD's Lead Technical Studies Program. HUD will consider funding applications for technical studies on other topics that are consistent with the overall goals and objectives of the Lead Technical Studies program, as described above. In such instances, it is important that the applicant describe in sufficient detail how the proposed study is consistent with the overall lead technical studies program goals and objectives.

Abstracts:

1) **Applicant:** National Center for Healthy Housing, Inc.
   Project Title: Analysis of Benefits of Abatement Techniques and Effectiveness in the HOME Study (the ABATE HOME Study)

Project Abstract: This study builds on a previously HUD-sponsored work, the Evaluation of the HUD Lead Hazard Control Grant Program, the HOME Study. The three main objectives of this study are:

(1) to determine the efficacy of the type and intensity of lead hazard control interventions used in the HOME Study (2003-2006) on blood lead levels and neurobehavioral factors;

(2) to identify which housing interventions are capable of routinely achieving compliance with low dust lead levels in the most cost-effective manner; and

(3) to determine if residential dust lead loadings are related to neurobehavioral outcomes in children.

The HOME Study was a randomized controlled trial carried out with funding from the National Institute of Environmental Health Sciences, HUD, and EPA. This ABATE HOME study is a retrospective analysis of the HOME Study data. The research hypothesis is that the HOME Study data will show that intervention practices currently used by HUD lead hazard control grantees can reduce dust lead levels to below 5 $\mu g/ft^2$ on floors and 50 $\mu g/ft^2$ on windowsills. The study will also provide information about the intensity of interventions needed to achieve clearance at these levels.

2) **Applicant:** National Center for Healthy Housing, Inc.
   Project Title: The MI CHILD Study (MIchigan CHildren's Lead Determination Study)

Project Abstract: The absence of recent data characterizing lead exposures in paint, dust, soil, and water while controlling for other key variables has made it difficult to understand the relative importance of different sources. This evaluation will help to fill this evidence gap by analyzing

data collected by Michigan Department of Health and Human Services' lead poisoning prevention program to characterize and assess recent lead levels in dust, soil, paint, and drinking water, while controlling for relevant confounding variables. These data will be modeled to predict exposures using Structural Equation Modeling. The study also will also use other models to estimate the relative importance of exposure sources and pathways, identifying factors that have a direct or indirect influence on blood lead levels. There are two main objectives for this evaluation:

(1) Analyze exposures and pathways from paint, dust, soil, and water; and

(2) Characterize recent lead levels in children's blood, paint, dust, soil, and drinking water in 350 Michigan homes, including estimating the influence of other characteristics.

The database in Michigan is unique; it has been developed pursuant to the state's HUD lead hazard control grant, Michigan state general fund dollars, and a Medicaid/CHIP (Children's Health Insurance Program) state plan amendment.

3) **Applicant:** The University of Texas at El Paso
Project Title: Lowering Children's Blood Lead Levels by Mitigating Household Lead Paint in Central El Paso, TX

Project Abstract: This study will use a holistic approach strategy, integrating community neighborhood-level education on child lead exposure solutions, with household-level lead hazard detection and mitigation. Three sets of objectives guide the collection of data needed to test the hypotheses:

(1) Measure child blood-lead levels (BLLs) in previously identified high-risk neighborhoods, geographically map child BLLs, identify and recruit homes with lead exposed children; provide mitigation education and quantify parents' knowledge, perceptions and attitudes towards mitigation pre- and post-education;

(2) Measure, through home visits, lead content with an X-ray fluorescence analyzer and determine the bioaccessibility of possible interior and exterior lead paint contamination sources; determine most likely source(s) of child exposure; inform parents of findings and review mitigation options and practical issues with them; and assist parents in mitigation; and

(3) Re-test child BLLs and environmental lead sources to determine efficacy of mitigation, and changes in attitudes and perceptions regarding perceived barriers to mitigation.

