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An Analysis of the EPA's Proposed Lead Hazard Standards For Homes

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Executive Summary

Exposure to lead in homes poses such large risks to children's health that reducing it is a major public health priority. To limit these risks, the Environmental Protection Agency (EPA) recently proposed national standards to identify hazardous levels of lead dust and lead in soil, as well as hazardous conditions for lead-based paint. Meeting those standards would require controls that would cost an average of thousands of dollars per home in 21 million homes where lead-based paint is present, according to the EPA.

Although the EPA believes its proposed standards reflect an appropriate balancing of benefits and costs, a proper assessment of its proposal suggests otherwise. Each of the EPA's proposed standards for paint, soil and dust would result in measures to control lead that have costs in excess of benefits. Together those costs, less the associated benefits, are likely to exceed $20 billion. Estimates of net costs would be still greater if based on an analysis that corrects remaining deficiencies in the EPA's work.

The EPA's proposal would likely increase unnecessarily the premature abandonment of housing in instances where control costs are large relative to the market value of homes. Such abandonment is especially undesirable because it will occur mostly in low-income neighborhoods of older homes. Standards with lower costs would result in less abandonment.

The EPA's media-specific, national standards would have other undesirable consequences. Perversely, about half of all the homes that do not meet the standards have risks of elevated blood-lead *less* than at other homes in full compliance with the standards. In addition, all homes built before 1978 would be subject to the *same* national standards, although exposure, risk and the cost of controls vary substantially among different households. As a consequence, the EPA's standards would result in controls in homes of more than one million middle-income families whose children face risks *lower* than the risks for children of poor families living in homes that meet the standards. Controls to reduce low risks are not likely to be cost-effective and are unfair to families facing lower risks who would bear the brunt of the control costs.

The EPA can set standards that would offer greater net benefits and avoid controls in lower-risk homes. To provide greater net benefits, the EPA should set less stringent standards based on a more careful reappraisal of the benefits and costs of controlling residential lead hazards. To avoid control measures in lower-risk homes, the EPA should set standards based on lead levels in all media and establish a range of lead levels where recommendations to control lead depend on risk factors specific to individual homes.

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Introduction

The exposure of children to lead is a serious public health problem. Elevated levels of lead in blood have been linked to a decline in intelligence as well as to a variety of neurological problems. According to a recent survey, nearly 900,000 children in the United States between one and five years of age have blood-lead levels above the level of concern established by the U.S. Centers for Disease Control.[1] Although lead-based paint was banned in 1978, it is the source of continuing exposure to children both directly and indirectly through the dust and soil that it contaminates.[2]

To address the health problem, Congress in 1992 directed the EPA to set standards that would identify hazardous levels of lead in dust and soil, as well as hazardous conditions for lead-based paint.[3] As a result, the EPA recently proposed residential lead-hazard standards that are more stringent than current guidelines and are applicable to 57 million homes where lead-based paint is present.[4] Although those standards will not be federally enforceable, the EPA expects compliance to become largely mandatory through the actions of state and local governments, mortgage lenders, insurance companies and the courts.

The EPA's choice of lead-hazard standards necessarily entails a tradeoff. More stringent standards better protect children's health, but imply that those who own homes with only moderate lead-levels would pay hundreds or thousands of dollars to control the hazards. In some cases, full remediation would cost half the value of affected homes.[5] Such high control costs could limit the supply of affordable housing in older cities.[6] Thus while lax standards may not adequately protect children's health, excessively stringent standards may impose costs that affected communities find large and burdensome relative to the value of the resulting health improvements.

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[1] See U.S. Center for Disease Control (1997).
[2] See U.S. Department of Housing and Urban Development (1990a).
[3] See Residential Lead-Based Paint Hazard Reduction Act of 1992. 1992. 42 U.S.C. § 4851.
[4] See U.S. EPA (1998b). Henceforth the Proposed Rule.
[5] See Heavens (1995).
[6] See Fraas and Lutter (1996).

Aspects of the design of the standards are also important. First, should the standards be specific for soil, paint, and dust, or should a single standard be based on a combination of lead levels in all those media? Furthermore, if there is a dust standard, should it vary according to which surfaces have an elevated dust-lead level? Second, should there be a uniform national standard, or site-specific ones? What would be the basis for any variability? Finally, what are the costs and benefits of those alternative approaches?

The EPA believes that its proposed hazard standards reflect an appropriate balancing of benefits and costs. It argues that balancing is consistent with congressional intent. In particular, after analyzing the Residential Lead-Based Paint Hazards Act of 1992 and its legislative history, the EPA concluded, "hazards standards should be based on a set of parameters identified by balancing the costs of reducing exposures to hazards with the benefits of avoiding adverse health risks."[7] The EPA's decision to set standards that balance benefits and costs gives special importance to its benefit-cost analysis.

The EPA estimated benefits and costs over fifty years, using two risk-assessment models and two different rates to discount future benefits and costs. The benefits are mostly increases in lifetime earnings associated with gains in IQ attributable to reduced lead exposure. The results of that analysis are shown in table 1. The EPA's new proposal would have negative net benefits except for the case using a 3 percent discount rate and a risk-assessment model called IEUBK.[8]

Table 1
Summary of EPA's Benefit and Cost Estimates
(Present Value, Billions of 1995 Dollars)

Discount Rate	Risk Model	Benefits ($billion)	Costs ($billion)	Net Benefits ($billion)
Three Percent	IEUBK	160.1	52.8	107.2
	Empirical	42.2	52.8	-10.6
Seven Percent	IEUBK	19.2	34.1	-14.9
	Empirical	5.2	34.1	-28.9

Source: Economic Analysis of Toxic Substances Control Act Section 403: Hazard Standards, U.S. EPA, 1998. Table 7-1a.

The EPA solicited comment on a broad range of issues related both to its analysis and its proposed standards. This comment provides a review of the EPA's analysis and the proposed

[7] See Proposed Rule, p. 30313.
[8] The IEUBK models the integrated exposure, uptake and biokinetics of lead in children.

rule, especially the extent to which the EPA's standards would succeed in balancing benefits and costs in the way the agency claims.

In this comment I show that a proper assessment of the EPA's proposed standards implies that they would have large net costs. First, the EPA's proposed paint standard would cost about $20 billion according to the EPA, but available empirical studies that account for dust-lead levels suggest deterioration of lead-based paint does not independently raise health risks. Second, the EPA's proposed standard for lead in soil would have net costs of about $2 billion, according to the EPA's empirical evidence. Third, the EPA's dust standards would impose net costs of about $700 million on approximately 2 million owners of low-risk homes. Estimates of net costs may rise above those figures if based on an analysis that corrects several deficiencies in the EPA's work.

The EPA's proposed standards are likely to increase premature abandonment of residential homes in cases where control costs are high relative to the market value of the homes. Such abandonment is especially undesirable because it will occur mostly in low-income neighborhoods of older homes. Abandonment represents an important social cost that could be mitigated by adopting a more cost-effective approach.

The EPA's media-specific, national standards have other undesirable consequences that I identify in an analysis more complete than the one the EPA conducted. First, roughly half of all the homes subject to controls have risks of elevated blood-lead *less* than at other homes in full compliance with the standards. Second, all homes built before 1978 would be subject to the *same* national standards, although exposure, risk and the cost of controlling lead vary substantially among different homes. As a result, more than one million middle-income families would have to undertake costly controls, although their children face lower risks than children of poor families living in homes that meet the standards. Controlling lead to reduce risks that are already low is generally less cost-effective than controls that reduce high risks. It is also unfair to families facing the low risks, because they would bear the brunt of the control costs.

My findings are based on a detailed examination of the EPA's risk assessment and benefit-cost analysis. Despite the sophistication of those analyses, they have a variety of flaws and deficiencies that permitted the EPA to conclude inappropriately that its proposed rule properly balances costs and benefits. I describe those flaws and deficiencies below and make recommendations to improve the EPA's analysis. Based on improvements and refinements to the

EPA's analysis that I could make, I recommend changes to the proposed standards that would yield greater net benefits.

The comment has five parts: a description of the children's health problem posed by lead and a summary of the EPA's proposal; a critique of the EPA's risk-assessment techniques and recommendations for improvements; an identification of shortcomings in the EPA's benefit-cost analysis and recommendations for improvements; an analysis of the agency's recommended standards and a proposal for better ones; and conclusions.

The Problem of Residential Lead and the EPA's Proposal

In young children – the most vulnerable population – lead has been linked to impairment of intelligence, small-muscle control, hearing, and emotional development, even at low levels where obvious symptoms are not present. In addition, children's blood-lead levels correlate with their IQ scores. In general, an increase in children's blood-lead levels of one microgram per deciliter (μg/dl) is associated with a decline of about 0.26 IQ points.[9]

Fortunately, because of federal bans on lead in gasoline and paint and controls on lead in drinking water and consumer products, blood-lead levels in children have fallen dramatically in the past fifteen years.[10] [See figures 1a and 1b for the National Health and Nutrition Examination Survey (NHANES) data.]

A continuation of the most recent trend would imply a substantial reduction in the number of cases of elevated blood-lead even if the EPA's proposed standards were never implemented. The EPA's analysis suggests that a decline in average blood-lead levels of 20 or 30 percent since the most recent survey would imply approximately a respective reduction of 48 or 66 percent in the number of children with blood-lead levels above 10 μg/dl.[11] During the three years between NHANES III Phases 1 and 2, a period several years after leaded gasoline was banned, geometric mean blood-lead levels fell by about 15 percent.[12] Thus declines of 20 to 30 percent over the six to eight years between NHANES III Phase 2 and the time of implementation of a final rule seem quite plausible. In this case the number of children with elevated blood-lead levels would be less than a half million.

[9] See Battelle (1998), henceforth designated the EPA Risk Analysis, p. 424.
[10] See Proposed Rule, p. 30305.
[11] See Battelle Memorial Institute (1998).
[12] See Pirckle et al. (1994).

Figure 1a
Percent of Children Ages 1-5 Years with Blood Lead Levels at least 10 µ g/dl

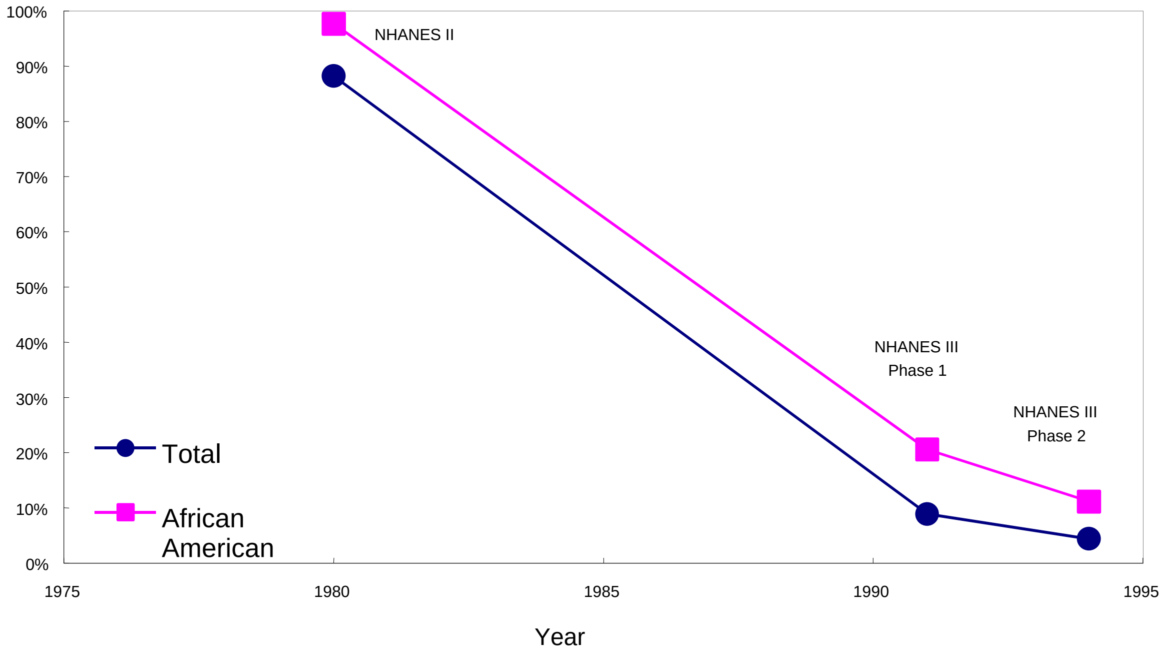
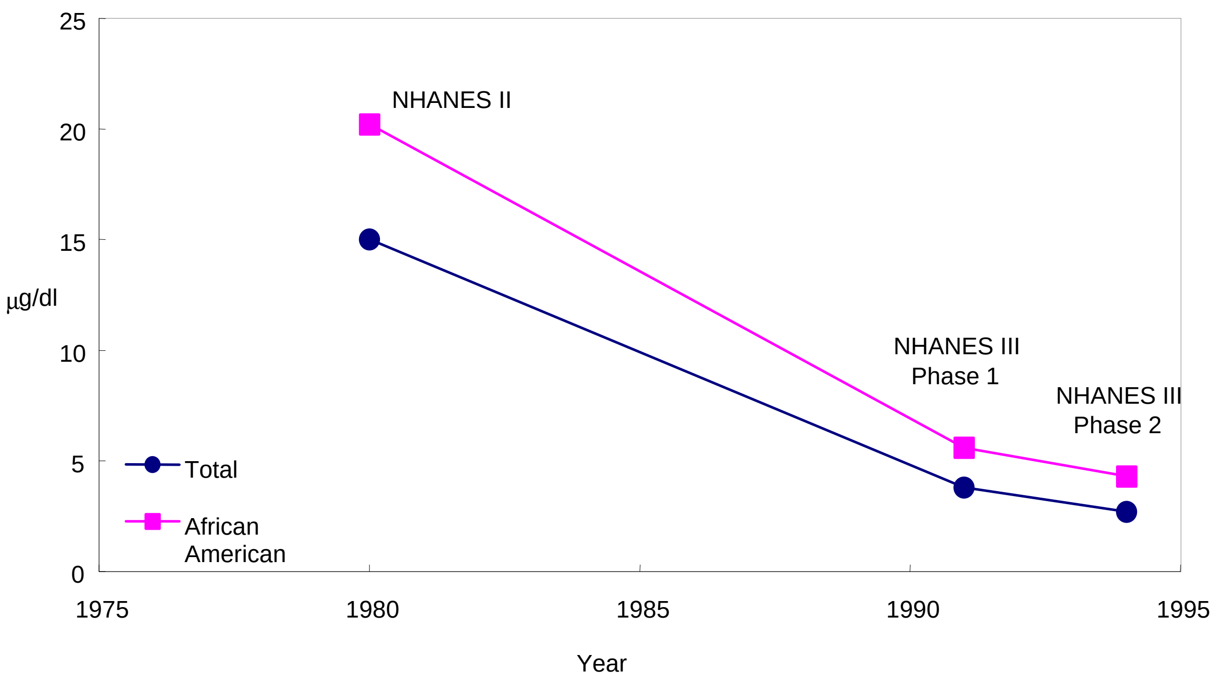


Figure 1b
Mean Blood Lead Level of Children Ages 1-5 Years (µg/dl)



Despite those improvements, African-American children between one and five years of age and children of low-income, urban families are at greater than average risk. For non-Hispanic black children one to five years of age, the mean blood-lead level was 4.3μg/dl, significantly above the mean value of 2.3 μg/dl for non-Hispanic white children.[13] The likelihood that any child between one and five years of age has blood-lead levels in excess of 10 μg/dl -- the level of health concern identified by the U.S. Centers for Disease Control -- is four times greater if the child is from a low-income, rather than a middle-income, family. [14]

Concern for those children has already resulted in significant federal regulation of lead hazards in housing. Owners are required to disclose any information about the presence of lead-based paint or lead hazards to prospective buyers or renters.[15] Professional lead-contractors must also keep records of any work and provide copies to owners.[16] Additionally, only government-certified workers may conduct inspections and abate residential lead hazards.[17] Finally, owners must provide a federally approved lead-hazard information pamphlet to prospective buyers or renters.[18]

The EPA recently proposed uniform, numerical hazard standards for lead-based paint, dust-lead and soil-lead. The standards would apply to most pre-1978 housing, as well as to other facilities occupied by children.[19] For walls, ceilings, and other large components, cracked, chipping or peeling paint would be deemed hazardous if it comprised more than 10 square feet (ft^2) of a structure's exterior, or more than 2 ft^2 of large interior components. For smaller components such as baseboards and trim, the proposed maximum amount of deteriorated paint is 10 percent of the total surface area. In addition, the proposal designates as hazardous lead dust at levels above 50 micrograms per square foot ($\mu g/ft^2$) on bare floors and above 250 $\mu g/ft^2$ on indoor windowsills. The proposed maximum amount of lead in soil is 2,000 parts per million (ppm) based on the average for an entire yard.