Appendix 4: FY 2019 Priority Research Topics on Lead Technical Studies

HUD Office of Lead Hazard Control and Healthy Homes

(1) Evaluation of the effectiveness of specific residential lead hazard control interventions. The effectiveness of lead hazard control interventions (i.e., interim controls or a combination of interim controls and abatement) over various time periods following implementation is a topic that has been primarily covered through HUD's Evaluation of the HUD Lead Hazard Control Grant Program (referred to as the National Evaluation) (see, e.g., http://nchh.org/resourcelibrary/Early_Overall_Findings.pdf) that assessed the impact of lead hazard control interventions conducted by 14 grantees that were among the first recipients of HUD lead hazard control grants. Follow-up research on a subset of the original study participants demonstrated that dust-lead levels generally remained low (particularly on floors) six years following interventions (Wilson et al., 2006). Although this research has demonstrated that interim controls can be effective in reducing dust-lead levels over an extended period, there is still value in conducting research on the efficacy and durability of specific interventions or combinations of interventions. For example, HUD has supported research that focused on the benefits of window replacement in reducing floor dust-lead levels for up to 12 years (Dixon et al., 2012). It is notable that these durability results were achieved even though the grant programs do not require ongoing lead-based paint maintenance after the interventions, in contrast to the requirement for such maintenance under most housing assistance programs covered by HUD's Lead Safe Housing Rule and described in Chapter 6 of the HUD Guidelines. Furthermore, because there is no recognized safe level of lead exposure for children, which is reflected by the action of the U.S. Centers for Disease Control and Prevention in adopting a "reference value" for lead in children's blood based on the blood lead level distribution in the children's population, vs. their previous "level of concern" approach, the ability of interim controls to maintain low dust-lead levels in treated homes has assumed even greater importance. Research supports the need to achieve and maintain low dust-lead levels in order to keep children's lead exposure as low as is feasible, so evaluations of the effectiveness of specific interim controls, combinations of interim controls, and/or ongoing lead-based paint maintenance activities following well characterized interim controls are of particular interest to HUD with respect to their ability to sufficiently maintain low dust-lead levels over both the short and long term (e.g., 3 or more years). HUD is also interested in the ability of specific lead hazard control treatments to consistently achieve low clearance levels (i.e., at or below the clearance levels of 10 $\mu g/ft^2$ for floors and 100 $\mu g/ft^2$ for window sills that are required for HUD's Lead Hazard Control Program grantees) (HUD OLHCHH Policy Guidance Number 2017-01 Rev 1, February 16, 2017).

(2) Analysis of Available Data and Databases. HUD is interested in supporting research using existing data to address key scientific issues related to the identification and control of lead-based paint hazards. Research efforts often generate large data sets that are analyzed to address primary research objectives; however, there is often important information to be gained by conducting additional analyses of the collected data. Such analyses can generally be conducted at low cost relative to the cost of the initial research. Applicants submitting proposals in this area should explain how the analyses would address one or more important issues and will result in improvements in lead hazard assessment and control methods. HUD is also interested in the

creative use of existing databases (e.g., Census data, blood-lead screening data, etc.) to improve the efficacy of lead hazard control programs (e.g., by improved targeting of the highest risk homes and neighborhoods), assess the effectiveness of enforcement and lead hazard control activities and regulations, and other uses of these data that further the goal of improving methods for the identification and control of residential lead-based paint hazards.

(3) Other Focus Areas that are Consistent with the Overall Goals of HUD's LTS Grant Program. HUD will consider funding applications for technical studies on other topics that are consistent with the overall goals and objectives of the LTS Grant Program, as described above. In such instances, it is important that the applicant describe in sufficient detail how the proposed study is consistent with the overall LTS Grant Program goals and objectives.

Appendix 5: Calculations on the incidence of elevated blood lead levels in children under Age 6 in HUD-Assisted Housing

As noted in the body of the report, regarding the incidence of elevated blood lead levels in children under age 6 (for whom the term is defined, in accordance with Title X) living in HUD-assisted housing:

- Based on the size of the HUD-assisted housing stock and research results described below, an expected 12,009 children under age 6 would have elevated blood lead levels in that housing if it had the same frequency of lead-based paint hazards as does the national housing stock.
- However, based on the findings of the American Healthy Homes Survey that government-supported housing is less likely to have lead-based paint hazards than unassisted housing, the number of HUD-assisted housing units with a child under age 6 with an elevated blood lead level is estimated to be 6,745, i.e., 56% as many.

The occurrence frequency estimates in this analysis reflect data from HUD's American Healthy Homes Survey (AHHS), conducted in 2005-2006.[137] The Survey was a nationally representative survey of primary non-institutional residences (i.e., vacation homes, barracks, dormitories and prisons were excluded); except where noted, national average prevalence frequencies from the Survey are used.

The estimated number of units under payment pertinent to the Lead Safe Housing Rule is based on the annual number of HUD-owned or assisted units in the largest housing assistance programs, adjusted for considering only those built before 1978, because they may have lead-based paint.[138] The assistance categories covered are for Section 8 Project-Based Assistance, Public Housing, and Tenant-Based Rental Assistance (for which housing choice vouchers are the most commonly used form of such assistance.

Data gathered from the FY 2021 Congressional Justifications[139] for the Administration's Budget, the 2013 American Housing Survey (AHS) (used in a research paper cited below), and the AHHS have been used to estimate the number of housing units expected to house children under age 6 with blood lead levels at or above the elevated blood lead level.