The EPA also proposed new clearance standards: lead levels that would have to be met before a control action or abatement could be declared complete. For lead dust, the clearance

[13] Ibid. Table 2.
[14] Ibid. Table 2.
[15] See Lead-Based Paint Poisoning Prevention in Certain Residential Structures. 1998. 40 CFR 745.107.
[16] See Ibid. p. 227.
[17] See Ibid. p. 220.
[18] See Lead-Based Paint Poisoning Prevention in Certain Residential Structures. 1998. 40 CFR 745.107.
[19] See Proposed Rule, p. 30302.

standards are 50 μg/ft^2 on bare floors, 250 μg/ft^2 on windowsills, and 800 μg/ft^2 in window troughs. The agency did not propose clearance standards for other lead media. [20]

The proposed standards are more stringent than the existing informal guidelines that identify hazard levels of 100 μg/ft^2 for bare floors, 500 μg/ft^2 for interior windowsills, and a range from 400 ppm to 5000 ppm for soil. (5000 ppm is the point at which the EPA currently strongly recommends abatement.[21])

The EPA's approach emphasized primary prevention: preemptively avoiding exposures that might raise children's blood-lead. While that approach has the clear benefit of prevention, it also has the disadvantage of requiring controls in large numbers of homes. If abatement is to reduce risks of elevated blood-lead before it occurs, abatement must be undertaken at many homes where children do not have elevated blood-lead levels. Indeed, I show below that the standards would result in abatement at 25 million homes.

The EPA data suggest that abating lead in paint, dust and soil will be expensive. For paint alone, interior abatement can run into many thousands of dollars, while exterior repair or abatement could cost tens of thousands of dollars per residence. Soil abatement can range from $2,000 to $19,000 for a single-family home. The agency estimates that a one-time abatement of dust, while relatively inexpensive, costs nearly $400 for a single-family housing unit.[22] Thus, aggregate national abatement costs could surpass a hundred billion dollars.[23]

Risk-Assessment

The EPA's two methods to predict blood-lead levels in children, the IEUBK and Empirical models, give very different estimates of risk, and therefore of benefits. The IEUBK model was developed and calibrated to predict blood-lead levels of children living at or near certain lead-contaminated Superfund sites. According to the EPA, such children live in housing where lead in soil contributes significantly to lead dust, and that lead is both easily accessible and readily absorbed. It is not clear, however, that the default parameters that the EPA selected for Superfund sites are applicable to all U.S. children.[24]

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[20] See Proposed Rule, p. 30355.
[21] See U.S. EPA (1995a).
[22] See Proposed Rule, p.30322.
[23] See U.S. HUD (1990).
[24] See Battelle Memorial Institute (1998, 5-14).

The agency's Empirical model is based on its Multimedia model, which is a epidemiological analysis of the relationship between the blood lead levels of nearly 200 children in Rochester, New York, and the levels of lead in their homes. In its Empirical model, the EPA adjusts that relationship to apply it to national survey data on lead levels, so as to develop estimates of the national distribution of children's blood-lead levels.

The sensitivity of blood-lead concentrations to increases of lead in soil and dust is not as large in the Rochester data as is predicted by the IEUBK model. The EPA notes that empirical studies rarely find relationships as strong as those predicted by the IEUBK model because factors outside the model contribute to an attenuation of the predicted relationships. Those factors include variations in how lead moves in the human body, in children's behavior, and in the extent of ground cover.[25]

The EPA's failure to provide a useful comparison or appraisal of the two models is disappointing. To make such a comparison, the EPA could apply the IEUBK model to the Rochester environmental lead levels to see whether it predicts the Rochester blood-lead levels as well as the agency's Multimedia model. The EPA could also compare its models with the recently published pooled analysis by Lanphear *et al.* (1998). Because it combines data from all comparable studies of blood-lead levels, the Lanphear *et al*. analysis is the most comprehensive empirical model currently available. Since the agency has not provided a useful comparison of its two models, the range of estimates for benefits is so large as to undercut the role of analysis in the standard-setting process.

Concerns with Both Models

Several specific flaws in the EPA's risk assessment apply to both models. By assuming that abatement would lower lead dust levels on carpets and rugs, the EPA significantly overestimates both the risk reduction and the benefits to children. The proposed standards apply only to "bare" floors, and abatement of carpeted floors and rugs through conventional techniques is unlikely to be effective and may even be infeasible.[26] Although information on the extent of

[25] See Ibid.
[26] See U.S. HUD (1990) and Proposed Rule, p.30336. See also Ewers et al. (1994).

carpeting and rugs is essential for a reliable benefits estimate, such information is not available in the NHANES survey, upon which the EPA based its national estimates.[27]

The EPA also overestimates the risk reduction and net benefits of its proposal by making optimistic assumptions about the effectiveness of soil abatement. The agency assumes that soil abatement (that is, replacement of soil) would permanently lower lead concentrations to 150 ppm. However, weather and aging will create more lead dust in those older neighborhoods where structures have been painted with lead-based paint, and lead may be transported across property boundaries. Indeed, such recontamination can raise soil-lead concentrations within a year or two of soil abatement.[28] More realistic assumptions about the effectiveness of soil abatement could lead to very different conclusions about the full cost of meeting the agency's standards, as well as to the benefits of abatement.

Further, the EPA's estimates of risk reduction depend on weakly supported assumptions about how abatement would change the distribution of blood-lead in children. Neither of the agency's models correctly predicts the number of children with elevated blood levels – that is, those reported in the NHANES survey. Thus, the EPA could not take the model estimates as nationally representative and was forced to modify the national distribution observed in the NHANES survey. The agency's modification assumes both that lead abatement has independent effects on the mean and the standard deviation of the distribution, and that those two effects are sufficient to characterize the change in the number of children with high blood-lead concentrations. The assumptions have no clear empirical basis, and a different approach may lead to different estimates.

To avoid those assumptions, the EPA could simply change its Empirical model to better predict the number of children with elevated blood-lead levels in the baseline.[29] When estimated with a geometric standard deviation of 1.9, that model comes close to replicating the numbers of children with high blood-lead observed in the NHANES study.[30]

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[27] See U.S. EPA (1995b).
[28] See U.S. EPA (1996b, 1-29).
[29] See Fraas and King (1998).
[30] See Battelle Memorial Institute (1998, 5-36). The IEUBK model, on the other hand, over-predicts the number of children with blood-lead concentrations above 10 or 20 µg/dl by factors of nearly three for the geometric standard deviation of 1.6 assumed by the EPA. Even with other assumptions about the geometric standard deviation, the over-prediction is still large, nearly a factor of two.

The EPA's Empirical Model

One key part of the EPA's Empirical model, i.e. the Multimedia model, has three significant differences from similar models in the literature. The Appendix to this paper summarizes the Multimedia model, a similar model using the same data (the Rochester Final Report) and the recently published pooled analysis by Lanphear *et al*.

First, the magnitude of the soil-lead effect in the EPA's risk-assessment is larger than in other empirical models. As shown in the Appendix, Lanphear *et al.* estimate that soil-lead concentrations have an effect on blood-lead almost five times smaller than the effect assumed in the EPA's Empirical model (0.021 instead of 0.11). The Rochester data give an estimated effect about 30 percent less than the effect in the EPA's model (0.08 instead of 0.11). Thus, the estimate of the effect of soil-lead in the EPA's Empirical model seems too high. The estimate in the IEUBK model is even greater.

Second, the EPA's Multimedia model inappropriately uses one variable that combines two distinct and different effects. Specifically, the model uses a variable defined as 0, 1, or 2, depending on compulsive behavior of eating non-food items such as paint-chips (pica) *and* the presence of deteriorated lead paint.[31] The EPA then uses the resulting estimated coefficient to generate reductions in blood-lead concentrations valued at $5 billion.[32]

But deteriorated paint by itself does not independently raise blood-lead levels, according to studies that control for levels of lead in dust. As shown in the Appendix, the Rochester Final Report shows a negative coefficient for the independent effect of interior paint deterioration on blood-lead. Similarly, Lanphear *et al.* report negative or statistically insignificant estimates of the effect of interior-paint quality and lead concentration on blood-lead.[33]

Using Rochester data courteously made available by the EPA, I modified the agency's Multimedia model by replacing the EPA's paint/pica variable with two variables: pica behavior and the presence of deteriorated paint. I find that while pica has a positive coefficient and is statistically significant, the interior-paint indicator variable has a *negative* coefficient and a t-ratio less than one. Since those variables have different effects, the Multimedia model would give better results if both variables were left separate. Such an approach would avoid the

[31] See Battelle Memorial Institute (1998, G-13).
[32] See Proposed Rule, p. 30350. The IEUBK model gives benefits of $59 billion for paint abatement.
[33] See Lanphear *et al.* (1998).

misleading conclusions that deteriorated paint independently affects blood-lead and that the lead-paint standard could generate benefits of $5 billion when lead dust is controlled.

Third, the EPA's Multimedia model is unusual in that it separates the effects of lead dust on floors from lead dust on windowsills, although both appear to have similar effects on blood-lead. In fact, both the Rochester Final Report and Lanphear *et al.* assume that those two effects are identical. Using the EPA data, I combine the measures of lead dust used by the EPA and find that the model performs nearly as well. In particular, I substitute a weighted average of the floor-lead and windowsill-lead wipe measures for the EPA's dust variables, using weights that reflect the percent of total surface areas wiped. The combined wipe measure has a statistically significant coefficient of 0.131, which is slightly less than the 0.153 that the EPA estimates. There is a slight decline -- 0.0023 -- in the R^2 associated with the use of my simplified model. Thus, there appears to be little empirical support for the notion that floor dust and windowsill dust have different effects on blood-lead.

<u>Recommendations For An Improved Risk-Assessment:</u>

- **The EPA should reassess both its IEUBK and Empirical models, based on:**
  - **a comparison of how well both the models predict the blood-lead levels observed in the Rochester study;**
  - **a comparison with the Lanphear *et al.* pooled analysis, and**
  - **adjustments to the models so that they better predict the number of children with elevated blood-lead in the baseline.**
- **The EPA should reassess its Empirical model, particularly**
  - **the basis for its prediction that deteriorated paint independently raises blood-lead when dust levels are held constant;**
  - **its estimate of the effect of soil-lead on blood-lead relative to the lower estimate in the pooled analysis, and**
  - **its assumption that floor dust and windowsill dust have separate effects on blood-lead.**
- **The EPA should avoid inappropriately assuming benefits for reducing dust on rugs and carpeted floors, unless it identifies an effective technology and proposes a standard for rugs and carpets.**

- **The EPA should use assumptions about how long soil replacement lowers lead levels that have a better empirical basis.**

Economic Analysis

In this section, I identify several shortcomings of the EPA's economic analysis: its treatment of homeowners' behavior, the possibility of premature abandonment of housing, and the discounting of future benefits.

Effects of the Rule on Homeowners' Behavior

The EPA's assumptions of how homeowners' behavior might change with the rule are completely inconsistent with economic models of behavior and with its predictions about how other institutions will respond. Although the EPA expects the proposed standards to become essentially mandatory, in its analysis it assumes that the birth of a child in target housing triggers an abatement.

The EPA's birth-trigger assumption gives estimates of net benefits that amount to a plausible upper-bound. Older children and adults are known to be less sensitive to potential residential lead hazards. Empirical studies have focused on children aged six years or younger for that reason. Yet abating homes with older children or without children is as costly as abating homes with newborns. As a result, abating lead hazards in households with older children or without children will generally result in lower net benefits than abating households where babies are expected.

The EPA's own sensitivity analysis illustrates that other assumptions more consistent with the agencies' predictions about the effects of the rule result in much lower net benefits. In an analysis assuming that real estate transactions, not births, trigger abatement, the EPA found net *costs* of $55 billion for the Empirical model and $6.3 billion for its IEUBK model.[34] Estimated net benefits were negative in that analysis because many of the control efforts are in homes with no children, or in homes with older children whose blood-lead levels are less sensitive to levels of environmental lead.

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[34] See U.S. EPA (1998a, 7-11).

In rental housing, compliance may be more rapid – and costs therefore greater than under the assumption that real estate transactions trigger abatement. Under the proposed rule, 24 million rental units will face standards that are essentially mandatory. [35] The EPA "…expects that public and private institutions may incorporate the standards into State and local laws, housing codes, and lending and insurance standards."[36] Elsewhere, the EPA states "…these standards will become part of Federal mortgage programs administered through HUD. In addition, it is likely that an indirect legal enforcement mechanism will develop through the threat of legal liability. Furthermore, mortgage lenders are likely to be more hesitant to fund property acquisitions if those properties exceed the section 403 standards."[37] If those expectations are realized, rental housing is likely to be in full compliance with the rule within a few years of promulgation. Thus an appropriate modeling assumption for rental housing would be full compliance within a few years of promulgation.

Effects on Housing Supply and Abandonment

The EPA concluded that the impact of the new rules on housing supply will be insignificant. That conclusion is based on an analysis with four serious deficiencies.[38]

- The EPA assumes that births trigger abatement. As explained above, impacts would be better estimated by assuming that compliance is triggered by promulgation of the rule, at least for landlords.
- The EPA assumes that all units will incur average abatement costs. In fact, abatement costs will vary among different homes. Some rental units that generate a low return may face abatement costs far above average. Such units are especially likely to be abandoned.
- The EPA uses the *Property Owners and Managers Survey*, which excludes two-family, owner-occupied dwellings, to form its conclusions. [39] That type of housing, however, is the dominant residential structure in large portions of northeastern cities like Rochester and Buffalo, New York.

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[35] See U.S. HUD (1990).
[36] See Proposed Rule, p. 30304.
[37] See U.S. EPA (1998a, 7-11).
[38] Ibid. p. 8-5.
[39] See U.S. Census Bureau (1998).

- The EPA assumes that no multifamily units will incur soil abatement costs. That appears inconsistent with other parts of the agency's cost analysis and is implausible, especially if the standards become effectively mandatory.

An alternative analysis that remedies those deficiencies is likely to reach substantially different conclusions. For example, the effect of mandatory abatement on housing supply could be quite significant. Fraas and Lutter estimated that effect by assuming that regulatory costs needed to comply with lead standards have the same effect on abandonment as property taxes.[40] Using that approach they estimated that total incremental abandonment could be as high as 2 million units over ten years.

The abatement costs projected by the EPA are close enough to those assumed by Fraas and Lutter to suggest the authors' broad argument is correct. In particular, the Fraas and Lutter analysis assumed average abatement-costs of about $2800. The EPA's current analysis suggests that expected abatement costs to meet the proposed standards are approximately $2000 for non-Hispanic whites and $1400 for African-Americans, who are more likely to live in smaller multifamily housing units that are less costly to abate.[41] Thus there is a risk of significant abandonment if the EPA's standards were to become mandatory.