- The first data column's values of the number of units with a child < 6 years old residing come from the rightmost column of table 2A.
- The second column, adjusting the first column's number of units for housing built before 1978, is based on 2013 American Housing Survey data used in the Eggers and Moumen study.

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[137] Cox D, Dewalt FG. Prevalence of Lead-Based Paint Hazards. *Op. cit.*

[138] Consumer Product Safety Commission. Ban of Lead-Containing Paint. *Op. cit.*

[139] HUD, FY 2021 Congressional Justifications, www.hud.gov/program_offices/cfo/reports/fy21_CJ, with program-specific justifications at, respectively:

- www.hud.gov/sites/dfiles/CFO/documents/9_FY21CJ_Program_PublicHousingFund.pdf
- www.hud.gov/sites/dfiles/CFO/documents/24_FY21CJ_PBRA.pdf
- www.hud.gov/sites/dfiles/CFO/documents/6_FY21CJ_Program_TBRA.pdf

Calculations on the Incidence of Elevated Blood Lead Levels in Children under Age 6 in HUD-Assisted Housing

- The third data column's calculation of the number of units with children with EBLLs uses the CDC's reference range value of the highest 2.5% of the under-6-year-old children's blood lead levels, assuming, conservatively, that each housing unit has at most one such child to get a conservatively high estimate of the number of units in this column.
- The fourth data column's estimate of the number of EBLLs in the categories of assisted units is adjusted for relative prevalence of significant lead-based paint hazards in government-supported housing units compared to the national prevalence (12.3% vs. 21.9%), according to the AHHS, i.e., only 56.2% of the nationally-expected number of units.[140] Considering the 95-percent confidence interval of 3.0 to 21.6% in the AHHS's estimate of the prevalence of significant lead-based paint hazards in government-supported housing units, there is a 2.5% probability that the relative percentage of assisted units with significant lead-based paint hazards is as low as 13.7%, and a similar 2.5% probability that the relative percentage is as high as 98.6%.

Estimated Number of Assisted Units with Child under age 6

Program	Units Under Payment	Adjusted for child < 6 years old residing [b]
Public Housing [a]	915,000	154,452
HUD Section 8 Project-Based Assistance [a]	1,200,000	202,560
Tenant Based Assistance (net) [a]	2,300,000	388,240

[a] Assistance estimates for HUD are from its FY 2021 Congressional Justifications for the assistance programs above.

[b] Based on 38.5% of HUD-assisted rental units having children (per Eggers, FJ, and Moumen, F., New AHS [American Housing Survey] PUF [Public Use File] Information on HUD-Assisted Rental Housing, HUD Office of Policy Development and Research, Washington, (Jan. 2014).[141] Table 11: Comparison of Other Housing and Household Characteristics), and, nationally, 43.9% of units with children having children under age 6, per Vespa, J, Lewis, JM, and Kreider, RM, America's Families and Living Arrangements: 2012. Population Characteristics, U.S. Department of Commerce, Economics and Statistics Administration, U.S. Census Bureau, P20-570 (Aug. 2013), Table 1, Households by Type and Selected Characteristics: ACS 2011, and Table 2, Multigenerational Households

[140] HUD Office of Healthy Homes and Lead Hazard Control, American Healthy Homes Survey: Lead and Arsenic Findings (April 2011), http://portal.hud.gov/hudportal/documents/huddoc?id=AHHS_REPORT.pdf. Table 5-1. Comparison of Prevalence of Housing Units with Significant Lead-Based Paint (LBP) Hazards, by Selected Housing (HU) Characteristics between NSLAH (HUD's National Survey of Lead and Allergens in Housing, conducted in 1998-1999 (HUD. National Survey of Lead and Allergens in Housing, Volume I, Revision 7.1: Analysis of Lead Hazards. Prepared by Westat, Inc., for HUD, October 31, 2002.) and AHHS. (Note that, per Table 5-1, the prevalence of LBP hazards in HUs with household incomes less than $30,000 and a child under age 6 is 22.1%, but the difference between that and the national 21.9% prevalence is not significant, so the more robust, national, statistic is used conservatively.)

[141] https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2445481.

by Race and Hispanic Origin of Reference Person: CPS 2012.[142] The estimate of HUD-assisted rental units having children under age 6 is, thus, 38.5% times 43.9%, or 16.88%. This publication also reports that the US had 114,991,725 households, both assisted and unassisted, of which 15,342,000 (13.3%) had at least one child under age 6. The estimated prevalence of children under age 6 in HUD-assisted rental units is 26% higher than the national prevalence. (Compare this 2011-based 13.3% estimate to the 2005 AHS estimate of the overall housing stock's percentage of 15.9% of housing units having a child under age 6 years. (HUD and U.S. Department of Commerce, American Housing Survey for the United States: 2005 (Aug. 2006), and AHHS (HUD, American Healthy Homes Survey, Table 3-1, Characteristics of the National Survey Population, with Comparisons to American Housing Survey (AHS) and Current Population Survey (CPS) Estimates).)