Discount Rates

The EPA's preferred discount rate is lower than it has used in the past. In its 1997 report to Congress, *The Benefits and Costs of the Clean Air Act*, the agency used a rate of 5 percent, as recommended by its Science Advisory Board, to discount costs and benefits.[42] Reduced lead exposure, the subject of the current analysis, was an important category of benefits in that report. In its current economic analysis, however, the agency uses a 3 percent rate and is silent on whether the proposed hazard standards would pass a benefit-cost test at the previous, higher rate. The agency does report, however, that net benefits are negative assuming a 7 percent discount rate. Since the key category of monetized benefits, the value of lifetime earnings, is fairly

[40] See Fraas and Lutter (1996).
[41] See U.S. EPA (1998).
[42] See U.S. EPA (1997a).

sensitive to assumptions about the discount rate, it is quite possible that the EPA's estimated net benefits would become negative at a 5 percent discount rate.

<u>Recommendations for an Improved Benefit-Cost Analysis:</u>

- **The EPA should develop an analysis that acknowledges that compliance will become effectively mandatory for landlords upon promulgation of the final rule. For owner-occupied homes, the agency should place much greater emphasis on the estimates it developed assuming that real-estate transactions trigger control actions.[43]**
- **The EPA should perform a complete analysis of the potential for adverse effects on the supply of affordable housing if state and local governments, lenders, insurers, and the courts adopted the standards. In particular, the agency should examine abandonment of housing in older, urban, low-income neighborhoods where control costs are a significant fraction of real-estate values.**
- **The EPA's analysis should use the 5 percent discount rate that its own Science Advisory Board recommended for use in its recent report to Congress on the Clean Air Act.**

<u>Standard Setting</u>

In this section I develop recommendations for residential lead-hazard standards. First I discuss soil standards, dust standards, and paint standards separately. Then I propose an alternative approach that reflects exposure and risk better than the EPA proposal and preserves homeowner discretion by using ranges rather than uniform numeric levels.

Soil

The EPA's proposed standard of 2000 ppm for lead in soil fails an empirically based benefit-cost test. Although the agency's IEUBK model indicates that a standard of 2000 ppm would offer net benefits at a 3 percent discount rate, its Empirical model indicates that tightening the soil standard from 5000 ppm to 2000 ppm imposes net costs of $2 billion.[44] Soil abatement

[43] See U.S. EPA (1998, 7-11).
[44] See Proposed Rule, Table 11, p. 30327. This table is superior to Table 7 on p.30325. Table 7, which appears to give a different result, inappropriately excludes the benefits of abating dust in homes that do not meet the soil standard.

would make even less economic sense using the smaller effect of soil-lead on blood-lead levels estimated by Lanphear *et al*. Finally, soil abatement may be less effective than the EPA assumes, because lead in neighboring areas and lead-based paint on nearby structures contribute to recontamination relatively soon after abatement.[45] If some recontamination occurs, then the cost-effectiveness of soil abatement may deteriorate substantially. On the basis of those empirical data, soil-lead hazard standards more stringent than the current guideline of 5000 ppm are inappropriate, although more-stringent standards in play areas may merit further consideration.

Dust

The EPA's proposal to set standards for dust on bare floors, but not on carpets or rugs, could have undesirable and unintended consequences. In houses with similar risk levels, abatement would depend on whether all rooms were carpeted. In fact, however, carpeted and uncarpeted floors have similar effects on blood-lead levels. The Rochester data, the Lanphear *et al*. pooled analysis, and even the EPA's own Multimedia model, all estimate the effect of lead dust on blood-lead by assuming lead levels on carpeted and bare floors can be averaged. The Rochester Final Report presents estimates of the probability of elevated blood-lead for different lead-dust levels that are very similar for carpeted floors and bare floors.[46]

There is no agreement on how to remove lead from existing carpets and rugs. Even the EPA stated that it did not have "adequate data on the effectiveness of carpet cleaning that would be needed to establish a dust clearance level for carpeted floors."[47] Indeed, one EPA report states: "Repeated vacuuming of old, contaminated carpets may increase lead-loading in surface dust if deeply embedded dust cannot be removed in its entirety. For such carpets, it may be better to remove them than to decontaminate them."[48] But if carpet is removed, it will cost about $1.50 per square foot to replace, in addition to the cost of vacating rooms.[49] Carpet replacement is an effective but costly form of reducing lead exposure.

The EPA could develop a standard that includes carpeted floors, based on the benefits and costs of known abatement technologies including replacement. Although the high costs of

[45] See U.S. EPA (1996b).
[46] See University of Rochester School of Medicine (1995, Figure 7).
[47] See Proposed Rule, p. 30336.
[48] See Battelle Memorial Institute (1997, viii).
[49] Personal communications by Beth Mader with various carpet installers in Washington, DC, January and March 1999.

abating carpeting may lead to a less-stringent dust standard, such an approach would better communicate risks and avoid wasteful unintended consequences, including exposure to lead dust.

Paint

The EPA bases its proposed paint standards on guidelines promulgated by the U.S. Department of Housing and Urban Development, not on data that relate the extent of deterioration to blood-lead concentrations.[50] Indeed, data that might identify such a relationship actually show that interior paint has no independent effect on expected blood-lead levels when dust levels are held constant (see the Appendix.) Thus, the paint-hazard standard proposed by the EPA -- which under the statute should represent conditions of deteriorated lead-based paint that result in adverse human health effects -- lacks a credible empirical basis.

Given that lack of empirical evidence, paint abatement is not a cost-effective way to reduce blood-lead levels, provided that lead dust is adequately controlled. Moreover, as a means of primary prevention, paint abatement may need to be conducted in a hundred homes to protect only a few children who eat paint chips.

The EPA estimated costs of $20 billion to meet the paint standard. That estimate amounts to nearly 40 percent of the total costs of the proposal.[51] Given that lead-dust is controlled, incurring the costs of $20 billion to meet the paint standard may provide negligible benefits.

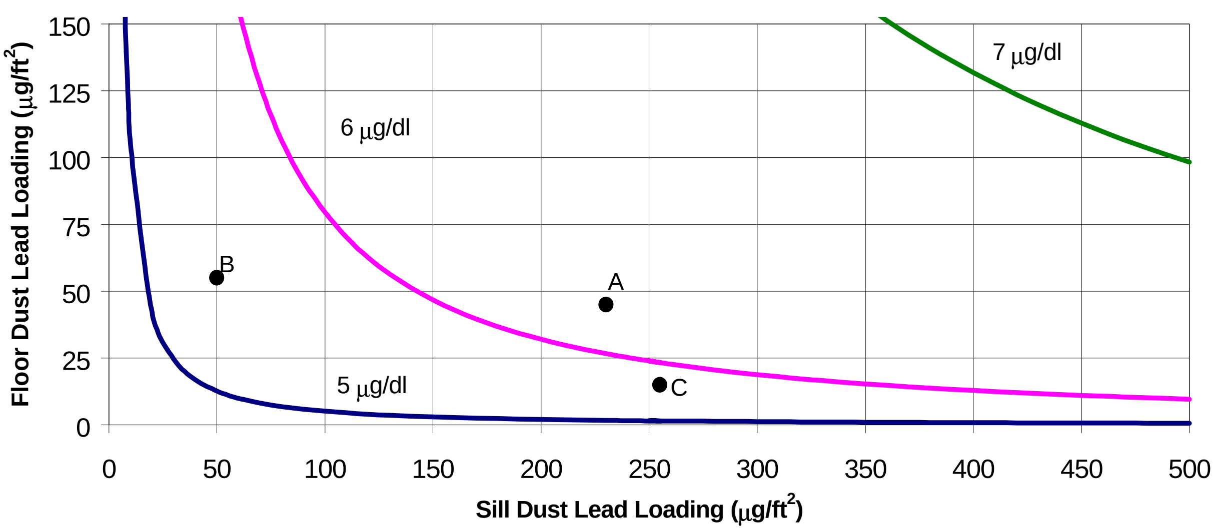
Joint Standards with Ranges: A Better Approach

The EPA's proposed lead standards have two undesirable and avoidable ramifications. First, they would result in abatement at millions of homes where expected blood-lead levels are lower than in other homes that meet the hazard levels. Second, they treat identically all target homes, even when exposure, risk and abatement-costs differ. After describing why those consequences are undesirable, I explain how an alternative approach based on joint standards with ranges is better.

[50] See Proposed Rule, p. 30330.
[51] See Proposed Rule, p. 30350 and U.S. EPA (1998a, Table 7-1a).

The EPA’s standards, because they specify limits to lead levels in media that independently affect blood lead, would perversely require abatement in some homes that actually have lower risk than other homes that meet the standards. To illustrate: *any* home with lead levels slightly above the standard in one medium, for example dust, and substantially below the standard in another medium, for example soil dust, would be subject to abatement of the medium with high lead-levels, regardless of actual risk. To illustrate further, I graph in figure 2 the combinations of lead dust on floors and sills that give expected blood-lead levels of 5, 6, and 7 μg/dl, assuming soil-lead equals 400 ppm. I also show in figure 2 the dust levels at three hypothetical homes. Home A has lead levels that just meet the standards; a child in that home would have a predicted blood-lead level of 6.2 μg/dl according to the EPA’s Multimedia model.

Figure 2
Expected Blood Lead Levels for Different Floor and Windowsill Dust Lead Loadings at Soil Lead Concentration of 400 ppm



Source: EPA's multimedia model, with paint-pica interaction set to zero.

In homes B and C, predicted blood-lead levels are 5.6 and 5.8 respectively, and risks are lower. Under the EPA’s standards, however, homes B and C would be subject to abatement, while home A, with higher risk, would not.

Such occurrences would be commonplace. Using the EPA’s own Empirical model, I estimate between 12 million and 16 million homes violate at least one proposed hazard standard and have expected blood-lead levels less than homes that meet the proposed standard.[52] (An estimate of 12.3 million is the lowest I find for the set of assumptions that I examined.[53] Less conservative assumptions generate somewhat higher estimates.) The 12 to 16 million lower-risk homes represent approximately half of all homes subject to abatement. Using the same assumptions that led to the estimate of 12 million cited earlier, I calculate that a total of 27 the number of homes subject to abatement is larger than the 21 million homes estimated in the EPA's preferred analysis.[54] Those estimates are not strictly comparable because the EPA assumed that the birth of a child would trigger abatement. I instead simply count homes that do not attain the standards.

For many of those homes subject to abatement, the risk of elevated blood-lead is quite small. To show how the risk of elevated blood-lead differs among those homes, I first use the EPA's Empirical model to estimate for all homes the probability that blood-lead levels exceed 10 μg/dl.[55] At homes that "just" meet the standard, that risk is 0.097. For all homes that do not meet the standards I estimate risk relative to that risk estimate and then construct a cumulative probability distribution. That distribution, shown in figure 3, indicates that roughly half of all the homes that do not meet the standards have lower risk than homes that just meet the standards. In addition, it implies that about 25 percent or six million of the homes that do not meet the standards have risk only half as high as some homes that meet the standards. Moreover, some homes that do not meet the proposed standards have risk levels only a fifth as high as homes that meet the standards. Thus the EPA's approach would result in abatement in homes much safer than homes that meet the hazard standards.

Abatement of dust-lead hazards in many of those lower-risk homes is substantially less cost-effective than in other homes and would apparently fail a benefit-cost test. As shown in figure 4 below, ten homes in the National Survey have expected blood-lead levels less than

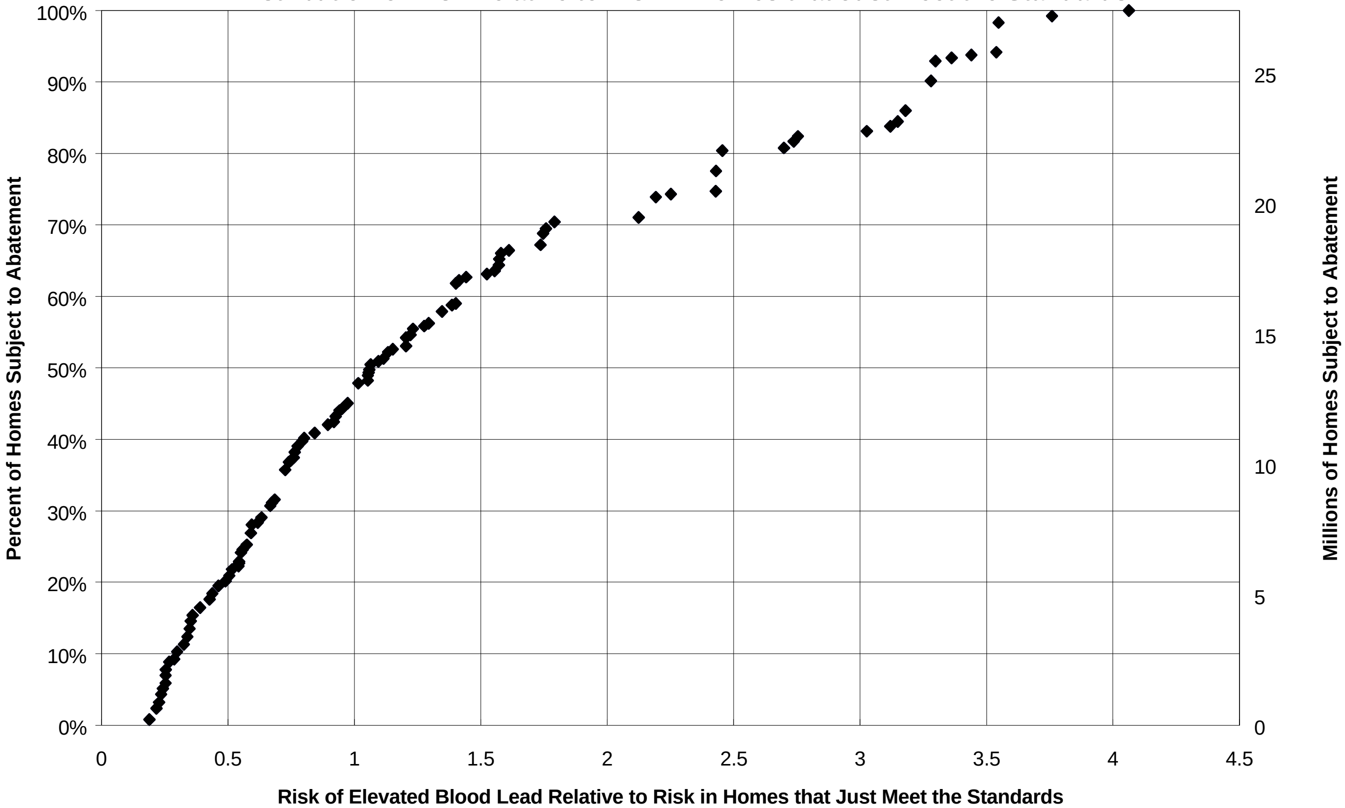
[52] I derive that estimate by using the EPA's Empirical model to predict blood-lead levels for the homes from the National Housing Survey listed in the EPA's table C1-7. It relies on EPA's model and may be sensitive to its underlying assumptions, including the form of the model. I make simplifying assumptions because the National Survey data do not correspond to the form of the standard. In particular, the survey does not identify the condition of paint on each painted surface.

[53] The estimate of 12 million homes assumes that *any* deteriorated paint indoors or outdoors means noncompliance with the standard, and that the pica variable in the Empirical model takes on a value of 1.5, as suggested by the EPA's table G.4, if any deteriorated lead-based paint is present.

[54] See U.S. EPA (1998a).