Estimated Number of Assisted Units with Child with Elevated Blood Lead Level

	Adjusted for child < 6 years old residing	Adjusted for child < 6 years old residing in pre-1978 housing	Est. no. EBLLs if LBPHs were as prevalent as in national housing stock	Est. no. EBLLs adjusted for relative prevalence of significant LBPHs in Government-supported housing units
Public Housing	154,452	114,758	2,869	1,611
HUD Section 8 Project-Based Assistance	202,560	108,572	2,714	1,524
Total (Net) Rental Units Under Tenant-Based Assistance	388,240	257,015	6,425	3,609
Total	745,252	480,345	12,009	6,745

[a] The first data column's values of the number of units with a child < 6 y residing come from the rightmost column of the preceding table.

The second data column, adjusting the first column's number of units for housing built before 1978, is based on the 2013 American Housing Survey, using that Survey's Table Creator website tool[143] to create a table of national area scope, for general housing characteristics of all occupied units, with filters for renter tenure (since the housing stock affected by the rule is rental housing), year built (to estimate pre-1978 housing), and subsidized renter status (since the housing is subsidized).[144] This table gives, using linear interpolation in the 1975-1979 housing age range to estimate the number of 1975-1977 units, which is then combined with the number of pre-1975 units to estimate the

[142] www.census.gov/prod/2013pubs/p20-570.pdf.

[143] http://sasweb.ssd.census.gov/ahs/ahstablecreator.html, which is linked from the American Housing Survey's homepage, www.census.gov/programs-surveys/ahs.html.

[144] http://sasweb.ssd.census.gov/ahs/ahstablecreator.html#?s_areas=a0000&s_year=n2013&s_tableName=Table1&s_byGroup1=a4&s_byGroup2=a21&s_filterGroup1=t3&s_filterGroup2=g1

percentage of pre-1978 units. For public housing, project-based rental assisted housing, and tenant-based rental assisted housing, 74.3%, 53.6%, and 66.2%, respectively, of the housing stock was constructed before 1978.

The third data column's calculation of the number of units with children with EBLLs uses the CDC's reference range value of the highest 2.5% of the under-6-year-old children's blood lead levels, assuming, conservatively, that each housing unit has at most one such child in order to get a conservatively high estimate of the number of units in this column. Accordingly, the second data column's number is multiplied by that percentage.

The fourth data column's estimate of the number of EBLLs in the categories of assisted units is adjusted for relative prevalence of significant lead-based paint hazards in government-supported housing units according to the AHHS. Specifically, its table 5-1 (Comparison of Prevalence of Housing Units with Significant Lead-Based Paint Hazards, by Selected Housing Characteristics between NSLAH and AHHS) shows that 21.9% of housing units have significant lead-based paint hazards, while only 12.3% of government-supported units (including assistance from the federal, state, or local government) have them, i.e., only 56.2% of the nationally-expected number of units.[145] Accordingly, the third data column's number is multiplied by that percentage. Considering, as noted above, that the AHHS gave a 95-percent confidence interval of 3.0 to 21.6% in the estimate of the prevalence of significant lead-based paint hazards in government-supported housing units, the 95% confidence interval for the percentage of assisted units with significant lead-based paint hazards is 13.7 to 98.6%, and the 95% confidence interval around the central estimate of 7,029 units with children with EBLLs is 1,714 to 12,344.

[145] HUD Office of Healthy Homes and Lead Hazard Control, American Healthy Homes Survey: Lead and Arsenic Findings (Apr. 2011), http://portal.hud.gov/hudportal/documents/huddoc?id=AHHS_REPORT.pdf, Table 5-1 Comparison of Prevalence of Housing Units with Significant Lead-Based Paint (LBP) Hazards, by Selected Housing (HU) Characteristics between NSLAH (HUD's National Survey of Lead and Allergens in Housing, conducted in 1998-1999 (HUD, National Survey of Lead and Allergens in Housing, Volume I, Revision 7.1: Analysis of Lead Hazards. Prepared by Westat, Inc., for HUD, October 31, 2002.) and AHHS. (Note that the prevalence of LBP hazards in HUs with household incomes less than $30,000 and a child under age 6 is 22.1%, but the difference between that and the national 21.9% prevalence is not significant, so the more robust, national, statistic is used conservatively.)