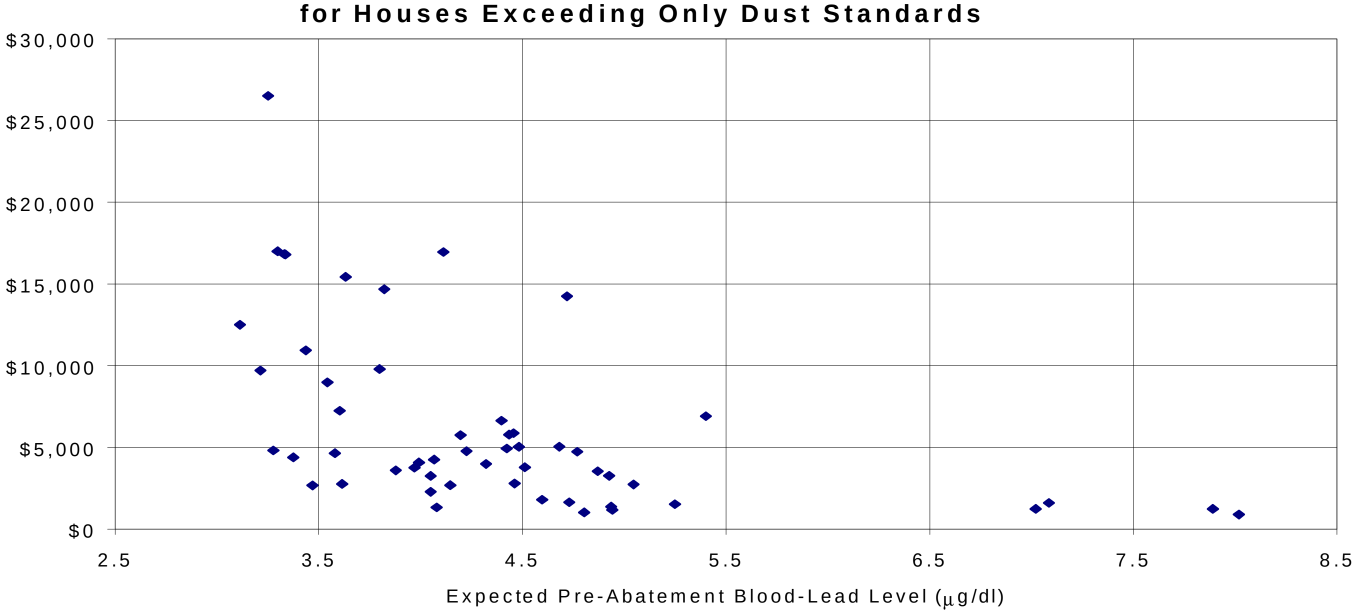
[55] To estimate that risk I calculate the probability that blood-lead exceeds 10 μg/dl, given the expected blood lead level implied by the different environmental lead levels, and a lognormal distribution with variance equal to 0.313 (as given by Table 4.3 of Battelle Memorial Institute 1998s).

Figure 3
Risk of Elevated Blood Lead in Homes Subject to Abatement
Distribution of Risk Relative to Risk in Homes that Just Meet the Standards



Note: Risk of elevated blood lead is calculated as the probability that blood lead exceeds 10μg/dl using the EPA's Empirical Model. Risk estimates are normalized by dividing by the maximum risk among the homes in the National Survey that meet the standard.

Figure 4
Abatement Cost Per IQ Point Gained
for Houses Exceeding Only Dust Standards



Note: Those estimates exclude costs associated with inspections and risk assessments.

4.5 μg/dl and would incur very high abatement costs per unit-gain in IQ. Abatements at those ten sampled homes, which represent 2 million actual homes, would entail costs of approximately $10,000 or more per IQ point gained, assuming abatements occur prior to the birth of a child.[56] The total cost of such abatements would be $1.1 billion if they occurred today. Valuing the resulting IQ gains at the EPA's preferred estimate of $8,300 (an estimate reflecting the effect of IQ on lifetime earnings and not a family's willingness to pay, which could be higher) implies benefits of $400 million. Thus the EPA's proposed standards, by leading to dust abatements among such low-risk homes, would raise the net cost of abating lead hazards by about $700 million, using the EPA's assumption that births trigger abatements.

The second major undesirable implication of the EPA's approach is that it would subject all homes to a set of single standards, although such uniform standards cannot be ideal for families that differ in terms of their risk and the cost of compliance. Indeed, risks to children vary for reasons apparently unrelated to measurable levels of environmental lead. The studies summarized in the Appendix show that risk factors that significantly predict blood lead levels in young children, even when environmental lead levels are held constant, include race, family income, having only one parent, and lead in drinking water. Risk also varies with age; for example, teen-age children are at less risk from environmental lead. Families also face different costs of abating lead hazards because of the design and construction of their homes and yards. Families that face lower risks or higher costs of abating lead may quite rationally decide to control lead hazards less than other families. The EPA's approach ignores that fact.

To assess the implications of the EPA's uniform standard I use an indirect approach because I have incomplete data about how risk and abatement costs vary among households. I estimate how many of the homes that violate one of the proposed standards have risk less than other homes that meet the standards only because of differences in risk factors specific to the family.

Risk factors unrelated to environmental lead can raise expected blood-lead levels by about 12 percent. For example, Lanphear *et al.* indicate that non-white children have blood-lead levels about 12 percent higher than whites, when socioeconomic status and environmental lead are held constant.[57] His results also imply that children of families at the lowest socioeconomic

[56] Following the EPA's methods, I include half the cost of a second abatement because the abatements are assumed effective for four years, while the child is at risk for six years.
[57] See Lanphear *et al.* (1998, Table 7).

level have blood-lead levels about 12 percent greater than children of families at the middle socioeconomic level, if race and environmental lead are held constant. Similarly, the Rochester Final Report estimates that children in single parent households have expected blood-lead levels 8 to 10 percent higher than other children, if environmental lead levels and race, but not income, are held constant.

In addition, risk factors unrelated to environmental lead imply that families residing in more than a million homes that violate one of the proposed standards have risk *lower* than other families residing in homes that meet the standards. Using the same assumptions that I used to estimate that 12.3 million lower-risk homes would be subject to abatement, I find that 4.6 million homes have expected blood-lead levels moderately (less than 12 percent) above the levels found in homes that meet the standards. With the alternative assumptions that imply 15.8 million lower-risk homes are subject to abatement, I find that 2.1 million homes have expected blood-lead levels within 12 percent of the levels projected for homes that meet the standards. Suppose that half of those families were middle- or high-income. Then more than a million families residing in homes that violate the proposed standards would face risks lower than families in homes that meet the standards.

The uniformity of the EPA's proposed standards causes those perverse effects. The EPA's approach would fit one size to all. Yet different abatement decisions will be appropriate for different families. The EPA's uniform standards, by treating different homes identically, will divert scarce abatement resources into homes occupied by families with lower risk.

The informal guidelines that the EPA's proposal would replace provide the basis for an alternative approach. Those guidelines specify a range of 400 ppm to 5000 ppm for lead in soil. Within that range, abatement was recommended according to "likelihood of children's exposure."[58] Thus, the EPA has explicitly acknowledged the legitimacy of site-specific information in making abatement decisions.

I illustrate an alternative approach based on joint standards with a range in figure 5. (The figure is a modification of one the EPA presented in its proposal.[59]) Each point in the diagram represents a different combination of environmental lead, such as 1000 ppm in soil and 100

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[58] See US EPA (1995a).
[59] See Proposed Rule, . p.30308.

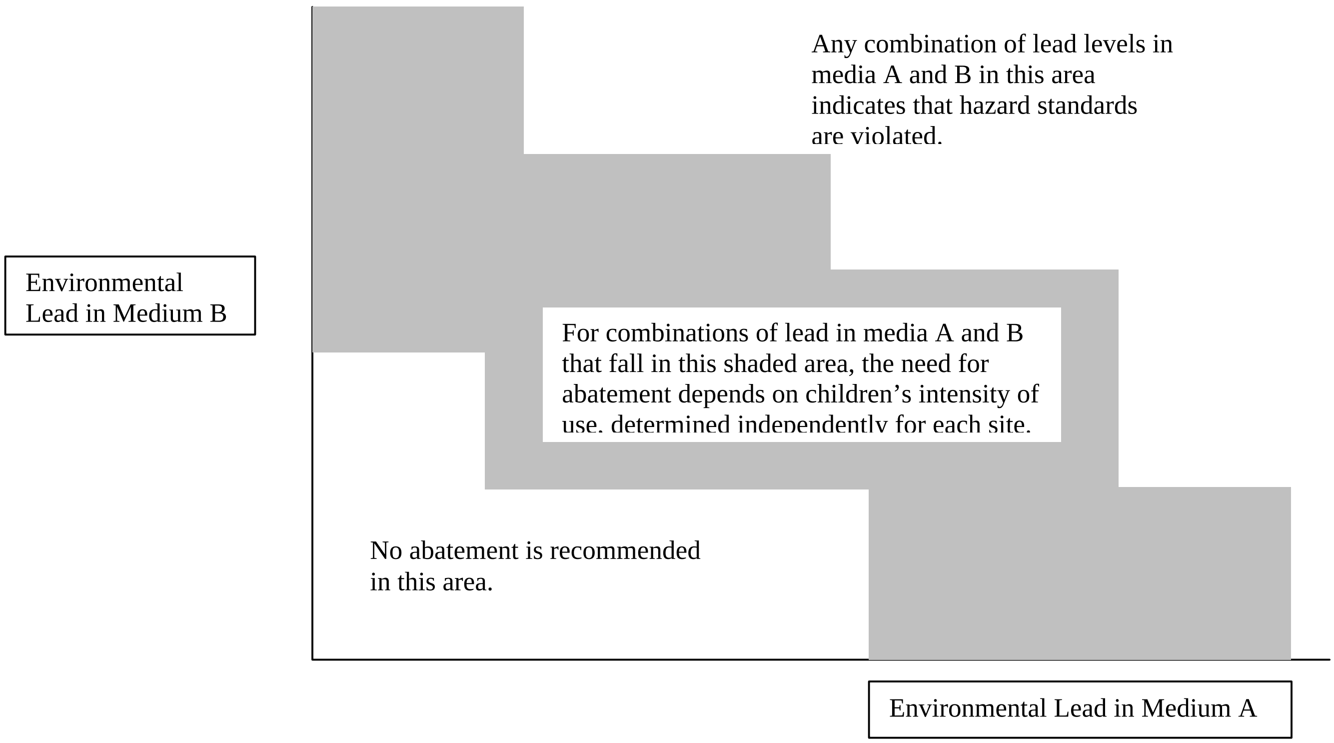
μg/ft^2 in dust. The figure groups homes into three categories depending on lead levels in both media. Homes with high lead levels, that is, homes above and to the right of the shaded area, would violate the lead hazard standards. Homes with medium lead levels, that is, homes in the shaded area, would face a recommendation by the EPA to take site-specific abatement measures. Finally, for homes with low lead levels, that is, those below and to the left of the shaded area, the EPA would not recommend any abatement action.

Joint standards with ranges would be a significant improvement over the EPA's proposal. They could substantially decrease the likelihood that, between any two homes, the one with greater predicted blood-lead would be treated more leniently. Further, focussing abatement efforts where risk is greater is likely to be more cost-effective. In addition, recognizing the appropriateness of site-specific information helps match risk with the intensity of recommended abatement.

The EPA's assertion that joint standards are "far less workable" than media-specific standards does not stand up to scrutiny.[60] First, the agency's argument that media-specific standards are more readily used as a basis for setting priorities misses the key point. Media-specific standards do not assign abatement priorities according to risk and in fact would result in abatements at many lower-risk homes. Second, the concern that joint standards are too hard to understand also seems overstated. Even a sophisticated version of figure 5 should be understandable to homeowners who manage to pay mortgages and property taxes. Finally, joint standards could be workable even though some homeowners will not sample all media. For lead dust, risk assessors are already required to sample both sills and floors in areas where children are most likely to be exposed.[61] For homeowners who know lead-levels in dust but not soil, the EPA could also establish dust-specific standards, while reserving the joint dust-soil standards for cases where dust and soil levels are known. Thus, there are no insurmountable technical difficulties to implementing joint standards.

[60] See Proposed Rule, p. 30309.
[61] See CFR 40 745.227 (c) (ii)(B)(iv and v)

Figure 5
An Alternative Approach



A determination of compliance based on data from multiple media would not appear to add significantly to the costs of the rule. Assessment of lead levels already requires computer analysis. Existing regulations already require trained and certified assessors and inspectors.[62] The incremental costs of applying a more complicated algorithm to determine compliance appear to be quite small relative to the costs of inspection, risk-assessment, and abatement.

<u>Recommendations for Improved Standards</u>

- **The EPA should analyze and adopt standards that are based on lead levels in all media and incorporate a range where the intensity of lead controls is at the discretion of homeowners, according to likelihood of exposure and risk.**
- **The standards should cover dust on windowsills and all flooring based on available evidence of risk, as well as on realistic estimates of the cost and effectiveness of control methods evaluated in field trials.**

- **The EPA should not promulgate a soil-hazard standard for yard-wide average concentrations that is more stringent than 5000 ppm.**
- **The EPA should not promulgate a separate paint-hazard standard without evidence that deteriorated paint would result in adverse human health effects when dust levels are controlled.**

Conclusions

The EPA's proposed lead hazard standards would impose billions of dollars in unnecessary costs on homeowners. Available empirical evidence suggests that unnecessary quantifiable net costs of up to $20 billion for paint, $2 billion for soil, and $700 million for dust may result from the EPA's proposed standards. Those estimates suffer, however, from a variety of deficiencies. Better estimates of net costs would likely be higher. The EPA should reassess the benefits and costs of abating residential lead and set standards that give the highest possible net benefits.

The EPA's standards are likely to result in premature abandonment of residential homes in instances where abatement costs are high relative to the market value of the homes. Such abandonment is especially undesirable because it will be concentrated in neighborhoods where low-income families occupy older homes. The EPA has not considered such abandonment in setting lead hazard standards, although it represents an important social cost that could be mitigated by adopting a more cost-effective approach.

The agency's approach would perversely result in abatement in roughly 12 to 16 million lower-risk homes and in millions of other homes with only slightly elevated risks. At least a million of the families occupying these homes are likely to have lower risk because of family-specific risk factors.

Different standards could avoid those undesirable effects. The EPA should adopt joint standards based on lead levels in all media and should specify ranges of lead levels within which homeowners would have discretion to control lead according to the risk factors of individual households.

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[62] See CFR 40 745.226

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Appendix

A Comparison of the EPA's Multimedia Model, the Rochester Model, and a Pooled Analysis

The EPA Multimedia Model[63]		Rochester Model[64]			Pooled Analysis[65] Lanphear *et al.*	
Variables	Coefficients and (95 percent confidence intervals)	Variables	Coefficients and (95 percent confidence intervals)		Variables	Coefficients and (p values)
			Simple Model	Full Model		
Intercept	.418 (-.062 to .898)	Intercept	NA	NA	Intercept	1.496
Logarithm of (area-weighted arithmetic mean (wipe) dust-lead loading from any floor)	.066 (-.014 to .146)	Average log of dust-lead loading through wipe samples for all surfaces	.18 (.11 to .24)	.20 (.12 to .28)	Logarithm of lead dust loading through wipe samples	.183 (<.0001)
Logarithm of (area-weighted arithmetic mean (wipe) dust-lead loading from windowsills)	.087 (.015 to .159)					
Dripline soil-lead concentration (fine soil fraction)	.114 (.044 to .184)	Dripline soil-lead (coarse soil fraction)	NA	.08 (.02 to .14)	Lead concentration in soil or exterior dust	.02116 (.0025)
Indicator of interior paint/pica for paint	.248 (.048 to .448)	Pica for either dirt or paint	.13 (.06 to .21)	.10 (.03 to .17)	Pica variables were included and found to be statistically significant.	
		Interior paint lead	NA	-.06 (-.13 to .01)	Paint condition	-.0808 (.1685)
		Soil present	NA	-.21 (.42 to .006)	NA	
		Water lead	NA	.07 (.001 to .13)	Water lead	.01398 (.2067)
		Ferritin	.12 (-.02 to .26)	.10 (-.03 to .23)	NA	
		Black	.16 (.08 to .24)	.14 (.06 to .22)	Non-white	.123 (.0079)
		Single parent	.10 (.02 to .18)	.08 (.01 to .15)	Socioeconomic status was included and found to be statistically significant.	
Sample size	178	Sample Size	NA	NA	Sample size	NA
R-Squared	0.2167	R-Squared	NA	NA	R-Squared	NA

63 See EPA Risk Analysis, p.G33.
64 See Rochester Final Report, tables 22 and 25.
65 See Lanphear *et al.*(1998).